NILU report 19/2024

Monitoring of long-range transported air pollutants in Norway

Annual Report 2023

nilu

NILU report 19/2024

Monitoring of long-range transported air pollutants in Norway

Annual Report 2023

Wenche Aas, Sabine Eckhardt, Nikolaos Evangeliou, Anne-Gunn Hjellbrekke, Stephen Platt, Sverre Solberg, and Karl Espen Yttri

NILU report 19/2024

ISBN 978-82-425-3164-3
ISSN 2464-3327

Norwegian Environment Agency M-2799 | 2024

Main office
NILU
P.O. Box 100
NO-2027 Kjeller, Norway

Tromsø
NILU
Framsenteret
P.O. Box 6606
Stakkevollan
NO-9296 Tromsø,
Norway

Trondheim
NILU
Kjøpmannsgata 8
NO-7013 Trondheim,
Norway

Phone 63 89 80 00
nilu@nilu.no
www.nilu.no

Stiftelsen NILU
Org.no. 941 705 561

ISO Certifications:
NS-EN ISO 9001
NS-EN ISO 14001

Accreditation:
NS-EN ISO/IEC 17025

Gothenburg
NILU Klimat- och
miljöinstitutet AB
Sven Hultins gata 5
SE-412 58 Gothenburg,
Sweden

Org.no. 559442-9580
www.nilu-research.se

Cover picture:
Source: NILU

Title
Monitoring of long range transported air pollutants in Norway
Annual Report 2023

Norwegian title
Overvåking av langtransportert forurenset luft og nedbør. Atmosfæriske tilførsler 2023.

Authors(s)
Wenche Aas, Sabine Eckhardt, Nikolaos Evangeliou, Anne-Gunn Hjellbrekke, Stephen Platt, Sverre Solberg, and Karl Espen Yttri

Short summary (English)
This report presents results from the monitoring of atmospheric composition and deposition of air pollution in 2023, and focuses on main components in air and precipitation, particulate and gaseous phase of inorganic constituents, particulate carbonaceous matter, ground level ozone and particulate matter. The level of pollution in 2023 was generally low though a few episodes occurred. There was an increase in the PM levels in southern Norway during June, caused by a mixture of sources, including emissions from wildfires in Canada.

Short summary (Norwegian)
Denne rapporten omhandler resultater fra overvåkningsprogrammet for langtransportert forurenset luft og nedbør og atmosfæriske tilførsler i 2023. Rapporten presenterer målinger av uorganiske hovedkomponentene i luft og nedbør, partikulært karbonholdig materiale, partikkelmasse og bakkenært ozon. Forurensningsnivået i 2023 var generelt lavt, men med noen høye episoder. Det var en økning i PM-nivåene i Sør-Norge i juni som skyldes bidrag fra flere kilder, inkludert utslipp fra skogbranner i Canada.

Keywords
Atmosphere and climate, Aerosols and particles, Ground level ozone, Acid rain and eutrophication
Atmosfære og klima, Aerosoler og partikler, Bakkenært ozon, Sur nedbør og overgjødsling

Number of pages 81	**Classification** A – Unclassified (open report)
Proejct leader Wenche Aas	**NILU project no.** O-121002 LANGTR.
Report prepared for: The Norwegian Environment Agency, P.O. Box 5672 Torgarden, N-7485 Trondheim	**Contract ref.:** 21087006
Signature of responsible person Aasmund Fahre Vik, Deputy Director	**Date** 10.06.2024

Citation:
Aas, W., Eckhardt, S., Evangeliou N., Hjellbrekke, A.-G., Platt, S., Solberg, S., Yttri, K.E. (2024). Monitoring of long-range transported air pollutants in Norway. Annual Report 2023. (NILU report 19/2024). Kjeller: NILU.

Contents

Summary

The monitoring program for long-range transboundary air pollutants, presented in this report, includes measurements of inorganic- and organic compounds, particles, and ground-level ozone. The main purpose is to quantify levels of pollutants and document any changes in atmospheric input, which is important for evaluating the effect of air pollution on ecosystems, health, materials, and climate. This report provides an overview of the pollution levels at Norwegian background stations in 2023 and compares these with changes over time. The main findings in the report are:

- Several components have a clear South-North gradient strongly influenced by long-range transport (LRT) from the European continent.
- In 2023, PM levels in Norway remained low, with no violation of limit values. However, there was an increase in PM levels in southern Norway in June, with monthly means ranging from 6.0 to 8.1 µg/m^3 for PM_{10} and 4.1 to 5.0 µg/m^3 for $PM_{2.5}$. The chemical composition reveals a mixture of sources, predominantly comprising carbonaceous aerosols of both natural and anthropogenic origin, including emissions from wildfires in Canada.
- There were two episodes with high concentrations of SO_2 in 2023. One in April at Zeppelin caused by emissions in Russia, and one in December observed at several sites at the mainland caused by volcanic eruptions in Iceland.
- 2023 was a year without marked ozone episodes in Norway. The highest measured hourly concentration was 135 µg/m^3 at Sandve in September. This is similar to the peak levels seen in recent years without marked episodes. Although the peak levels were low, limit values set by the EU, WHO, UN-ECE and FHI were broken in 2023.
- There has been a clear reduction in observed concentrations for most of the components in the last 20 years, in line with the emission reductions in Europe. There are also decreasing trends from 2010, but with substantial variations between the sites and components.

Sammendrag

Overvåkingsprogrammet for langtransporterte luftforurensninger, som presenteres i denne rapporten, omhandler målinger av uorganiske- og organiske forbindelser, partikler og bakkenært ozon. Hovedmålet er å kvantifisere nivåene og dokumentere eventuelle endringer i atmosfærisk tilførsel, noe som er viktig for å kunne evaluere luftforurensningenes effekt på økosystem, helse, materialer og klima. Denne rapporten gir en oversikt over forurensingsnivået på norske bakgrunnsstasjoner i 2023 og sammenligner disse med utvikling over tid. Hovedfunnene i rapporten er:

- De fleste komponentene har en sør-nord-gradient. Dette skyldes både nærheten til kontinentet og at en del av forurensningen fra kontinentet avsettes på vei nordover.
- PM-nivået i 2023 var lavt, uten brudd på grenseverdier. Det var en økning i PM-nivåene i Sør-Norge i juni, med månedsmidler på 6,0 til 8,1 µg/m^3 for PM_{10} og 4,1 til 5,0 µg/m^3 for $PM_{2.5}$. Den kjemiske sammensetningen viste et bidrag av partikler fra flere kilder dominert av karbonpartikler av både naturlig og antropogent opphav, inkludert utslipp fra skogbranner i Canada.
- Det var to episoder med høye konsentrasjoner av SO_2 i 2023. En i april på Zeppelin forårsaket av utslipp i Russland, og en i desember observert på flere steder på fastlandet og skyldes vulkanutbrudd på Island.
- 2023 var et år uten markerte ozonepisoder i Norge. Høyeste målte timekonsentrasjon var 135 µg/m^3 på Sandve i september og nest høyeste var 133 µg/m^3 på Prestebakke i mai. Disse nivåene tilsvarer toppnivåene de siste årene uten markerte episoder. Selv om toppnivåene var lave i 2023, ble grenseverdier satt av EU, WHO, UN-ECE og FHI brutt.
- Det er en klar reduksjon i observerte konsentrasjoner for de fleste av komponentene de siste 20 årene, i tråd med utslippsreduksjonene i Europa. Det er også avtagende trender fra 2010, men det er stor variasjon mellom stasjoner og komponenter.

Monitoring of long-range transported air pollutants in Norway
Annual Report 2023

1 The monitoring programme.

The main objective of the monitoring programme is to quantify the levels of regional air pollution and to document any changes. These observations are important for studies on the influence on ecosystems, human health, materials, and climate change.

The programme started in 1973 with measurements of sulfur and nitrogen compounds and was soon after extended with ozone. The first observations were conducted in Southern Norway. The measurement programme and the monitoring network was then expanded to provide improved information on atmospheric contribution of air pollution for all of Norway. Aerosol particles and carbonaceous aerosol was included in 2000/1.

The atmospheric monitoring programme presented in this report includes observations of sulfur- and nitrogen compounds in air and precipitation, levoglucosan, elemental- and organic carbon (EC/OC) in aerosols, ground level ozone, particulate matter (PM_{10} and $PM_{2.5}$). Data from in total 17 sites in the Norwegian rural background environment is presented. In 2022 the sites in Vatnedalen and Høylandet were closed and replaced by Grungedal and Overhalla, respectively. Location and basic information regarding the monitoring programme at various sites are illustrated in Figure 1.1, whereas more detailed information of what is measured at each site can be found in Appendix D.

The national monitoring programme is conducted on behalf of the Norwegian Environment Agency with additional funding from the Ministry of Climate and Environment. The observations in Finnmark county are financed by the Ministry of Foreign Affairs through the Norwegian Environment Agency. The ozone measurements at Haukenes are financed by the local municipalities. Observations from Osen (forest) are part of the national forest damage monitoring conducted by NIBIO (Timmermann et al., 2023).

Data and results from this national monitoring programme are reported to various international programmes and all data are openly available at http://ebas.nilu.no. Details regarding sampling methods and chemical analysis are described in Appendix E .

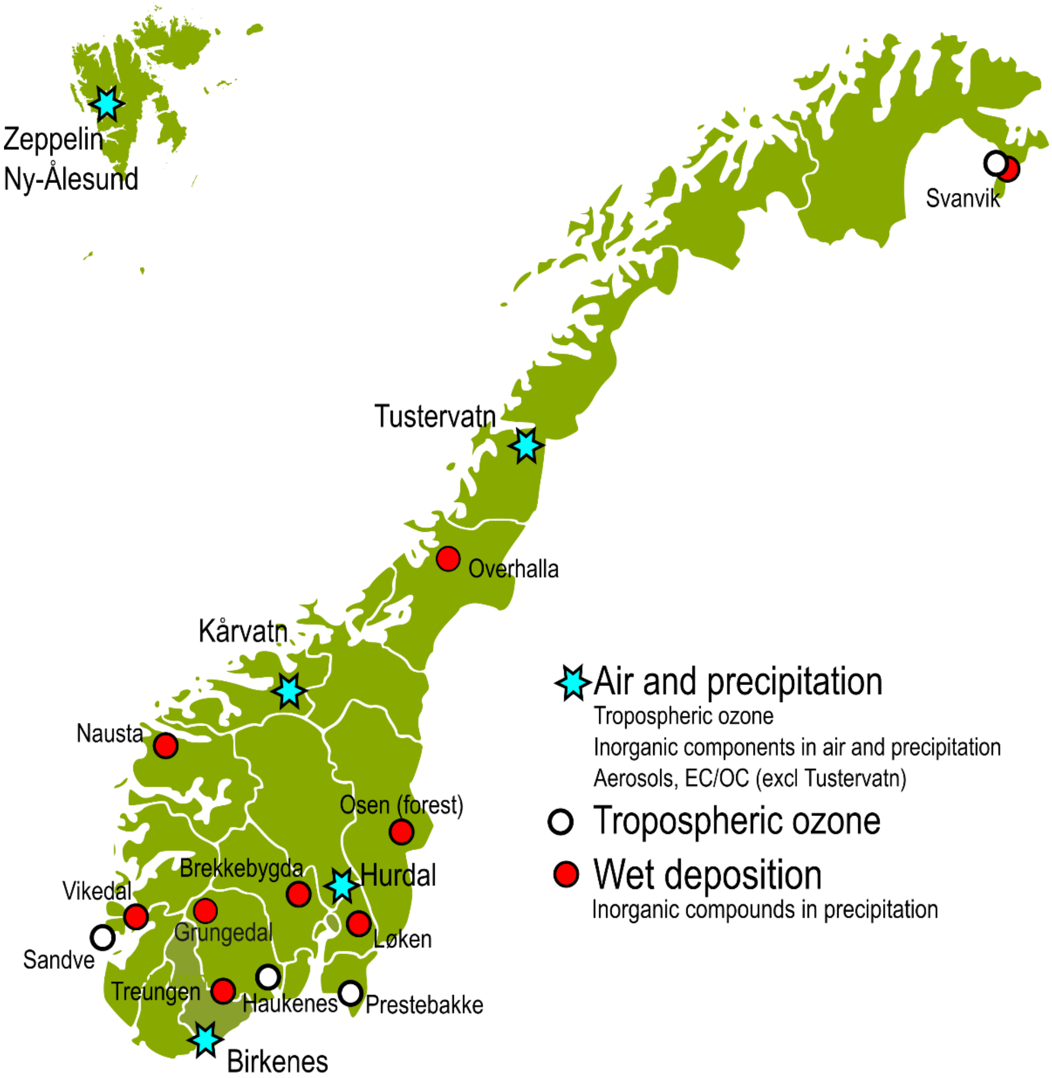


Figure 1.1: Norwegian background sites and measurement programmes 2023.

2 The weather in Norway 2023

The variation in meteorological conditions from year to year is decisive for the observed concentrations of pollutants in air and precipitation in Norway. At rural sites, the level of pollutants is mostly determined by atmospheric transport from other countries. The distribution of high- and low-pressure systems controls this transport, and temperature, humidity and precipitation are determining the degree of deposition, washout and chemical transformation in the air masses. Knowledge of the meteorological conditions and how it varies from day to day and from south to north is therefore important for understanding the air pollutant levels.

For the country as a whole, the mean temperature in 2023 was close to normal (0.1°C below) with 5 % more precipitation than normal (1991-2020 baseline) (Gangstø et al., 2023). Although the average over the country and over the year was close to normal, 2023 was a meteorological year of extremes considering particular months and regions.

The year started with higher temperatures and wetter conditions than normal in the north in January and February, while southern parts experienced slightly lower temperatures than normal. The year continued with temperatures lower than normal in the south in March and now also the northern part experienced much lower temperatures than normal. For the country as a whole, the mean temperature in March was as much as 2.9°C below normal. The April temperature was closer to normal in most parts of the country while southeastern parts received extreme amounts of precipitation, even up to 3 times the normal at some stations.

In May this pattern switched again with extremely dry conditions in the southeast and extremely wet conditions in parts of Northern Norway. Weatherwise, the country was so to speak split in two in May 2023. June was warm and dry over many parts of the country leading to the 4th warmest and 8th driest June since 1900.

In July, this switched again with very wet conditions and low temperatures in most of south Norway while it was warmer and drier than normal in the north. Again, the country was split in two weatherwise. This pattern continued into August, which was extremely wet in the southeast, partly due to the extreme weather event 'Hans' causing floodings in several areas and setting more than 100 records linked to precipitation. Although it was dry in parts of the north and close to normal in the west, this month was the 4th wettest August since 1900.

For the whole summer season (June-August) very high mean temperatures were experienced in the Arctic with Svalbard airport setting a record for this mean value of 7.7°C as compared to the previous records of 7.4°C (2022) and 7.2°C (2020).

September was warmer than normal in most of the country, and the country average this month was the 5th warmest September since 1900. Although some areas received precipitation above normal September, the very wet summer season in the south and southeast part came to an end during this month.

October was colder than normal for the country as a whole and this continued into November with substantially lower temperatures than normal (3.5°C difference). The cold conditions continued into December when all parts of the country had temperatures below normal (3.2°C difference for the country as a whole) (Gangstø et al., 2023).

3 Overview of different Air Quality Guidelines (AQG) and limit values

There are many target values, limit values and guideline values that set criteria levels of air pollution to protect health and environment. These are developed by several bodies, e.g. the EU, World Health Organisation (WHO), UN-ECE and by the Norwegian authorities represented by the Norwegian Institute of Public Health (FHI) and the Norwegian Environmental Agency.

The EU has defined limit values for different air pollutants (EU, 2008) and these are implemented in Norwegian law. Norway has stricter limit values for some components than EU, for instance $PM_{2,5}$ and PM_{10} (FHI, 2013; Lovdata, 2022) . The EU also has a set of long-term objectives and target values.

The World Health Organisation (WHO, 2021) has defined a set of Air Quality Guidelines (AQG) for key air pollutants that pose health risk. WHO published updated AQG in 2021, and for some pollutants the concentrations that can cause health damage are substantially lower than the previous AQG published in 2005. National authorities have published air quality criteria (FHI, 2023), that are based on the AQG from WHO, but also on other relevant research on air pollution and health effects. The EU air quality directive is being updated with stricter limit values which will be closer to the WHO AQG than the current directive (EU, 2008). UN-ECE has developed threshold values for ozone for the protection of vegetation (CLTRAP 2023 and references therein).

An overview of different limit values, targets and guidelines are given for PM in Table 3.1 and for ozone in Table 3.2 (for health) and Table 3.3 (vegetation). Guidelines and limit values for NO_2 and SO_2 are not included since these are not very relevant for Norwegian regional air quality levels.

Table 3.1: EU and national limit values and Air-Quality Guidelines and Criteria for PM_{10} and $PM_{2.5}$.

	24-hours	**Annual**
EU limit values (EU, 2008)		
PM_{10}	50 µg/m^3 (≤ 35 days/ yr)	40 µg/m^3
$PM_{2.5}$		25 µg/m^3
National limit values (Lovdata, 2022)		
PM_{10}	50 µg/m^3 (≤ 25 days/ yr)	20 µg/m^3
$PM_{2.5}$		10 µg/m^3
WHO Air-Quality Guidelines (WHO, 2021)		
PM_{10}	45 µg/m^3 (the 99th percentile)	15 µg/m^3
$PM_{2.5}$	15 µg/m^3 (the 99th percentile)	5 µg/m^3
National Air-Quality Criteria (FHI, 2023)		
PM_{10}	30 µg/m^3	15 µg/m^3
$PM_{2.5}$	15 µg/m^3	5 µg/m^3

Table 3.2: Limit values and Air-Quality Guidelines and Criteria for ground-level ozone, for the protection of human health. Note that several of these metrics refer to the MDA8 as explained in the footer to the table.

Value (µg/m³)	Averaging time (hours)	Ref	Description
180	1	EU (2008)	EU's information threshold
240	1	EU (2008)	EU's alert threshold
120	8[a)]	EU (2008)	EU's target value. 8-hour mean value not to be exceeded on more than 25 days per year averaged over 3 years.
120	8[a)]	EU (2008)	EU's long-term objective.
60	8[b)]	WHO (2021) FHI (2023)	Mean over the peak season
100	8[a)]	WHO (2021)	Short-term AQG (The 99-percentile of the highest 8h means through the year)
100	1	FHI (2013,2023)	National Air Quality Criteria
80	8[a)]	FHI (2013, 2023)	National Air Quality Criteria

a) The highest 8-hour running mean value for each day calculated such that the 8-hour periods are assigned to the day on which the period ends (=MDA8).

b) Defined as the average of the daily maximum 8h running mean concentration in the 6 consecutive months with the highest 6-months running O_3 concentration.

Table 3.3: Critical levels and target values defined for the protection of vegetation from ozone exposure.

AOT40 (ppb hours)	Period	Reference	Comment
3000	3-months growing season	CLTRAP (2023)	UN-ECE's critical level for agricultural crops and semi-natural vegetation [1)]
5000	1 April – 30 Sept	CLTRAP (2023)	UN-ECE's critical level for forests [1)]
9000	1 May – 31 July	EU (2008)	EU's target value for vegetation. Should be averaged over five years [2)]
3000	1 May – 31 July	EU (2008)	EU's long-term objective for vegetation [2)]

1) UN-ECE's AOT values should be based on the hours with global incoming radiation > 50 W/m^2

2) EU's AOT values should be based on the period 08-20 CET

4 Status of the observations in 2023

4.1 Annual levels and spatial gradients

Norway is influenced by major anthropogenic emission regions in Europe, which are of great importance for the observed levels of air pollutants and their regional distribution. The annual and monthly mean concentration in air and precipitation in 2023 for all sites and components are given in Appendix A.

Several components have a clear South to North gradient strongly influenced by long-range transport (LRT) from the European continent. Figure 4.1 illustrates spatial gradients for selected pollutants in 2022. Sulfate concentrations were highest in south and southeast, except at Svanvik, which is influenced by emissions from Russia with elevated concentrations, especially of sulfate. However, concentrations have decreased considerably after the smelter in Nikel closed in December 2020 (Berglen et al., 2022). The ICP Forest site in Osen also experiences relatively high sulfate concentration, but the precipitation amount is low, thus receiving comparably lower wet deposition of sulfate (Table A.2). Wet depositions were highest in southwest, partly due to higher precipitation on the west coast. Maximum ozone concentrations showed a similar pattern with highest levels in southern Norway (Figure 4.1).

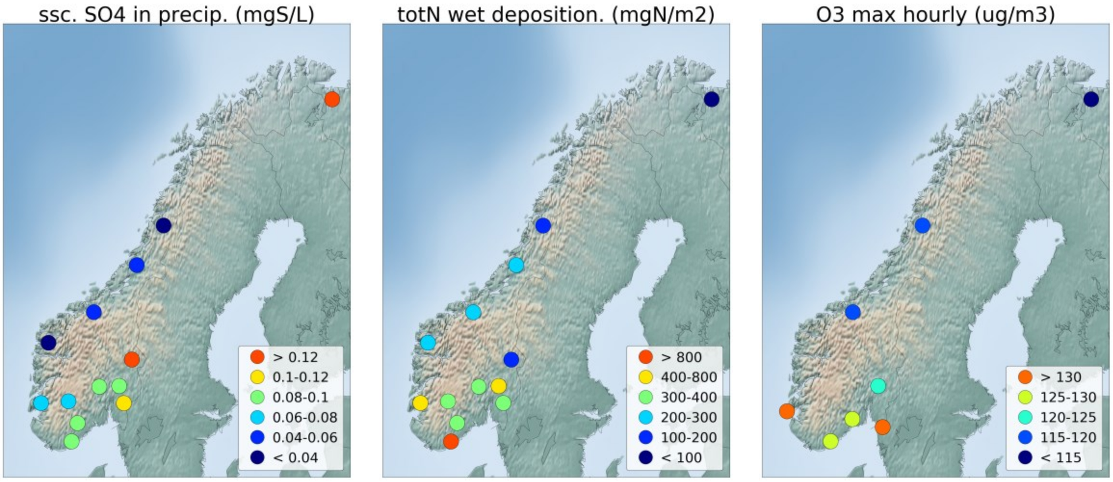


Figure 4.1: Annual volume weighted mean concentrations of sea salt corrected (ssc) sulfate (left), total wet deposition of nitrogen (middle), and the highest hourly concentration of ozone (right) observed in 2023. Note that the colours only represent the spatial distribution and do not indicate any exceedances of limit values or similar.

Air pollution levels at rural sites in Norway are amongst the lowest in Europe (Aas et al., 2024; EMEP, 2023), with annual mean aerosol mass concentrations in 2023 ranging from 2.6 to 4.2 µg/m^3 for PM_{10} and 1.5 to 2.6 µg/m^3 for $PM_{2.5}$. These levels meet both national limits and WHO Air Quality Guidelines (AQG) as outlined in Table 3.1. Carbonaceous aerosol levels, including organic carbon (OC) (< 1.1 µg C/m^3) and elemental carbon (EC) (< 0.08 µg C/m^3), remained relatively low. In particular, OC (0.12 µg C/m^3) and EC (0.011 µg C/m^3) levels at the remote Arctic Zeppelin site were substantially lower compared to levels observed at the Norwegian mainland (Table A.4).

The ozone levels in 2023 were relatively low, exceedances of limit values for ozone are discussed in Chapter 4.4.

4.2 Episodes of high concentrations of sulfur dioxide

Sulfur dioxide episodes may result from anthropogenic emissions, such as burning of fossil fuels, and natural emissions from volcanic activity. In 2023, both such episodes were observed. At Zeppelin, concentrations rose to more than 50 times the annual mean in late April (Figure 4.3). FLEXPART footprints largely covered parts of the Khanty-Mansiysk, Yamalo-Nenets, and Krasnoyarsk regions in Russia. The major source contributing to this SO_2 episode is from the energy sector. This is different if we look at black carbon for the same period, then the main source is flaring activities.

In late December, increased sulfur dioxide levels were observed at sites on the Norwegian mainland, matching the high levels seen at Zeppelin in April. These increases were associated with emissions from the eruption at the Reykjavik Peninsula in Iceland (Figure 4.2).

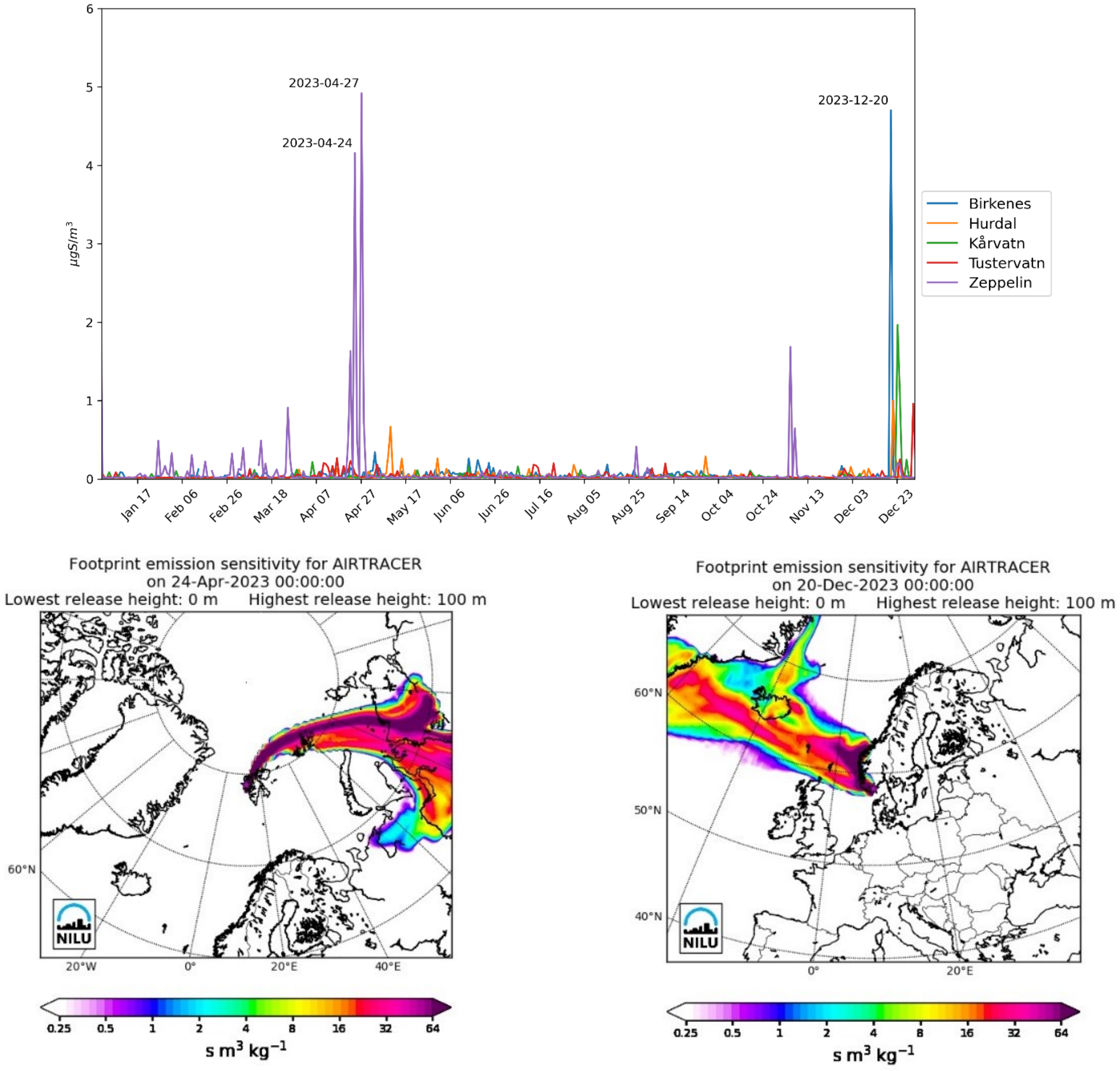


Figure 4.2: Flexpart footprints of the airmasses arriving 24 April at Zeppelin and 20 December at Birkenes calculated with the Flexpart model (Pisso et al., 2019). The unit (second) shows the residence time in the surface layer (100 m) of the air masses arriving at the actual date.

4.3 Episodes of high concentrations of PM

In 2023, the highest monthly mean for PM_{10} occurred in June, ranging from 6.0 to 8.1 µg/ m^{3}across all sites. Similarly, the highest monthly mean for $PM_{2.5}$ (4.1 to 5.0 µg/ m^3) was also observed in June. This increase coincided with a period when parts of Europe were affected by emissions from Canadian wildfires, as demonstrated by concentrations of equivalent black carbon (eBC) emitted from wildfires calculated by FLEXPART for Birkenes for June 2023 (Figure 4.3, panel A). The footprint of air masses arriving at Birkenes on 17 June 2023 is shown in panel B. This coincides with a peak in the biomass burning tracer levoglucosan at 11.9 ng/m^3 for the week 14 to the 21 of June (not shown). FLEXPART source attribution indicates a mixed influence from domestic wood burning and wildfires during this period.

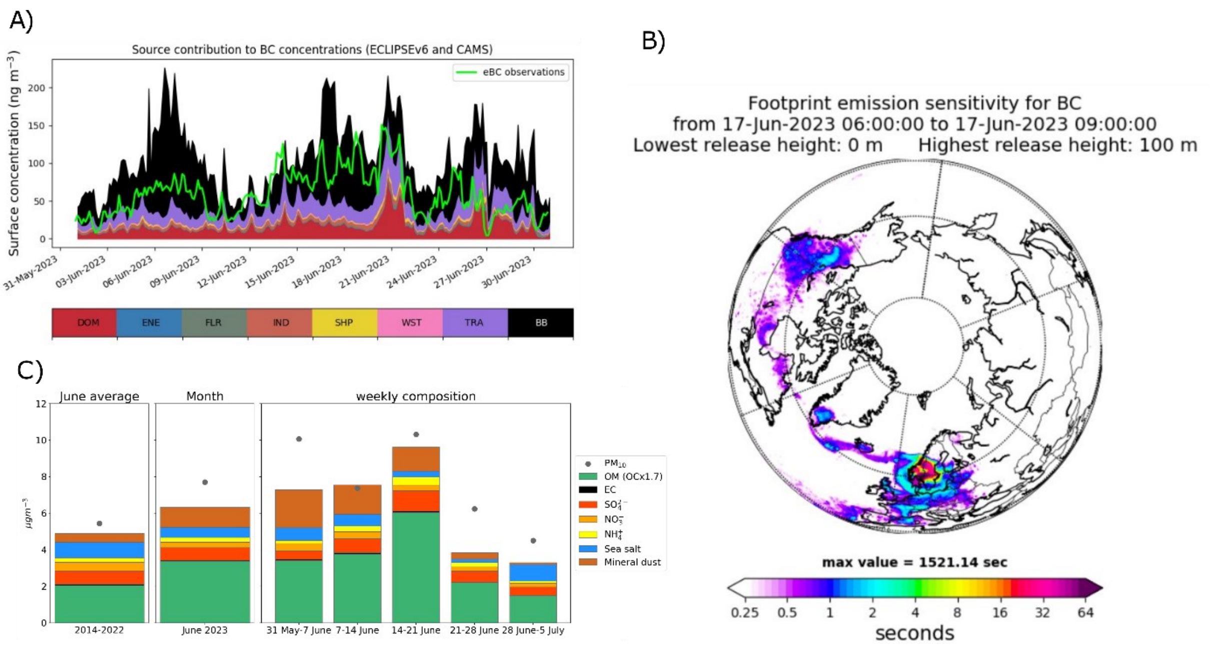


Figure 4.3: Observed concentrations of equivalent black carbon (eBC) and BC emitted from various sources (DOM = Domestic; ENE = Energy; FLR = Flaring; IND = Industry; SHP = Shipping; WST = Waste; TRA = Traffic; BB = Wild fires) calculated by FLEXPART for Birkenes June 2023 (panel A); Flexpart footprint of the airmasses arriving 17 June at Birkenes calculated with the Flexpart model (Pisso et al., 2019). The unit (second) shows the residence time in the surface layer (100 m) of the air masses arriving at the actual date (panel B); Mean chemical composition of PM_{10} at Birkenes for: June 2014 – 2022 (panel C, left), June 2023 (panel C, middle), and for 31 May to 5 July 2023 (panel C, right).

At Birkenes, PM levels were 50% higher in June 2023 compared to the previous ten-years mean for June. Organic matter, calculated as OC multiplied by 1.7, constituted the largest fraction of PM_{10} at 45%, followed by secondary inorganic aerosol (Sum of SO_4^{2-}, NO_3^-, and NH_4^+) at 16%, mineral dust (MD) at 15%, and sea salt aerosol at 6% (Figure 4.3, panel C, middle). The high fractions of OM and MD stood out in the aerosol composition. The very low EC fraction (0.7%) indicated an overwhelming contribution of secondarily formed particles and emissions from natural sources to OM. Although source specific organic tracers of biomass burning (BB) emissions, biogenic secondary organic aerosol (BSOA) and primary biological aerosol particles (PBAP) were increased by 66 to 166%, their relative share of OM was not much elevated compared to previous years, except to some extent for the BSOA tracers. This suggests minor changes in the source composition of the organic aerosol. However, depletion of the BB tracer levoglucosan during long-range atmospheric transport could mask a higher contribution from BB. Elevated levels of BSOA and PBAP have been linked to emissions from wildfires (Yttri et al., 2024), although distinguishing them from local sources is challenging. Indeed, June 2023 experienced both the highest monthly mean and maximum temperature for 2023, which favors emissions of biogenic volatile organic compounds and subsequent BSOA formation, as well as emissions of PBAP.

4.4 Episodes of high concentrations of ozone

In summer, episodes of elevated ozone in Norway may occur, often associated with high pressure systems over Europe, typically over Central or Eastern parts, setting up a southerly or south-westerly transport of warm, polluted air masses. Ozone episodes are typically a fair-weather phenomenon associated with hot and sunny days. The northern hemispheric ozone baseline level varies between 40 and 80 $\mu g/m^3$ and is typically highest in spring. On top of this baseline level, episodes with long-range transport of more polluted air masses increase the ozone levels regularly in summer. The ozone levels at Norwegian monitoring sites are also influenced by local effects such as surface dry deposition and episodes of local NO_X emissions reducing ozone but in general, surface ozone in Norway is the result of polluted air masses transported from Europe on top of the hemispheric baseline.

2023 was in general an "ozone-poor" year without marked episodes of elevated surface ozone. The highest hourly concentration was 135 ug/m^3, measured at Sandve 11th September, which is unusually late in the year for ozone episodes. The second highest level was 133 $\mu g/m^3$ at Prestebakke 13th May, and the 4d backward footprint for this day is shown in Figure 4.4. These peak levels are similar to peak levels seen in the recent years except for the years with marked ozone episodes, as e.g. 135 $\mu g/m^3$ (2021), 134 $\mu g/m^3$ (2020), 135 $\mu g/m^3$ (2017) and so on

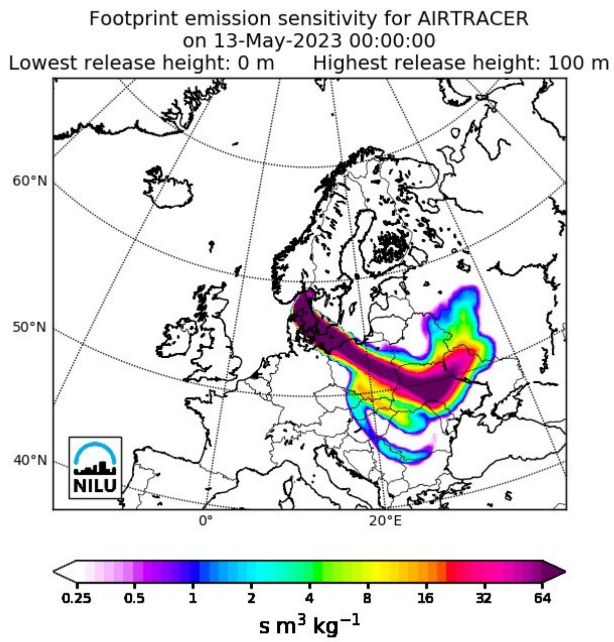


Figure 4.4: Flexpart footprints of the airmasses arriving at Prestebakke 13th May, calculated with the Flexpart model (Pisso et al., 2019.) The unit (second) shows the residence time in the surface layer (100 m) of the air masses arriving at the actual date.

Although 2023 was year without distinct ozone episodes, several of the limit values were exceeded. The EU's health related long-term objective of maximum daily 8-h average (MDA8) > 120 μg/m^3 (Table 3.2) was exceeded at Birkenes and Sandve in 2023 with one day at each station (Table A19) a limit value that corresponds with WHO's short term AQG. Both of FHI's two air quality guidelines for ozone were broken at all stations in 2023. The WHO's peak season (6-months) limit value of 60 μg/m^3 was also exceeded at all stations in 2023. This reflects that these limit values are so close to the hemispheric baseline levels that it will be very demanding to meet these guidelines.

Furthermore, the EU's long-term objective for natural vegetation which is identical to the UN-ECE's critical level (3-months AOT40 > 3000 ppb hours) was exeeded at Birkenes and Prestebakke in 2023. The UN-ECE's critical level for forest (6-months AOT40 > 5000 ppb hours) was broken at Prestebakke.

5 Trends in air pollution

An important goal of the monitoring programme is to measure the effectiveness of the protocols, i.e., the 1999 Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone (UNECE, 2012). Since Norway is influenced by major emission sources in Continental Europe, the Norwegian rural background monitoring network can indicate changes to overall emission reductions in Europe.

For the statistical analysis, the non-parametric Mann-Kendall Test was applied on annual means for detecting and estimating trends (Gilbert, 1987) The Sen-Theil slope estimator was used to quantify the magnitude of the trends (Hussain and Mahmud, 2019). Tables with the calculated linear trends for 2000-2023 and 2010-2023 averaged for all sites with measurements in these respective periods are given in Appendix B. For data prior to 2000, please refer to Table in Annex C.

5.1 Trends in inorganic compounds

Figure 5.1 shows the time series of annual mean concentrations of sulfur and nitrogen components in air and precipitation at selected sites in Norway with long time series. The average trends in sulfur are between -2.7 to -3.3% per year between 2000-2023 depending on component (Table B.1). There is also a clear reduction in oxidised nitrogen, between -1.4 to -2.6% per year (Table B.1). This is also the case for reduced nitrogen though ammonium in aerosol has a larger reduction (-2.8 %/yr) than in precipitation (-1.0 %/yr). These large differences between the changes found for the different reduced nitrogen components can be explained by the interaction of ammonia with the sulfur and oxidized nitrogen components. It can be noted that the results imply that the contribution of ammonia emissions to aerosols has been largely reduced during the 2000–2023 period, due to the impact of Sox and NO_X emission reductions in Europe (Aas et al., 2024). The observed reductions in levels of sulfur and nitrogen species agree with reported downwards trends in pollutant emissions in Europe (Aas et al., 2024; Colette et al., 2021; Lewis et al., 2023).

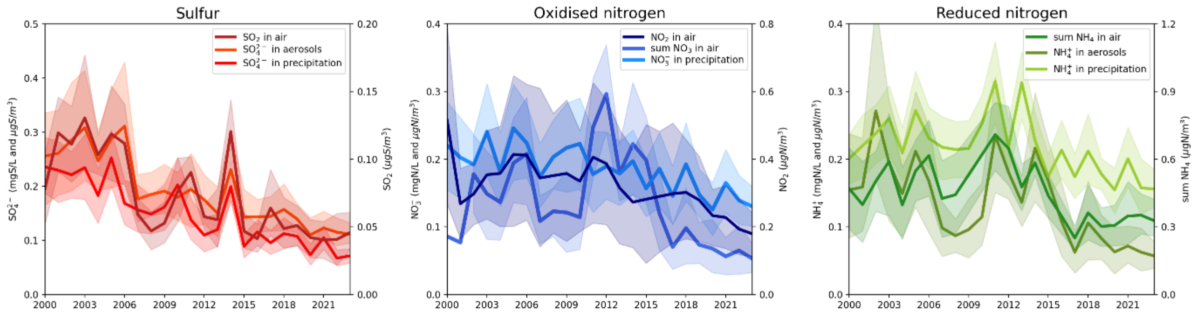


Figure 5.1: Average trends in sulfur and nitrogen components measured at Norwegian background sites (2000-2023). The solid line in the trend plots indicate the average annual mean concentrations for all the sites and the shaded area the 95% confidence interval. There are 11 sites with long term observations of sulfur and nitrogen in precipitation and 5 with measurements in air and aerosol (4 for NO_2).

5.2 Trends in aerosols

Trends in PM measurements at Birkenes, as depicted in Table B.3, show a statistically significant decrease in both PM_{10} (-1.7% /yr) and $PM_{2.5}$ (-2.4 % /yr) over the span of more than two decades, from 2000/1 to 2023. The decrease is less pronounced for PM_{10} due to contributions from natural sources such as sea salt aerosol (SSA), mineral dust (MD) and primary biological aerosol particles (PBAP), which dominate the coarse fraction of PM_{10}. The primary drivers behind the reduction in PM levels are the declining concentrations of secondary inorganic aerosol (SIA), such as SO_4^{2-} (-3.2% /yr) and NH_4^+ (-2.8% /yr) and fine fraction organic carbon (OC) (-1.4% /yr). These trends reflect the successful efforts in reducing anthropogenic emissions of SO_2 and carbonaceous aerosol from combustion sources. The efficiency of reducing OC and EC from fossil fuel combustion appears somewhat more efficient than from biomass burning. This is evident in the lower reduction rate observed for the biomass burning tracer levoglucosan (-2.2% /yr) compared to EC (-3.0% /yr) from 2008 to 2023. Since the year 2000, there has been a consistent increase in the SSA concentration at Birkenes at a rate of 2.1% /yr.

The PM levels at Hurdal (PM_{10}: -1.6% /yr; $PM_{2.5}$: -2.8% /yr) and Kårvatn (PM_{10} -2.2% /yr; $PM_{2.5}$: -3.7% /yr) exhibit decreasing trends from 2011 to 2023. The reduction rates for PM_{10} are slightly lower compared to Birkenes over the same period, and the decrease is not statistically significant at either site. Conversely, there is a statistically significant decrease in $PM_{2.5}$, mainly attributed to reductions in secondary inorganic aerosol constituents.

In 2023, SSA constituted 23% of PM_{10} at Birkenes, equal to that of SIA species (SO_4^{2-}, NO_3^-, NH_4^+) (21%), but lower than organic matter (OM) at 32%, while MD accounted for 8% (Figure 5.2). Since 2000, the SSA fraction of PM_{10} has increased notably at a rate of 6.7% /yr. Despite declining emissions from combustion, the OC fraction of PM_{10} increases by 1.4% /yr and for $PM_{2.5}$ by 1.9% /yr. This underscores the importance of organic aerosols from natural sources like BSOA and PBAP. Conversely, the fractions of NH_4^+ (-2.7 /yr) and SO_4^{2-} (-1.4% /yr) to PM_{10} have shown a decreasing trend. This shift in aerosol composition at Birkenes reflects a change in the relative source composition of PM, where emissions from natural sources become more dominant compared to anthropogenic sources, typically being long-range transported pollution. The chemical composition of PM at Hurdal and Kårvatn shows less influence from SIA and SSA compared to Birkenes, emphasizing the longer distance from important source regions of SIA precursors in continental Europe and to the coast, respectively, with OM comprising the major fraction at 42 – 45%.

The chemical composition of PM at the remote Zeppelin site exhibits a greater influence of SSA and MD compared to sites on the Norwegian mainland, while showing less OM and SIA (Figure 5.2). This reflects a remote Arctic environment characterized by a relatively larger influence from natural sources than anthropogenic ones.

A statistically significant downward trend was observed for EC, ranging from -3.2% /yr to -4.3% /yr at all rural background sites. However, for OC, the downward trend was statistically significant only for Birkenes (-1.2 to -1.4%) and for OC in $PM_{2.5}$ at Kårvatn (-2.2% /yr) (Table B.3).

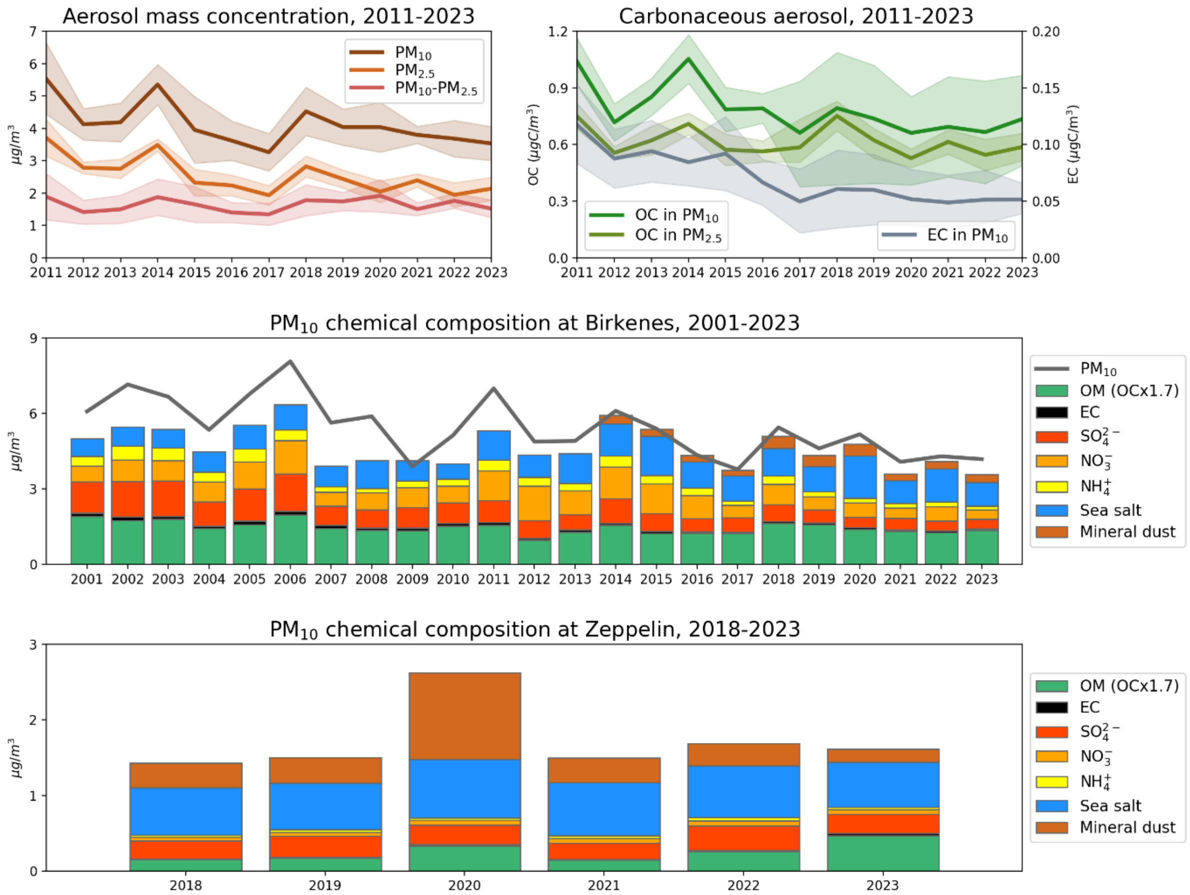


Figure 5.2: Trends for PM_{10}, $PM_{2.5}$, and $PM_{10-2.5}$ (upper left) and carbonaceous aerosol (OC and EC) (upper right) averaged for Birkenes Observatory, Hurdal and Kårvatn (2011 – 2023). Mass closure for PM_{10} at Birkenes (middle panel) (2001 - 2023), and Zeppelin (lower panel) (2018 – 2023).

5.3 Trends in surface ozone

For surface ozone, the annual mean concentration is of little interest since pollution episodes typically lead to enhanced ozone in summer and reduced levels in winter and thus the impact on the annual mean is unclear. Furthermore, the number and levels of European summer episodes vary from year to year and is closely related to the weather situation. There has, however, been a gradual decrease in the European peak levels since the early 2000s which is reflected also at Norwegian sites. The trends and significance of these are not straight-forward to quantify though since the high peaks only occur certain years and are strongly tied to the weather anomalies in the respective years.

The general pattern of the development of peak ozone levels in Norway is a very gentle decrease through the years with marked spikes in a few years. This pattern reflects the “competition” between the general ozone reduction in European air masses due to the reduction in emissions of NO_X and VOC on one side and the ongoing climate change leading to more frequent and severe heat waves promoting ozone formation on the other side. As an example, 2006 was the last year when the ozone level in Norway exceeded the EU information threshold of 180 ug/m^3.

Figure 5.3 shows the development of ozone metrics linked to damage on vegetation (AOT40 = Accumulated Ozone over the Threshold of 40 ppb, Table 3.2) and human health (days with ozone exceeding certain recommendations, Table 3.2). These time series are characterized by a slow reduction with time while at the same time strongly variable from year to year.

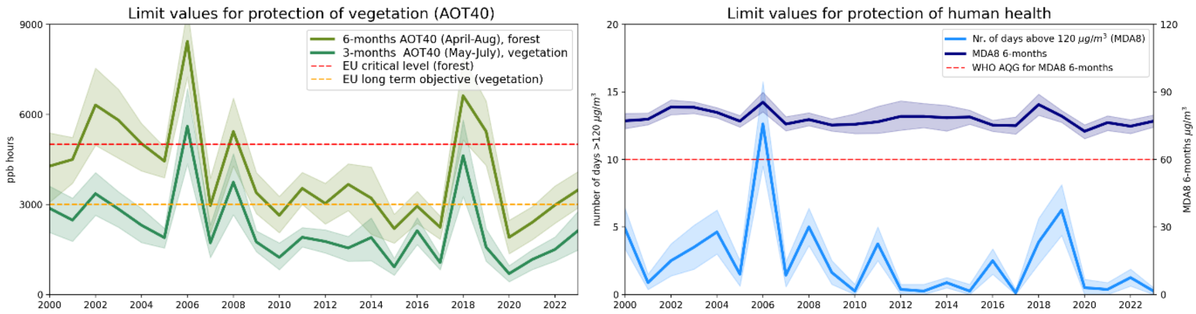


Figure 5.3: Average trends in different ozone metrics relevant for protection of vegetation (left,) and health (right) at Norwegian background sites 2000-2023. The solid line in the trend plots indicate the average annual mean concentrations for all the eight sites and the shaded area the 90% confidence interval of the means. The number of days above 180 ug/m^3 (MDA8) in light blue refers to EU’s long-term objective (Table 3.2) while the MDA-6months season in purple, is the mean over the peak where the WHO AQG of 60 ug/m^3 is indicated in red.

5.4 Summary of trends

A summary of the average relative trends covered in this report is illustrated in the box plot in Figure 5.4. The average trends for the different sites and compounds are found in Appendix B. There are clear reductions for most of the components the last 20 years. The reductions are also seen for the shorter latter period from 2010(11), but there are larger variations between the sites, thus larger spread in the box plots, which is also reflected in less significant trend for this period (Table B.2). It should be mentioned that both the AOT metrics and the number of days above certain limits are metrics above certain levels, and thus sensitive to the prevailing levels in the particular years, and peaks in certain years could have strong influence on the trends.

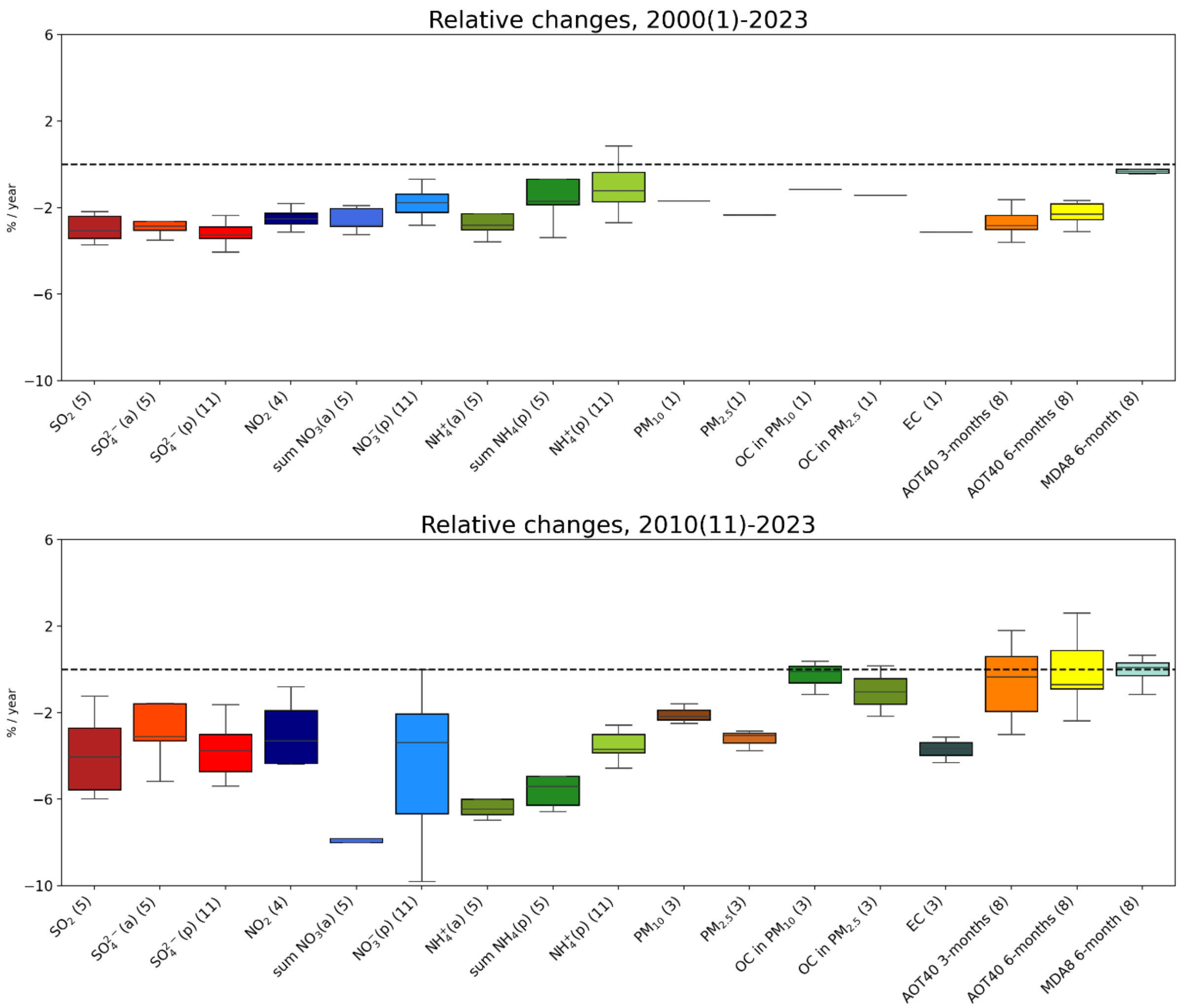


Figure 5.4: Average relative trends (Sen-Theil slope estimates) in annual levels for the period 2000(1)-2023 (top) and 2010(11)-2023 (bottom). Number of sites in the parentheses. (a) indicates in aerosols and (p) in precipitation. The box plots represent the 50th, 25th, and 75th percentiles and the whiskers lie within the 1.5 inter-quartile ranges for the trends of all the sites, including those with not significant trends.

6 References

Aas, W., Fagerli, H., Alastuey, A., Cavalli, F., Degorska, A., Feigenspan, S., Brenna, H., Gliß, J., Heinesen, D., Hueglin, C., Holubová, A., Jaffrezo, J.-L., Mortier, A., Murovec, M., Putaud, J.-P., Rüdiger, J., Simpson, D., Solberg, S., Tsyro, S., Tørseth, K., and Yttri, K. E.: Trends in Air Pollution in Europe, 2000–2019, Aerosol Air Qual. Res., 24, 230237, https://doi.org/10.4209/aaqr.230237, 2024.

Berglen, T. F., Nilsen, A.-_C., Vadset, M., Uggerud, H. T., Bjørklund, M., and Andresen, E.: Grenseområdene Norge-Russland. Luft- og nedbørkvalitet, årsrapport 2021, NILU, Kjeller, Norway, 2022.

CLTRAP, 2023: Manual on Methodologies and Criteria for Modelling and Mapping Critical Loads and Levels and Air Pollution Effects, Risks, and Trends, Coordination Centre for Effects (CCE), German Environment Agency, 2023.

Colette, A., Solberg, S., Aas, W., and Walker, S.-E.: Understanding Air Quality Trends in Europe, Focus on the relative contribution of changes in emission of activity sectors, natural fraction and meteorological variability, European Topic Centre on Air pollution, transport, noise and industrial pollution, 2021.

EMEP: Transboundary particulate matter, photo-oxidants, acidification and eutrophication components. Joint MSC-W & CCC & CEIP Report., Norwegian Meteorological Institute, Oslo, 2023.

EU: Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe, 2008.

FHI: Luftkvalitetskriterier. Virkninger av luftforurensning på helse, Folkehelseinstituttet, Oslo, 2013.

FHI: Reviderte luftkvalitetskriterier, Folkehelseinstituttet, 2023.

Gangstø, R., Grinde, L., Mamen, J., Tajet, H. T. T., Tunheim, K., and Aaboe, S.: Været i Norge. Klimatologisk oversikt. Året 2023, Norwegian Meteorological Institute, Oslo, 2023.

Gilbert, R. O.: Statistical methods for environmental pollution monitoring, 1987.

Hussain, Md. and Mahmud, I.: pyMannKendall: a python package for non parametric Mann Kendall family of trend tests., J. Open Source Softw., 4, 1556, https://doi.org/10.21105/joss.01556, 2019.

Lewis, R. B., Aas, W., Denby, B., Hjellbrekke, A. G., Mu, Q., Ytre-Eide, M., and Fagerli, H.: Deposition of sulfur and nitrogen in Norway 2017-2021, Norwegian Meteorological Institute, 2023.

Lovdata: Forskrift om begrensning av forurensning (forurensningsforskriften). Kapittel 7. Lokal luftkvalitet. § 7-9. Grenseverdier, 2022.

Pisso, I., Sollum, E., Grythe, H., Kristiansen, N. I., Cassiani, M., Eckhardt, S., Arnold, D., Morton, D., Thompson, R. L., Groot Zwaaftink, C. D., Evangeliou, N., Sodemann, H., Haimberger, L., Henne, S., Brunner, D., Burkhart, J. F., Fouilloux, A., Brioude, J., Philipp, A., Seibert, P., and Stohl, A.: The Lagrangian particle dispersion model FLEXPART version 10.4, Geosci. Model Dev., 12, 4955–4997, https://doi.org/10.5194/gmd-12-4955-2019, 2019.

Timmermann, V., Børja, I., Clarke, N., Eriksen, R., Gohli, J., Hylen, G., Jepsen, J. U., Krokene, P., Lange, H., Meissner, H., Nagy, N. E., Nordbakken, J.-F., Solberg, S., Solheim, H., Vindstad, L., Økland, B., and Aas, W.: The state of health of Norwegian forests. Results from the national forest damage monitoring 2021, NIBIO, Ås, 2023.

UNECE: 1999 Protocol to Abate Acidification, Eutrophication and Ground-level Ozone to the Convention on Long-range Transboundary Air Pollution, as amended on 4 May 2012, 2012.

WHO: WHO global air quality guidelines. Particulate matter (PM2.5 and PM10), ozone, nitrogen dioxide, sulfur dioxide and carbon monoxide. Executive summary., World Health Organization, Geneva, 2021.

Yttri, K. E., Bäcklund, A., Conen, F., Eckhardt, S., Evangeliou, N., Fiebig, M., Kasper-Giebl, A., Gold, A., Gundersen, H., Myhre, C. L., Platt, S. M., Simpson, D., Surratt, J. D., Szidat, S., Rauber, M., Tørseth, K., Ytre-Eide, M. A., Zhang, Z., and Aas, W.: Composition and sources of carbonaceous aerosol in the European Arctic at Zeppelin Observatory, Svalbard (2017 to 2020), Atmospheric Chem. Phys., 24, 2731–2758, https://doi.org/10.5194/acp-24-2731-2024, 2024.

Appendix A

Annual and monthly mean concentrations

Table A.1: Annual volume weighted mean concentrations of inorganic ions in precipitation in 2023 (ssc= sea salt corrected, tot = total).

Site	pH	ssc SO_4 mg S/l	tot SO_4 mg S/l	NO_3 mg N/l	NH_4 mg N/l	Ca mg/l	K mg/l	Mg mg/l	Na mg/l	Cl mg/l	mm
Birkenes	5.073	0.097	0.185	0.213	0.237	0.092	0.076	0.101	1.062	1.744	1911
Grungedal	5.144	0.074	0.097	0.190	0.123	0.092	0.079	0.029	0.288	0.350	1150
Treungen	5.037	0.091	0.112	0.174	0.180	0.079	0.047	0.025	0.253	0.405	1102
Løken	5.098	0.111	0.136	0.196	0.256	0.102	0.136	0.039	0.314	0.503	845
Hurdal	4.889	0.094	0.109	0.175	0.166	0.086	0.044	0.018	0.198	0.296	1329
Osen (forest)	5.206	0.121	0.134	0.119	0.124	0.049	0.045	0.006	0.138	0.292	735
Brekkebygda	4.999	0.091	0.101	0.133	0.136	0.054	0.060	0.015	0.135	0.206	1299
Vikedal	5.205	0.062	0.223	0.115	0.160	0.150	0.108	0.195	1.922	3.314	2710
Nausta	5.289	0.030	0.142	0.043	0.084	0.072	0.089	0.132	1.344	2.316	1983
Kårvatn	5.131	0.050	0.162	0.069	0.090	0.096	0.082	0.134	1.346	2.351	1610
Overhalla	5.249	0.046	0.265	0.069	0.182	0.172	0.153	0.271	2.624	4.511	1120
Tustervatn	5.228	0.040	0.162	0.053	0.101	0.094	0.104	0.157	1.464	2.568	1002
Svanvik	5.071	0.122	0.204	0.106	0.150	0.149	0.102	0.103	0.980	1.700	344
Ny-Ålesund	5.316	0.065	0.650	0.086	0.211	0.485	0.329	0.848	6.952	12.068	350

Table A.2: Annual wet deposition of inorganic components in 2023 (ssc= sea salt corrected, tot = total).

Site	H^+	ssc SO_4 mg S/m²	tot SO_4 mg S/m²	NO_3 mg N/m²	NH_4 mg N/m²	Ca mg /m²	K mg /m²	Mg mg /m²	Na mg /m²	Cl mg /m²	mm
Birkenes	16148	185	353	407	453	176	145	192	2030	3331	1911
Grungedal	8246	85	111	219	141	106	91	33	331	403	1150
Treungen	10120	100	123	192	199	87	52	28	278	447	1102
Løken	6742	94	115	166	216	86	115	33	265	425	845
Hurdal	17168	125	145	233	221	114	59	24	263	394	1329
Osen (forest)	4572	89	98	87	91	36	33	4	102	215	735
Brekkebygda	13020	118	131	173	176	70	77	19	176	267	1299
Vikedal	16907	169	604	311	435	406	292	529	5209	8982	2710
Nausta	10196	60	282	85	166	142	176	262	2664	4592	1983
Kårvatn	11898	80	261	112	145	155	132	216	2167	3786	1610
Overhalla	6309	51	296	77	204	193	171	304	2939	5051	1120
Tustervatn	5933	40	162	53	101	94	104	157	1467	2572	1002
Svanvik	2916	42	70	36	52	51	35	35	337	584	344
Ny-Ålesund	1694	23	228	30	74	170	115	297	2436	4229	350

Table A.3: Annual mean concentrations of inorganic components in air in 2023.

Site	SO_2	SO_4^{2-}	NO_2	sum of (HNO_3 + NO_3^-)	NO_3^-	sum of (NH_3 + NH_4^+)	NH_4^+	Mg^{2+}	Ca^{2+}	K^+	Cl^-	Na^+
	µg-S/m³	µg-S/m³	µg-N/m³	µg-N/m³	µg-N/m³	µg-N/m³	µg-N/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³
Birkenes II	0.050	0.159	0.233	0.104	0.085	0.282	0.104	0.040	0.034	0.033	0.487	0.386
Hurdal	0.032	0.103	0.264	0.068	0.052	0.240	0.062	0.012	0.019	0.019	0.111	0.115
Kårvatn	0.032	0.084	0.115	0.034	0.022	0.529	0.038	0.016	0.025	0.016	0.204	0.155
Tustervatn	0.035	0.108	0.104	0.035	0.024	0.336	0.053	0.027	0.021	0.017	0.406	0.288
Zeppelinfjellet	0.080	0.102	-	0.024	0.013	0.245	0.026	0.025	0.020	0.020	0.336	0.220

Table A.4: Annual mean concentrations of aerosol mass and carbonaceous aerosols in 2023.

	PM_{10}					$PM_{2.5}$			
	PM_{10} mass	OC	EC	TC	Levoglucosan	$PM_{2.5}$ mass	OC	EC	TC
	µg/m³	µg C/m³	µg C/m³	µg C/m³	ng/m³	µg/m³	µg C/m³	µg C/m³	µg C/m³
Birkenes II	4.18	0.80	0.054	0.85	7.86	2.60	0.56	0.050	0.61
Hurdal	3.80	1.14	0.078	1.21	-	2.28	0.71	0.078	0.79
Kårvatn	2.62	0.73	0.039	0.77	-	1.54	0.49	0.040	0.53
Zeppelinfjellet	-	0.12	0.011	0.14	0.45				

Table A.5: Monthly and annual volume weighted mean pH in precipitation in 2023.

SITE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	2023
Birkenes	5.040	5.000	5.089	5.308	5.495	5.091	5.013	4.989	5.159	5.142	5.048	4.992	5.073
Grungedal	5.193	5.262	5.134	5.479	5.910	4.966	5.030	4.935	5.297	5.331	5.152	5.227	5.144
Treungen	5.047	4.893	4.913	5.589	5.890	4.728	4.975	4.904	5.380	5.183	4.979	4.894	5.037
Løken	4.962	5.154	4.991	5.504	5.340	4.731	5.244	5.050	5.424	5.240	4.969	4.896	5.098
Hurdal	5.032	5.006	5.095	5.141	4.966	5.369	5.027	4.550	5.115	5.150	5.180	4.872	4.889
Osen (forest)	5.284	5.318	5.513	5.481	5.945	5.187	5.115	5.161	5.170	5.176	5.133	5.100	5.206
Brekkebygda	5.024	4.991	4.908	5.425	5.180	4.829	4.830	5.015	5.205	5.297	5.035	4.921	4.999
Vikedal	5.439	5.452	5.232	5.390	4.856	5.044	4.920	5.280	5.123	5.203	5.493	5.369	5.205
Nausta	5.305	5.127	5.116	5.324	5.150	5.100	5.199	5.219	5.474	5.414	5.700	5.362	5.289
Kårvatn	5.445	5.375	5.247	4.794	4.989	4.793	4.900	5.052	5.243	5.390	5.701	5.208	5.131
Overhalla	5.521	5.503	5.369	5.485	5.511	5.233	4.964	4.735	5.295	5.385	5.361	5.352	5.249
Tustervatn	5.334	5.328	5.209	4.845	5.309	5.249	5.095	4.856	5.273	5.375	5.286	5.475	5.228
Svanvik	5.136	5.068	4.869	4.880	4.959	4.953	4.794	5.064	5.362	5.111	5.329	4.790	5.071
Ny-Ålesund	6.050	5.432	5.773	5.605	5.121	5.738	6.204	5.064	5.212	5.491	5.331	5.575	5.316

Table A.6: Monthly and annual volume weighted average concentrations of sulfate (sea salt corrected) in precipitation in 2023. Unit: mg S/L.

SITE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	2023
Birkenes	0.044	0.049	0.065	0.212	0.225	0.094	0.126	0.124	0.155	0.070	0.072	0.070	0.097
Grungedal	0.018	0.025	0.033	0.176	0.553	0.099	0.086	0.047	0.083	0.035	0.063	0.076	0.074
Treungen	0.026	0.036	0.026	0.202	0.543	0.165	0.093	0.102	0.125	0.048	0.043	0.056	0.091
Løken	0.042	0.050	0.034	0.270	0.162	0.173	0.121	0.083	0.188	0.083	0.085	0.116	0.111
Hurdal	0.042	0.019	0.030	0.203	0.375	0.218	0.067	0.086	0.120	0.034	0.068	0.124	0.094
Osen (forest)	0.040	0.056	0.070	0.277	0.488	0.161	0.075	0.060	0.130	0.151	0.139	0.150	0.124
Brekkebygda	0.033	0.014	0.029	0.341	0.065	0.123	0.085	0.054	0.132	0.038	0.045	0.105	0.091
Vikedal	0.019	0.039	0.050	0.236	0.213	0.136	0.094	0.046	0.058	0.044	0.035	0.051	0.062
Nausta	0.005	0.009	0.014	0.211	0.265	0.120	0.086	0.025	0.044	0.015	0.006	0.016	0.030
Kårvatn	0.007	0.013	0.017	0.116	0.093	0.122	0.092	0.057	0.029	0.016	0.028	0.086	0.050
Overhalla	0.008	0.024	0.008	0.113	0.083	0.086	0.057	0.127	0.035	0.015	0.037	0.003	0.046
Tustervatn	0.007	0.026	0.012	0.228	0.055	0.129	0.111	0.066	0.039	0.020	0.033	0.008	0.040
Svanvik	0.083	0.051	0.075	0.268	0.189	0.200	0.174	0.095	0.106	0.110	0.174	0.239	0.122
Ny-Ålesund	0.056	0.029	0.216	0.160	0.073	0.115	0.075	0.072	0.028	0.029	0.071	0.002	0.065

Table A.7: Monthly and annual volume weighted average concentrations of nitrate in precipitation in 2023. Unit: mg N/L.

SITE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	2023
Birkenes	0.148	0.220	0.179	0.359	0.313	0.161	0.199	0.325	0.326	0.117	0.200	0.146	0.213
Grungedal	0.079	0.080	0.106	0.282	0.585	0.156	0.158	0.401	0.130	0.048	0.193	0.224	0.190
Treungen	0.113	0.189	0.116	0.311	0.774	0.286	0.106	0.136	0.250	0.101	0.147	0.158	0.174
Løken	0.185	0.200	0.150	0.325	0.315	0.260	0.169	0.116	0.392	0.172	0.227	0.239	0.196
Hurdal	0.160	0.169	0.147	0.323	0.559	0.331	0.122	0.128	0.269	0.090	0.103	0.185	0.175
Osen (forest)	0.099	0.115	0.129	0.248	0.616	0.046	0.045	0.034	0.144	0.163	0.158	0.190	0.119
Brekkebygda	0.109	0.132	0.137	0.363	0.168	0.214	0.090	0.048	0.213	0.090	0.193	0.197	0.133
Vikedal	0.097	0.171	0.132	0.412	0.324	0.231	0.079	0.028	0.115	0.085	0.126	0.041	0.115
Nausta	0.034	0.078	0.056	0.379	0.101	0.176	0.066	0.005	0.021	0.020	0.030	0.058	0.043
Kårvatn	0.054	0.034	0.039	0.237	0.143	0.167	0.121	0.052	0.021	0.035	0.104	0.032	0.069
Overhalla	0.037	0.063	0.050	0.183	0.120	0.092	0.052	0.102	0.053	0.035	0.054	0.042	0.069
Tustervatn	0.025	0.041	0.033	0.321	0.054	0.170	0.076	0.077	0.045	0.043	0.065	0.028	0.053
Svanvik	0.161	0.123	0.139	0.327	0.222	0.169	0.139	0.058	0.058	0.055	0.143	0.296	0.106
Ny-Ålesund	0.134	0.086	0.110	0.118	0.045	0.133	0.084	0.138	0.071	0.075	0.068	0.036	0.086

Table A.8: Monthly and annual volume weighted average concentrations of ammonium in precipitation in 2023. Unit: mg N/L.

SITE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	2023
Birkenes	0.098	0.154	0.192	0.669	0.745	0.160	0.269	0.255	0.462	0.154	0.141	0.081	0.237
Grungedal	0.038	0.060	0.092	0.461	2.017	0.136	0.010	0.050	0.116	0.030	0.065	0.102	0.123
Treungen	0.056	0.050	0.061	0.635	1.933	0.203	0.132	0.090	0.324	0.028	0.038	0.033	0.180
Løken	0.141	0.181	0.106	0.628	0.530	0.230	0.407	0.117	0.508	0.117	0.117	0.110	0.256
Hurdal	0.083	0.097	0.117	0.452	0.683	0.324	0.106	0.119	0.284	0.039	0.078	0.067	0.166
Osen (forest)	0.073	0.085	0.107	0.356	1.039	0.361	0.023	0.030	0.100	0.117	0.064	0.060	0.124
Brekkebygda	0.041	0.030	0.059	0.698	0.171	0.158	0.083	0.056	0.270	0.041	0.067	0.057	0.136
Vikedal	0.137	0.218	0.163	0.618	0.378	0.245	0.060	0.148	0.117	0.182	0.128	0.094	0.160
Nausta	0.043	0.198	0.116	0.521	0.405	0.338	0.175	0.034	0.016	0.027	0.141	0.050	0.084
Kårvatn	0.113	0.093	0.115	0.138	0.140	0.152	0.081	0.094	0.047	0.047	0.084	0.079	0.090
Overhalla	0.135	0.230	0.337	0.274	0.483	0.188	0.033	0.033	0.095	0.091	0.172	0.167	0.182
Tustervatn	0.043	0.103	0.146	0.361	0.107	0.360	0.206	0.078	0.080	0.023	0.021	0.116	0.101
Svanvik	0.106	0.087	0.079	0.222	0.199	0.138	0.059	0.076	0.335	0.078	0.073	0.078	0.150
Ny-Ålesund	0.381	1.102	0.831	0.155	0.142	0.093	0.036	0.059	0.025	0.074	0.035	0.032	0.211

Table A.9: Monthly and annual precipitation amount at Norwegian background stations in 2023. Unit: mm.

SITE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	2022
Birkenes	296	61	166	109	45	64	165	176	213	196	237	183	1911
Grungedal	133	61	78	80	19	58	171	188	166	74	68	52	1150
Treungen	157	31	81	88	11	50	134	146	184	73	96	51	1102
Løken	83	41	55	74	1	19	160	238	64	22	54	34	845
Hurdal	129	40	56	134	18	32	244	292	134	51	138	59	1329
Brekkebygda	124	38	49	101	0	84	206	407	136	36	73	46	1299
Vikedal	371	278	155	76	90	87	303	252	383	279	121	316	2710
Nausta	273	203	104	9	62	15	238	218	255	298	60	247	1983
Kårvatn	96	175	138	67	114	70	159	224	138	237	53	138	1610
Overhalla	83	140	75	51	110	85	92	80	145	148	34	77	1120
Tustervatn	136	121	80	6	91	42	59	89	168	105	40	64	1002
Svanvik	12	20	20	4	17	23	49	64	71	41	16	8	344
Ny-Ålesund	12	38	6	41	44	13	8	41	75	32	23	17	350

Table A.10: Monthly and annual mean concentrations of sulfur dioxide in air in 2023. Unit: µg S/m3.

SITE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	2023
Birkenes II	0.018	0.022	0.032	0.043	0.057	0.080	0.035	0.043	0.059	0.019	0.019	0.176	0.050
Hurdal	0.010	0.011	0.018	0.021	0.077	0.042	0.024	0.024	0.037	0.022	0.021	0.073	0.032
Kårvatn	0.017	0.013	0.022	0.023	0.022	0.033	0.029	0.024	0.032	0.028	0.017	0.124	0.032
Tustervatn	0.016	0.011	0.024	0.079	0.038	0.035	0.039	0.023	0.034	0.024	0.021	0.068	0.035
Zeppelinfjellet	0.077	0.065	0.112	0.429	0.025	0.022	0.025	0.039	0.027	0.016	0.101	0.028	0.080

Table A.11: Monthly and annual mean concentrations of sulfate in aerosol in 2023. Unit: µg S/m3.

SITE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	2023
Birkenes II	0.081	0.113	0.059	0.178	0.296	0.258	0.207	0.152	0.283	0.086	0.085	0.105	0.159
Hurdal	0.053	0.074	0.052	0.127	0.193	0.165	0.120	0.099	0.176	0.055	0.055	0.072	0.103
Kårvatn	0.022	0.043	0.076	0.091	0.180	0.211	0.136	0.072	0.061	0.027	0.043	0.068	0.084
Tustervatn	0.072	0.086	0.096	0.144	0.178	0.172	0.123	0.098	0.099	0.047	0.067	0.113	0.108
Zeppelinfjellet	0.137	0.108	0.171	0.281	0.120	0.074	0.056	0.040	0.020	0.046	0.077	0.093	0.102

Table A.12: Monthly and annual mean concentrations of nitrogen dioxide in 2023. Unit: µg N/m3.

SITE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	2023
Birkenes II	0.262	0.294	0.306	0.203	0.176	0.452	0.131	0.144	0.243	0.152	0.218	0.231	0.233
Hurdal	0.285	0.602	0.428	0.180	0.184	0.178	0.160	0.148	0.211	0.174	0.231	0.413	0.264
Kårvatn	0.143	0.171	0.111	0.085	0.074	0.119	0.105	0.056	0.093	0.060	0.241	0.132	0.115
Tustervatn	0.461	0.074	0.091	0.071	0.064	0.074	0.076	0.061	0.107	0.051	0.042	0.071	0.104

Table A.13: Monthly and annual mean concentrations of sum of nitrate and nitric acid in air in 2023. Unit: µg N/m3.

SITE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	2023
Birkenes II	0.073	0.132	0.041	0.156	0.163	0.129	0.103	0.122	0.195	0.038	0.053	0.046	0.104
Hurdal	0.092	0.122	0.043	0.056	0.081	0.063	0.052	0.064	0.101	0.027	0.059	0.066	0.068
Kårvatn	0.021	0.025	0.056	0.031	0.052	0.069	0.037	0.031	0.029	0.020	0.020	0.021	0.034
Tustervatn	0.026	0.031	0.035	0.056	0.061	0.041	0.029	0.033	0.041	0.021	0.022	0.024	0.035
Zeppelinfjellet	0.022	0.021	0.029	0.031	0.021	0.026	0.021	0.024	0.020	0.020	0.020	0.031	0.024

Table A.14: Monthly and annual mean concentrations of sum of ammonium and ammonia in air in 2023. Unit: µg N/m³.

SITE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	2023
Birkenes II	0.127	0.178	0.137	0.402	0.531	0.526	0.306	0.316	0.446	0.138	0.155	0.126	0.282
Hurdal	0.168	0.240	0.107	0.238	0.421	0.378	0.246	0.212	0.363	0.150	0.186	0.176	0.240
Kårvatn	0.496	0.436	0.462	0.349	0.643	0.812	0.884	0.532	0.493	0.365	0.315	0.602	0.529
Tustervatn	0.193	0.197	0.260	0.365	0.454	0.645	0.396	0.399	0.364	0.336	0.190	0.247	0.336
Zeppelinfjellet	0.176	0.197	0.246	0.256	0.342	0.226	0.246	0.341	0.291	0.187	0.225	0.200	0.245

Table A.15: Monthly and annual mean of aerosol mass concentrations in 2023. Unit: µg/m³.

SITE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	2023
							PM_{10}						
Birkenes	2.08	3.59	1.79	4.12	7.18	8.10	4.27	3.88	6.00	3.06	2.98	1.11	4.18
Hurdal	2.39	2.74	2.83	2.95	5.46	7.08	4.27	5.24	5.45	2.57	1.97	2.44	3.80
Kårvatn	0.87	1.68	1.51	2.10	4.23	5.97	3.41	2.97	3.74	1.77	1.64	1.40	2.62
							$PM_{2.5}$						
Birkenes II	1.43	1.56	1.06	2.54	3.51	4.98	2.68	3.04	3.23	1.39	3.89	0.74	2.60
Hurdal	1.85	2.17	1.45	1.92	3.82	4.64	2.12	1.89	2.61	1.21	1.65	2.05	2.28
Kårvatn	0.45	0.81	0.72	2.26	2.71	4.09	2.13	1.51	1.46	0.75	0.66	0.94	1.54

Table A.16: Monthly and annual mean concentrations of organic carbon (OC) in 2023. Unit: µgC/m³.

SITE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	2023
							OC in PM_{10}						
Birkenes II	0.257	0.467	0.350	0.790	1.450	2.145	0.808	0.956	1.043	0.475	0.412	0.380	0.799
Hurdal	0.538	0.604	0.407	0.588	1.386	2.365	1.641	2.197	1.768	0.924	0.527	0.655	1.134
Kårvatn	0.188	0.214	0.239	0.440	0.792	1.758	1.391	1.306	1.368	0.562	0.264	0.303	0.733
Zeppelin	0.096	-	0.144	0.208	0.065	0.069	0.187	0.140	0.076	0.090	0.071	0.265	0.125
							OC in $PM_{2.5}$						
Birkenes II	0.216	0.418	0.326	0.658	1.101	1.587	0.490	0.474	0.587	0.297	0.313	0.310	0.564
Hurdal	0.506	0.581	0.335	0.512	1.083	1.758	0.714	0.661	0.836	0.420	0.447	0.652	0.708
Kårvatn	0.149	0.196	0.211	0.416	0.679	1.437	0.786	0.632	0.529	0.313	0.262	0.275	0.491

Table A.17: Monthly and annual mean concentrations of elemental carbon (EC) in 2023. Unit: µgC/m³.

SITE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	2023
	EC in PM_{10}												
Birkenes II	0.044	0.055	0.059	0.075	0.083	0.060	0.024	0.035	0.059	0.033	0.071	0.048	0.054
Hurdal	0.112	0.118	0.071	0.068	0.083	0.058	0.036	0.047	0.070	0.058	0.095	0.127	0.078
Kårvatn	0.019	0.031	0.021	0.055	0.041	0.038	0.027	0.026	0.050	0.032	0.079	0.059	0.039
Zeppelinfjellet	0.007	-	0.021	0.029	0.008	0.007	0.009	0.006	0.003	0.003	0.009	0.034	0.011
	EC in $PM_{2.5}$												
Birkenes II	0.043	0.061	0.058	0.063	0.065	0.047	0.030	0.036	0.051	0.034	0.060	0.049	0.050
Hurdal	0.110	0.115	0.071	0.061	0.090	0.053	0.030	0.049	0.077	0.054	0.092	0.130	0.077
Kårvatn	0.019	0.035	0.023	0.055	0.043	0.045	0.025	0.028	0.041	0.034	0.071	0.055	0.040

Table A.18: Monthly and annual mean concentrations of levoglucosan in PM_{10} in 2023. Unit: ng /m³.

SITE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	2023
Birkenes II	7.23	14.50	9.55	11.67	5.54	4.33	1.15	1.36	3.18	8.25	13.83	15.40	7.85
Zeppelinfjellet	0.767	-	0.938	0.054	0.021	0.052	0.229	0.206	0.421	0.986	0.402	1.176	0.449

Table A.19: Different metrics for ozone in 2023: The annual number of days with Max Daily 8h running average (MDA8) exceeding different health indicators and thresholds, and Accumulated exposure over the threshold of 40 ppb (AOT40) during the growing season for forest (6 months: 1 April – 30 Sept.), semi-natural vegetation (1 May – 31 July) and the maximum hourly concentrations. The values above the critical levels for vegetation are marked in bold.

	6-months MDA8, µg/m³	MDA8 >80 µg/m³	MDA8 >120 µg/m³	AOT 40 (ppb hours)		Max hourly conc.	
Site	(AQG= 60 µg/m³)	nr of days	nr of days	3 months, vegetation	6 months, forest	µg /m³	Date
Birkenes II	83	123	1	**3024**	4454	125	14/05/2023
Hurdal	77	103	0	2968	3887	123	14/06/2023
Prestebakke	83	102	0	**3935**	**5119**	133	13/05/2023
Haukenes	77	106	0	2577	3476	127	13/05/2023
Sandve	81	99	1	1478	2908	135	11/09/2023
Kårvatn	71	99	0	1737	3595	119	14/05/2023
Tustervatn	72	113	0	805	2596	116	10/09/2023
Svanvik	69	68	0	669	1648	111	16/05/2023
Zeppelin	72	120	0	488	1817	112	14/04/2023

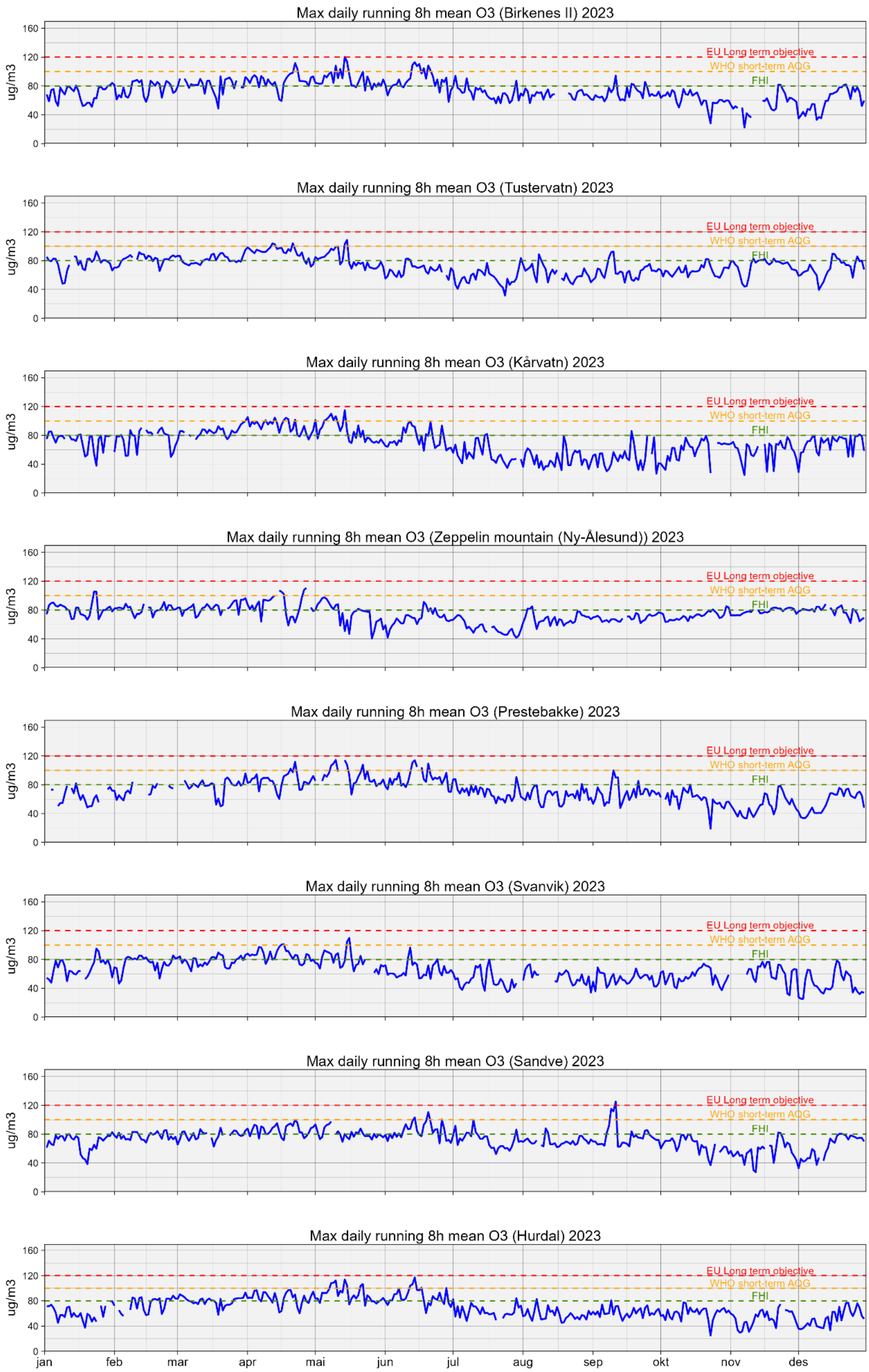


Figure A.1: Norwegian ozone sites in 2023 compared to threshold and target values set by (EU, 2008; FHI, 2013, 2023; WHO, 2021).

Appendix B

Trend results 2000(2010) to 2023

Table B.1: Absolute and relative change and corresponding 95% confidence intervals in annual concentrations for sulfur and nitrogen compounds in air and precipitation for 2000-2023 and 2010-2023. The number of sites with a significant outcome is provided.

		Nr of sites		Abs. change (mg/L or ug S(N)/m^3)/y		Relative change (%/y)	
component	period	tot	sign	slope	Conf. Interval.	slope	Conf. Interval.
SO_2	2000-2023	5	5	-0.003	(-0.004, -0.002)	-2.94	(-3.75, -2.13)
SO_2	2010-2023	5	3	-0.003	(-0.005, -0.001)	-3.9	(-6.36, -1.44)
SO_4^{2-} in aerosols	2000-2023	5	5	-0.007	(-0.013, -0.001)	-2.65	(-3.69, -1.61)
SO_4^{2-} in aerosols	2010-2023	5	4	-0.006	(-0.011, -0.001)	-2.94	(-4.79, -1.09)
SO_4^{2-} in precip.	2000-2023	11	11	-0.007	(-0.01, -0.004)	-3.26	(-3.6, -2.92)
SO_4^{2-} in precip.	2010-2023	10	6	-0.006	(-0.009, -0.003)	-3.76	(-4.51, -3.01)
NO_2	2000-2023	4	4	-0.012	(-0.03, 0.006)	-2.48	(-3.34, -1.62)
NO_2	2010-2023	4	3	-0.014	(-0.039, 0.011)	-2.94	(-5.71, -0.17)
NO_3^- in aerosol	2000-2023	5	1	-0.002	(-0.003, -0.001)	-2.46	(-3.9, -1.02)
NO_3^- in aerosol	2010-2023	5	5	-0.01	(-0.015, -0.005)	-8.01	(-9.89, -6.13)
sum(HNO_3 NO_3^-)	2000-2023	5	5	-0.004	(-0.007, -0.001)	-2.57	(-3.28, -1.86)
sum(HNO_3+NO_3^-)	2010-2023	5	5	-0.014	(-0.023, -0.005)	-7.57	(-8.82, -6.32)
NO_3^- in precip.	2000-2023	11	8	-0.004	(-0.006, -0.002)	-1.41	(-2.23, -0.59)
NO_3^- in precip.	2010-2023	10	6	-0.005	(-0.008, -0.002)	-2.3	(-3.24, -1.36)
NH_4^+ in aerosol	2000-2023	5	4	-0.005	(-0.01, -0.0)	-2.79	(-3.47, -2.11)
NH_4^+ in aerosol	2010-2023	5	4	-0.01	(-0.016, -0.004)	-6.13	(-7.32, -4.94)
sum(NH_4^++NH_3)	2000-2040	5	3	-0.01	(-0.028, 0.008)	-1.09	(-3.63, 1.45)
sum(NH_4^++NH_3)	2010-2023	5	3	-0.026	(-0.041, -0.011)	-5.12	(-7.13, -3.11)
NH_4^+ in precip.	2000-2023	11	6	-0.003	(-0.005, -0.001)	-1.04	(-1.72, -0.36)
NH_4^+ in precip.	2010-2023	10	7	-0.008	(-0.011, -0.005)	-3.17	(-4.15, -2.19)

Table B.2: Absolute and relative change and corresponding 95% confidence intervals in annual concentrations for selected ozone metrics for 2000-2023 and 2010-2023. The number of sites with a significant outcome is provided.

		Nr of sites		Abs. change (μg/m^3/y or ppb h/y)		Relative change (%/y)	
component	period	tot	sign	slope	Conf. Interval.	slope	Conf. Interval.
AOT_3mon	2000-2023	8	5	-66	(-97, -35)	-2.54	(-3.41, -1.67)
AOT_3mon	2010-2023	8	0	-8	(-36, 19)	-0.43	(-1.95, 1.09)
AOT_6mon	2000-2023	8	5	-109	(-162, -55)	-2.05	(-2.88, -1.22)
AOT_6mon	2010-2023	8	0	4	(-48, 56)	0.35	(-1.67, 2.37)
MDA8_6mon	2000-2023	8	1	-0.22	(-0.35, -0.09)	-0.27	(-0.43, -0.11)
MDA8_6mon	2010-2023	8	1	-0.30	(-0.77, 0.18)	-0.33	(-0.86, 0.20)

Table B.3: Average absolute and relative changes and corresponding 95% confidence intervals in annual concentrations for aerosol mass concentration, organic- and elemental carbon, and levoglucosan for 2000(1)-2023 and 2011-2023. Individual trends for the different sites and components are also provided.

				Absolute change		Relative change	
Site	Period	component	p_value	µg/m³/y	Conf. Int.	%/y	Conf. Int.
Birkenes	2000-2023	PM_{10} mass conc.	0.0001	-0.113	(-0.156, -0.07)	-1.68	(-2.33, -1.05)
Birkenes	2001-2023	$PM_{2.5}$ mass conc.	0.00002	-0.097	(-0.127, -0.068)	-2.35	(-3.07, -1.64)
Birkenes	2002-2023	PM_{10}-$PM_{2.5}$ mass	0.38	-0.013	(-0.039, 0.013)	-0.55	(-1.66, 0.54)
Birkenes	2001-2023	TC in PM_{10}	0.0051	-0.015	(-0.023, -0.007)	-1.36	(-2.09, -0.67)
Birkenes	2001-2023	TC in $PM_{2.5}$	0.0013	-0.014	(-0.021, -0.007)	-1.69	(-2.55, -0.8)
Birkenes	2001-2023	OC in PM_{10}	0.013	-0.01	(-0.018, -0.003)	-1.15	(-1.9, -0.34)
Birkenes	2001-2023	OC in $PM_{2.5}$	0.0051	-0.010	(-0.016, -0.003)	-1.43	(-2.36, -0.44)
Birkenes	2001-2023	OC in PM_{10}-$PM_{2.5}$	0.74	0	(-0.004, 0.003)	0	(-1.54, 1.18)
Birkenes	2001-2023	EC in PM_{10}	0.000007	-0.004	(-0.005, -0.003)	-3.12	(-3.67, -2.11)
Birkenes	2001-2023	EC in $PM_{2.5}$	0.000001	-0.003	(-0.005, -0.002)	-3.25	(-3.72, -2.29)
Birkenes	2011-2023	PM_{10} mass conc.	0.04	-0.143	(-0.249, -0.038)	-2.49	(-4.34, -0.66)
Hurdal	2011-2023	PM_{10} mass conc.	0.06	-0.072	(-0.158, 0.014)	-1.57	(-3.45, 0.31)
Kårvatn	2011-2023	PM_{10} mass conc.	0.2	-0.073	(-0.153, 0.006)	-2.17	(-4.54, 0.19)
		Average PM_{10}		-0.096	(-0.197, 0.005)	-2.08	(-3.24, -0.92)
Birkenes	2011-2023	$PM_{2.5}$ mass conc.	0.009	-0.1	(-0.162, -0.039)	-3.03	(-4.89, -1.17)
Hurdal	2011-2023	$PM_{2.5}$ mass conc.	0.009	-0.09	(-0.162, -0.026)	-2.84	(-4.89, -0.77)
Kårvatn	2011-2023	$PM_{2.5}$ mass conc.	0.047	-0.095	(-0.174, -0.016)	-3.73	(-6.85, -0.63)
		Average $PM_{2.5}$		-0.095	(-0.105, -0.085)	-3.2	(-4.38, -2.02)
Birkenes	2011-2023	OC in PM_{10}	0.67	0.003	(-0.014, 0.019)	0.4	(-1.84, 2.56)
Hurdal	2011-2023	OC in PM_{10}	0.95	-0.001	(-0.022, 0.021)	-0.09	(-1.97, 1.8)
Kårvatn	2011-2023	OC in PM_{10}	0.30	-0.009	(-0.023, 0.004)	-1.15	(-2.99, 0.56)
		Average OC in PM_{10}		-0.002	(-0.017, 0.013)	-0.28	(-2.25, 1.69)
Birkenes	2011-2023	OC in $PM_{2.5}$	1.0	0.001	(-0.01, 0.011)	0.18	(-1.71, 1.97)
Hurdal	2011-2023	OC in $PM_{2.5}$	0.2	-0.008	(-0.022, 0.005)	-1.0	(-2.81, 0.62)
Kårvatn	2011-2023	OC in $PM_{2.5}$	0.06	-0.013	(-0.024, -0.001)	-2.17	(-4.03, - 0.2)
		Average OC in $PM_{2.5}$		-0.007	(-0.025, 0.011)	-1	(-3.89, 1.89)
Birkenes	2011-2023	EC in PM_{10}	0.009	-0.003	(-0.005, -0.001)	-3.12	(-5.0, -1.42)
Hurdal	2011-2023	EC in PM_{10}	0.002	-0.006	(-0.008, -0.004)	-4.29	(-5.76, -2.88)
Kårvatn	2011-2023	EC in PM_{10}	0.002	-0.003	(-0.004, -0.002)	-3.9	(-5.42, -2.36)
		Average EC in PM_{10}		-0.004	(-0.009, 0.001)	-3.68	(-5.14, -2.22)
Birkenes	2008-2023	Levoglucosan in PM_{10}	0.003	-0.260	(-0.466, -0.054)	-2.24	(-4.01, -0.47)

Appendix C

Annual average concentrations all years

Table C.1: Volume weighted annual mean concentrations and wet deposition of main components in precipitation at Norwegian background stations in 1973-2023.

Site	Code	Year	xSO4-S	NO3-N	NH4-N	K	Ca	Cl	Mg	Na	pH	mm	Capture
Birkenes	NO0001R	1972	1,215						0,15	0,78	4,23	1456	100
Birkenes	NO0001R	1973	1,091		0,377		0,15		0,11		4,27	1072	100
Birkenes	NO0001R	1974	1,113	0,519	0,538		0,23		0,19		4,25	1563	100
Birkenes	NO0001R	1975	1,019	0,480	0,485		0,20		0,17		4,27	1341	100
Birkenes	NO0001R	1976	1,181	0,545	0,538		0,18		0,12		4,25	1430	100
Birkenes	NO0001R	1977	1,046	0,451	0,561		0,17	2,51	0,17	1,37	4,27	1597	100
Birkenes	NO0001R	1978	1,177	0,619	0,577		0,17	1,71	0,12	0,95	4,11	1242	100
Birkenes	NO0001R	1979	1,238	0,565	0,647		0,22	2,33	0,15	1,26	4,09	1560	100
Birkenes	NO0001R	1980	1,224	0,575	0,630	0,16	0,21	1,58	0,12	0,85	4,16	1158	100
Birkenes	NO0001R	1981	1,053	0,518	0,525	0,14	0,20	1,82	0,14	0,99	4,21	1317	100
Birkenes	NO0001R	1982	1,056	0,557	0,714	0,18	0,22	3,32	0,21	1,51	4,27	1592	100
Birkenes	NO0001R	1983	0,920	0,491	0,495	0,21	0,24	2,31	0,17	1,35	4,32	1312	100
Birkenes	NO0001R	1984	1,093	0,565	0,622	0,21	0,21	2,81	0,19	1,55	4,24	1600	100
Birkenes	NO0001R	1985	0,971	0,574	0,570	0,21	0,16	1,39	0,09	0,78	4,24	1413	100
Birkenes	NO0001R	1986	0,898	0,509	0,566	0,16	0,16	1,87	0,13	1,05	4,30	1148	87
Birkenes	NO0001R	1987	0,740	0,424	0,455	0,19	0,13	1,82	0,13	1,08	4,38	1570	100
Birkenes	NO0001R	1988	0,807	0,557	0,590	0,16	0,14	1,59	0,12	0,93	4,26	1921	98
Birkenes	NO0001R	1989	0,865	0,738	0,607	0,17	0,17	2,95	0,19	1,55	4,27	1159	93
Birkenes	NO0001R	1990	0,708	0,465	0,457	0,14	0,14	3,20	0,21	1,75	4,37	1856	99
Birkenes	NO0001R	1991	0,745	0,569	0,496	0,14	0,14	2,79	0,19	1,52	4,33	1245	100
Birkenes	NO0001R	1992	0,736	0,522	0,437	0,07	0,12	2,00	0,13	1,17	4,37	1346	100
Birkenes	NO0001R	1993	0,773	0,550	0,510	0,12	0,15	3,63	0,23	1,98	4,37	1245	100
Birkenes	NO0001R	1994	0,637	0,549	0,506	0,06	0,15	1,69	0,12	0,93	4,48	1396	100
Birkenes	NO0001R	1995	0,508	0,472	0,394	0,07	0,09	2,03	0,14	1,19	4,48	1393	99
Birkenes	NO0001R	1996	0,581	0,518	0,455	0,08	0,12	2,13	0,15	1,22	4,43	1187	99

Site	Code	Year	xSO4-S	NO3-N	NH4-N	K	Ca	Cl	Mg	Na	pH	mm	Capture
Birkenes	NO0001R	1997	0,526	0,496	0,450	0,09	0,10	2,07	0,13	1,09	4,50	1239	100
Birkenes	NO0001R	1998	0,527	0,453	0,414	0,08	0,10	1,84	0,13	1,02	4,50	1494	97
Birkenes	NO0001R	1999	0,453	0,412	0,335	0,08	0,10	2,18	0,14	1,20	4,59	1717	96
Birkenes	NO0001R	2000	0,384	0,467	0,309	0,09	0,09	3,58	0,23	1,83	4,50	1181	100
Birkenes	NO0001R	2001	0,421	0,409	0,366	0,04	0,06	1,31	0,09	0,77	4,61	1222	79
Birkenes	NO0001R	2002	0,354	0,328	0,316	0,09	0,10	1,52	0,12	0,90	4,72	1574	100
Birkenes	NO0001R	2003	0,459	0,504	0,469	0,08	0,12	1,52	0,11	0,87	4,59	1374	100
Birkenes	NO0001R	2004	0,361	0,363	0,334	0,06	0,12	1,77	0,14	1,08	4,69	1700	100
Birkenes	NO0001R	2005	0,428	0,472	0,421	0,08	0,13	2,72	0,18	1,63	4,68	1240	100
Birkenes	NO0001R	2006	0,318	0,424	0,341	0,08	0,10	2,11	0,15	1,18	4,70	1834	100
Birkenes	NO0001R	2007	0,304	0,326	0,277	0,06	0,11	1,61	0,12	0,96	4,75	1447	100
Birkenes	NO0001R	2008	0,257	0,348	0,286	0,08	0,13	2,59	0,20	1,59	4,77	1990	100
Birkenes	NO0001R	2009	0,327	0,438	0,365	0,07	0,10	1,97	0,15	1,22	4,72	1807	100
Birkenes	NO0001R	2010	0,376	0,459	0,361	0,06	0,10	1,35	0,08	0,75	4,69	1113	100
Birkenes	NO0001R	2011	0,258	0,385	0,422	0,10	0,12	2,65	0,19	1,50	4,86	1778	100
Birkenes	NO0001R	2012	0,225	0,380	0,326	0,09	0,16	1,87	0,13	1,07	4,86	1993	100
Birkenes	NO0001R	2013	0,212	0,350	0,366	0,10	0,17	2,30	0,16	1,34	4,97	1427	100
Birkenes	NO0001R	2014	0,313	0,348	0,350	0,10	0,16	2,46	0,18	1,44	4,77	2335	100
Birkenes	NO0001R	2015	0,178	0,292	0,283	0,10	0,15	2,27	0,16	1,29	4,91	2173	100
Birkenes	NO0001R	2016	0,173	0,346	0,293	0,12	0,15	2,27	0,16	1,32	4,91	1414	100
Birkenes	NO0001R	2017	0,196	0,311	0,292	0,10	0,17	2,02	0,14	1,17	4,95	2088	100
Birkenes	NO0001R	2018	0,204	0,432	0,444	0,09	0,14	2,60	0,18	1,49	4,95	1515	100
Birkenes	NO0001R	2019	0,156	0,262	0,239	0,08	0,12	1,25	0,09	0,74	4,99	2010	100
Birkenes	NO0001R	2020	0,159	0,290	0,283	0,09	0,16	2,43	0,17	1,41	5,03	2286	100
Birkenes	NO0001R	2021	0,167	0,328	0,304	0,10	0,20	2,21	0,15	1,29	5,02	1478	100
Birkenes	NO0001R	2022	0,104	0,240	0,225	0,08	0,14	2,23	0,14	1,30	5,04	1618	100
Birkenes	NO0001R	2023	0,097	0,213	0,237	0,08	0,09	1,74	0,10	1,06	5,07	1911	100

Site	Code	Year	xSO4-S	NO3-N	NH4-N	K	Ca	Cl	Mg	Na	pH	mm	Capture
Vatnedalen	NO0237R	1974	0,545	0,071	0,083				0,06		4,53	880	100
Vatnedalen	NO0237R	1975	0,513	0,168	0,221				0,10		4,66	993	100
Vatnedalen	NO0237R	1976	0,497	0,184	0,357				0,10		4,77	717	100
Vatnedalen	NO0237R	1977	0,432	0,202	0,249		0,13		0,06		4,71	761	100
Vatnedalen	NO0237R	1978	0,399	0,154	0,224		0,14		0,10		4,62	862	100
Vatnedalen	NO0237R	1979	0,563	0,218	0,197		0,20		0,06		4,38	948	100
Vatnedalen	NO0237R	1980	0,451	0,157	0,101	0,09	0,14	0,96	0,06	0,57	4,55	792	100
Vatnedalen	NO0237R	1981	0,488	0,188	0,175	0,11	0,15	1,23	0,09	0,73	4,49	906	98
Vatnedalen	NO0237R	1982	0,383	0,179	0,163	0,14	0,13	1,13	0,08	0,63	4,62	966	93
Vatnedalen	NO0237R	1983	0,294	0,134	0,105		0,14	1,08	0,08		4,75	1235	96
Vatnedalen	NO0237R	1984	0,390	0,176	0,127		0,16	1,10	0,08		4,60	777	96
Vatnedalen	NO0237R	1985	0,432	0,218	0,189		0,15	0,43	0,04		4,57	794	96
Vatnedalen	NO0237R	1986	0,511	0,214	0,185	0,22	0,13	0,89	0,07	0,68	4,54	987	100
Vatnedalen	NO0237R	1987	0,413	0,167	0,146	0,17	0,12	0,53	0,04	0,39	4,60	730	100
Vatnedalen	NO0237R	1988	0,369	0,230	0,203	0,09	0,13	0,85	0,08	0,50	4,55	898	100
Vatnedalen	NO0237R	1989	0,341	0,223	0,290	0,10	0,13	1,02	0,08	0,57	4,78	980	100
Vatnedalen	NO0237R	1990	0,267	0,140	0,116	0,10	0,14	1,50	0,11	0,76	4,71	1448	80
Vatnedalen	NO0237R	1991	0,323	0,199	0,170	0,11	0,29	1,38	0,12	0,76	4,69	865	99
Vatnedalen	NO0237R	1992	0,285	0,166	0,106	0,10	0,15	1,30	0,10	0,72	4,75	1055	97
Vatnedalen	NO0237R	1993	0,227	0,178	0,103	0,18	0,23	6,48	0,44	3,54	4,83	894	100
Vatnedalen	NO0237R	1994	0,285	0,216	0,154	0,05	0,08	1,16	0,08	0,66	4,75	1005	100
Vatnedalen	NO0237R	1995	0,250	0,177	0,131	0,12	0,11	1,28	0,10	0,83	4,82	824	100
Vatnedalen	NO0237R	1996	0,308	0,232	0,206	0,10	0,16	0,53	0,04	0,39	4,78	601	100
Vatnedalen	NO0237R	1997	0,237	0,151	0,142	0,11	0,22	1,76	0,10	1,07	4,95	858	100
Vatnedalen	NO0237R	1998	0,253	0,180	0,285	0,08	0,13	0,97	0,06	0,61	5,02	902	100
Vatnedalen	NO0237R	1999	0,237	0,162	0,244	0,12	0,12	1,27	0,08	0,73	5,05	1133	100
Vatnedalen	NO0237R	2000	0,153	0,142	0,146	0,09	0,11	1,32	0,08	0,77	5,02	1296	100

Site	Code	Year	xSO4-S	NO3-N	NH4-N	K	Ca	Cl	Mg	Na	pH	mm	Capture
Vatnedalen	NO0237R	2001	0,163	0,092	0,103	0,10	0,12	0,69	0,05	0,50	5,27	709	96
Vatnedalen	NO0237R	2002	0,220	0,139	0,167	0,16	0,15	0,96	0,08	0,55	5,02	590	100
Vatnedalen	NO0237R	2003	0,174	0,165	0,145	0,13	0,16	0,66	0,06	0,42	4,97	803	100
Vatnedalen	NO0237R	2004	0,174	0,125	0,199	0,14	0,19	0,84	0,06	0,63	5,30	969	100
Vatnedalen	NO0237R	2005	0,187	0,150	0,138	0,07	0,16	0,68	0,05	0,46	5,17	1073	100
Vatnedalen	NO0237R	2006	0,121	0,161	0,115	0,10	0,12	0,72	0,06	0,47	5,17	1011	100
Vatnedalen	NO0237R	2007	0,102	0,105	0,131	0,12	0,17	1,06	0,10	0,73	5,31	846	100
Vatnedalen	NO0237R	2008	0,102	0,169	0,134	0,14	0,24	1,49	0,14	0,94	5,34	1020	98
Vatnedalen	NO0237R	2009	0,168	0,181	0,147	0,16	0,21	0,68	0,05	0,42	5,35	815	100
Vatnedalen	NO0237R	2010	0,185	0,154	0,197	0,21	0,16	0,50	0,04	0,36	5,38	595	95
Vatnedalen	NO0237R	2011	0,094	0,107	0,240	0,13	0,17	0,98	0,07	0,65	5,51	1225	98
Vatnedalen	NO0237R	2012	0,080	0,131	0,115	0,09	0,15	0,61	0,04	0,52	5,44	831	99
Vatnedalen	NO0237R	2013	0,093	0,135	0,347	0,15	0,14	0,78	0,05	0,60	5,50	991	98
Vatnedalen	NO0237R	2014	0,167	0,148	0,174	0,14	0,23	0,99	0,07	0,92	5,44	957	100
Vatnedalen	NO0237R	2015	0,072	0,090	0,120	0,13	0,16	1,56	0,10	1,27	5,50	1166	99
Vatnedalen	NO0237R	2016	0,086	0,078	0,114	0,17	0,14	2,72	0,17	1,83	5,30	814	100
Vatnedalen	NO0237R	2017	0,083	0,104	0,122	0,11	0,08	0,87	0,03	0,84	5,52	1272	100
Vatnedalen	NO0237R	2018	0,097	0,126	0,131	0,11	0,10	0,84	0,04	0,83	5,51	967	98
Vatnedalen	NO0237R	2019	0,101	0,107	0,136	0,13	0,08	0,79	0,03	0,92	5,72	1033	100
Vatnedalen	NO0237R	2020	0,069	0,063	0,032	0,15	0,16	1,08	0,05	0,94	5,53	1280	99
Vatnedalen	NO0237R	2021	0,112	0,113	0,120	0,19	0,15	0,73	0,05	0,69	5,50	633	100
Vatnedalen	NO0237R	2022	0,120	0,119	0,127	0,16	0,27	1,45	0,08	1,18	5,57	773	99
Grungedal	NO0239R	2023	0,074	0,190	0,123	0,08	0,09	0,35	0,03	0,29	5,14	1150	100
Treungen	NO0236R	1974	0,941				0,15		0,07		4,27	1039	100
Treungen	NO0236R	1975	0,948	0,415	0,379		0,16		0,06		4,25	891	100
Treungen	NO0236R	1976	1,044	0,522	0,422		0,10		0,06		4,20	688	94
Treungen	NO0236R	1977	0,814	0,443	0,390		0,11	0,62	0,05	0,32	4,32	1166	100

Site	Code	Year	xSO4-S	NO3-N	NH4-N	K	Ca	Cl	Mg	Na	pH	mm	Capture
Treungen	NO0236R	1978	0,874	0,377	0,411		0,14	0,50	0,04	0,25	4,22	945	100
Treungen	NO0236R	1979											
Treungen	NO0236R	1980	0,886	0,367	0,386	0,07	0,14	0,47	0,04	0,25	4,23	758	99
Treungen	NO0236R	1981	0,867	0,392	0,464	0,09	0,12	0,60	0,05	0,34	4,29	948	93
Treungen	NO0236R	1982	0,847	0,446	0,500	0,08	0,14	0,94	0,07	0,47	4,32	1130	90
Treungen	NO0236R	1983	0,832	0,395	0,433		0,18	0,69	0,05		4,35	1089	91
Treungen	NO0236R	1984	0,765	0,363	0,266		0,15	0,66	0,05		4,27	1196	93
Treungen	NO0236R	1985	0,681	0,393	0,375	0,08	0,13	0,45	0,04	0,45	4,33	892	92
Treungen	NO0236R	1986	1,069	0,565	0,631	0,12	0,14	0,85	0,07	0,47	4,19	1030	100
Treungen	NO0236R	1987	0,678	0,374	0,369	0,10	0,13	0,90	0,07	0,49	4,39	1130	100
Treungen	NO0236R	1988	0,744	0,497	0,454	0,05	0,10	0,50	0,05	0,28	4,27	1348	100
Treungen	NO0236R	1989	0,756	0,605	0,436	0,05	0,10	0,91	0,06	0,45	4,26	754	100
Treungen	NO0236R	1990	0,631	0,425	0,366	0,05	0,06	1,02	0,07	0,51	4,37	1182	75
Treungen	NO0236R	1991	0,594	0,425	0,346	0,06	0,13	0,82	0,06	0,40	4,42	806	99
Treungen	NO0236R	1992	0,606	0,395	0,336	0,05	0,08	0,69	0,05	0,41	4,44	923	100
Treungen	NO0236R	1993	0,589	0,409	0,322	0,07	0,11	1,39	0,09	0,74	4,46	792	100
Treungen	NO0236R	1994	0,536	0,443	0,351	0,04	0,08	0,73	0,05	0,38	4,49	1015	100
Treungen	NO0236R	1995	0,499	0,438	0,399	0,07	0,09	0,99	0,08	0,56	4,48	904	100
Treungen	NO0236R	1996	0,485	0,400	0,373	0,04	0,10	0,70	0,05	0,37	4,49	839	100
Treungen	NO0236R	1997	0,407	0,372	0,318	0,04	0,12	0,69	0,06	0,35	4,56	887	100
Treungen	NO0236R	1998	0,480	0,401	0,414	0,06	0,09	0,57	0,04	0,31	4,53	959	100
Treungen	NO0236R	1999	0,350	0,323	0,308	0,04	0,06	0,80	0,06	0,42	4,67	1330	100
Treungen	NO0236R	2000	0,327	0,362	0,308	0,05	0,08	0,97	0,07	0,53	4,59	1562	100
Treungen	NO0236R	2001	0,303	0,285	0,275	0,04	0,05	0,45	0,04	0,25	4,77	1141	100
Treungen	NO0236R	2002	0,316	0,269	0,281	0,05	0,08	0,42	0,04	0,24	4,79	934	100
Treungen	NO0236R	2003	0,348	0,365	0,349	0,04	0,09	0,44	0,04	0,25	4,67	1002	100
Treungen	NO0236R	2004	0,309	0,298	0,264	0,06	0,10	0,69	0,06	0,40	4,79	1271	100

Site	Code	Year	xSO4-S	NO3-N	NH4-N	K	Ca	Cl	Mg	Na	pH	mm	Capture
Treungen	NO0236R	2005	0,343	0,377	0,366	0,06	0,11	0,86	0,06	0,51	4,75	898	100
Treungen	NO0236R	2006	0,234	0,284	0,204	0,05	0,09	0,62	0,05	0,37	4,79	1522	100
Treungen	NO0236R	2007	0,225	0,241	0,177	0,05	0,08	0,45	0,04	0,27	4,82	1008	100
Treungen	NO0236R	2008	0,208	0,276	0,256	0,06	0,11	0,76	0,08	0,53	4,93	1150	100
Treungen	NO0236R	2009	0,214	0,336	0,249	0,05	0,06	0,92	0,06	0,48	4,82	1213	100
Treungen	NO0236R	2010	0,285	0,340	0,319	0,03	0,07	0,42	0,03	0,23	4,79	849	100
Treungen	NO0236R	2011	0,194	0,262	0,230	0,05	0,09	0,62	0,05	0,34	4,95	1177	100
Treungen	NO0236R	2012	0,153	0,281	0,226	0,05	0,07	0,69	0,05	0,38	4,96	1092	100
Treungen	NO0236R	2013	0,165	0,265	0,303	0,08	0,09	0,71	0,06	0,42	5,12	1151	100
Treungen	NO0236R	2014	0,213	0,278	0,262	0,06	0,11	0,82	0,07	0,48	4,90	1463	100
Treungen	NO0236R	2015	0,124	0,210	0,185	0,07	0,11	0,81	0,07	0,48	4,96	1153	99
Treungen	NO0236R	2016	0,157	0,275	0,297	0,09	0,09	0,77	0,07	0,47	4,98	957	100
Treungen	NO0236R	2017	0,142	0,224	0,243	0,07	0,11	0,45	0,05	0,27	5,12	1186	100
Treungen	NO0236R	2018	0,152	0,296	0,281	0,05	0,10	0,62	0,05	0,37	5,02	878	100
Treungen	NO0236R	2019	0,119	0,186	0,198	0,07	0,11	0,35	0,03	0,20	5,15	1644	100
Treungen	NO0236R	2020	0,091	0,147	0,159	0,05	0,10	0,55	0,04	0,32	5,21	1587	100
Treungen	NO0236R	2021	0,123	0,198	0,166	0,09	0,15	0,71	0,06	0,42	5,11	1026	100
Treungen	NO0236R	2022	0,074	0,174	0,092	0,04	0,12	0,59	0,04	0,34	5,07	1028	100
Treungen	NO0236R	2023	0,091	0,174	0,180	0,05	0,08	0,41	0,03	0,25	5,04	1102	100
Løken	NO0218R	1972	1,117				0,54		0,09	0,50	4,35	614	100
Løken	NO0218R	1973	1,031						0,06		4,47	569	100
Løken	NO0218R	1974	0,942	0,325	0,236				0,08		4,43	828	100
Løken	NO0218R	1975	1,033	0,439	0,422				0,08		4,33	659	100
Løken	NO0218R	1976	1,184	0,496	0,496				0,09		4,34	532	100
Løken	NO0218R	1977	0,958	0,416	0,427		0,22		0,07		4,41	699	100
Løken	NO0218R	1978	1,082	0,474	0,515		0,24		0,07		4,25	597	100
Løken	NO0218R	1979	1,024	0,483	0,568		0,30		0,07		4,22	783	100

Site	Code	Year	xSO4-S	NO3-N	NH4-N	K	Ca	Cl	Mg	Na	pH	mm	Capture
Løken	NO0218R	1980	0,976	0,384	0,497	0,16	0,25	1,54	0,08	0,90	4,33	695	100
Løken	NO0218R	1981	0,768			0,16	0,20	0,76	0,06	0,55	4,48	700	97
Løken	NO0218R	1982	1,071	0,601	0,794	0,18	0,23	1,48	0,11	0,75	4,33	858	92
Løken	NO0218R	1983	0,906	0,473	0,606		0,28	1,17	0,10		4,42	656	94
Løken	NO0218R	1984	0,903	0,486	0,747		0,30	1,18	0,10		4,45	746	96
Løken	NO0218R	1985	0,857	0,471	0,510		0,30	0,79	0,09		4,36	896	96
Løken	NO0218R	1986	0,958	0,569		0,17	0,26	0,96	0,07	0,58	4,31	700	100
Løken	NO0218R	1987	0,789	0,403	0,449	0,14	0,17	0,69	0,06	0,44	4,40	859	100
Løken	NO0218R	1988	0,759	0,495	0,487	0,12	0,20	0,95	0,08	0,59	4,31	882	100
Løken	NO0218R	1989	0,923	0,693	0,568	0,11	0,18	1,40	0,10	0,75	4,26	421	100
Løken	NO0218R	1990	0,736	0,469	0,436	0,09	0,12	1,12	0,08	0,58	4,36	718	71
Løken	NO0218R	1991	0,649	0,497	0,444	0,12	0,18	1,29	0,09	0,67	4,41	722	100
Løken	NO0218R	1992	0,611	0,441	0,380	0,09	0,11	0,90	0,05	0,53	4,46	687	100
Løken	NO0218R	1993	0,658	0,442	0,378	0,11	0,18	0,74	0,05	0,43	4,46	714	100
Løken	NO0218R	1994	0,427	0,375	0,288	0,08	0,30	0,76	0,06	0,44	4,64	739	100
Løken	NO0218R	1995	0,517	0,430	0,355	0,12	0,24	1,15	0,09	0,68	4,56	656	100
Løken	NO0218R	1996	0,487	0,393	0,394	0,12	0,27	1,04	0,09	0,59	4,61	674	100
Løken	NO0218R	1997	0,418	0,401	0,405	0,12	0,16	0,89	0,06	0,50	4,63	549	100
Løken	NO0218R	1998	0,429	0,388	0,381	0,16	0,14	0,91	0,07	0,53	4,63	716	100
Løken	NO0218R	1999	0,383	0,356	0,349	0,11	0,10	1,08	0,07	0,60	4,71	1009	95
Løken	NO0218R	2000	0,326	0,331	0,236	0,05	0,07	0,76	0,06	0,41	4,60	1056	100
Løken	NO0218R	2001	0,329	0,309	0,260	0,07	0,13	0,52	0,04	0,29	4,75	819	100
Løken	NO0218R	2002	0,264	0,284	0,251	0,08	0,12	0,49	0,04	0,28	4,84	856	100
Løken	NO0218R	2003	0,325	0,374	0,339	0,08	0,15	0,52	0,05	0,30	4,72	651	100
Løken	NO0218R	2004	0,233	0,280	0,198	0,09	0,13	0,78	0,07	0,47	4,80	953	100
Løken	NO0218R	2005	0,343	0,378	0,316	0,10	0,14	0,80	0,06	0,53	4,77	686	100
Løken	NO0218R	2006	0,212	0,335	0,296	0,10	0,09	0,80	0,06	0,46	4,79	967	100

Site	Code	Year	xSO4-S	NO3-N	NH4-N	K	Ca	Cl	Mg	Na	pH	mm	Capture
Løken	NO0218R	2007	0,243	0,297	0,281	0,09	0,16	0,67	0,06	0,36	4,92	729	100
Løken	NO0218R	2008	0,193	0,284	0,224	0,10	0,13	1,00	0,09	0,58	4,90	997	100
Løken	NO0218R	2009	0,168	0,319	0,295	0,11	0,11	0,73	0,06	0,37	5,06	837	100
Løken	NO0218R	2010	0,226	0,291	0,238	0,10	0,12	0,33	0,04	0,15	4,95	664	98
Løken	NO0218R	2011	0,211	0,253	0,411	0,11	0,14	0,95	0,08	0,44	5,11	1101	100
Løken	NO0218R	2012	0,163	0,268	0,227	0,08	0,11	0,62	0,05	0,35	5,04	767	98
Løken	NO0218R	2013	0,173	0,274	0,485	0,11	0,14	1,17	0,09	0,69	5,22	837	98
Løken	NO0218R	2014	0,233	0,285	0,253	0,14	0,18	0,97	0,09	0,55	4,91	965	99
Løken	NO0218R	2015	0,124	0,262	0,230	0,14	0,15	0,88	0,08	0,50	5,01	851	99
Løken	NO0218R	2016	0,169	0,304	0,314	0,12	0,12	0,61	0,06	0,37	5,03	692	100
Løken	NO0218R	2017	0,120	0,246	0,212	0,17	0,18	0,68	0,06	0,40	5,12	797	100
Løken	NO0218R	2018	0,166	0,270	0,261	0,18	0,21	0,88	0,10	0,51	5,14	619	100
Løken	NO0218R	2019	0,134	0,230	0,253	0,20	0,17	0,56	0,05	0,33	5,23	1004	100
Løken	NO0218R	2020	0,101	0,217	0,233	0,12	0,14	0,91	0,07	0,52	5,19	1000	100
Løken	NO0218R	2021	0,167	0,294	0,377	0,16	0,23	0,65	0,07	0,38	5,34	611	100
Løken	NO0218R	2022	0,117	0,272	0,293	0,25	0,20	1,09	0,10	0,65	5,27	551	100
Løken	NO0218R	2023	0,111	0,196	0,256	0,14	0,10	0,50	0,04	0,31	5,10	845	100
Nordmoen	NO0044R	1986 (from 1 March)	0,990	0,486		0,09	0,13	0,51	0,04	0,32	4,20	702	94
Nordmoen	NO0044R	1987	0,715	0,368		0,13	0,14	0,37	0,03	0,17	4,34	1015	100
Nordmoen	NO0044R	1988	0,778	0,447	0,382	0,06	0,12	0,43	0,04	0,24	4,26	1050	100
Nordmoen	NO0044R	1989	0,872	0,567	0,400	0,06	0,14	0,57	0,05	0,27	4,26	827	100
Nordmoen	NO0044R	1990	0,772	0,445	0,348	0,05	0,10	0,64	0,05	0,31	4,31	822	96
Nordmoen	NO0044R	1991	0,588	0,399	0,307	0,05	0,09	0,57	0,04	0,29	4,43	781	99
Nordmoen	NO0044R	1992	0,578	0,399	0,266	0,04	0,10	0,46	0,03	0,26	4,42	821	100
Nordmoen	NO0044R	1993	0,560	0,367	0,254	0,07	0,08	0,41	0,03	0,23	4,45	926	100
Nordmoen	NO0044R	1994	0,456	0,395	0,297	0,03	0,07	0,42	0,03	0,24	4,55	837	100
Nordmoen	NO0044R	1995	0,524	0,371	0,326	0,09	0,13	0,66	0,06	0,39	4,49	776	100

Site	Code	Year	xSO4-S	NO3-N	NH4-N	K	Ca	Cl	Mg	Na	pH	mm	Capture
Nordmoen	NO0044R	1996	0,437	0,341	0,240	0,04	0,14	0,43	0,04	0,24	4,52	820	100
Nordmoen	NO0044R	1997	0,321	0,333	0,237	0,06	0,12	0,33	0,04	0,19	4,65	688	100
Nordmoen	NO0044R	1998	0,359	0,275	0,213	0,12	0,11	0,37	0,03	0,21	4,64	817	100
Nordmoen	NO0044R	1999	0,373	0,313	0,260	0,05	0,08	0,40	0,03	0,23	4,65	1014	100
Hurdal	NO0056R	1997	0,326	0,315	0,266	0,04	0,07	0,26	0,02	0,15	4,62	722	86
Hurdal	NO0056R	1998	0,419	0,317	0,306	0,06	0,10	0,35	0,03	0,20	4,67	1017	96
Hurdal	NO0056R	1999	0,405	0,350	0,328	0,05	0,08	0,44	0,03	0,24	4,66	1103	95
Hurdal	NO0056R	2000	0,329	0,316	0,247	0,05	0,08	0,62	0,04	0,36	4,64	1330	100
Hurdal	NO0056R	2001	0,331	0,361	0,285	0,05	0,08	0,31	0,03	0,18	4,69	961	100
Hurdal	NO0056R	2002	0,249	0,268	0,255	0,07	0,09	0,34	0,03	0,19	4,79	734	100
Hurdal	NO0056R	2003	0,316	0,348	0,322	0,05	0,09	0,35	0,04	0,22	4,66	830	100
Hurdal	NO0056R	2004	0,243	0,267	0,275	0,09	0,11	0,44	0,03	0,28	4,84	903	99
Hurdal	NO0056R	2005	0,350	0,429	0,438	0,18	0,12	0,84	0,05	0,53	4,89	739	100
Hurdal	NO0056R	2006	0,235	0,334	0,355	0,20	0,15	0,77	0,05	0,45	5,06	1043	100
Hurdal	NO0056R	2007	0,256	0,281	0,364	0,18	0,23	0,53	0,05	0,34	5,13	813	100
Hurdal	NO0056R	2008	0,205	0,316	0,313	0,16	0,19	0,73	0,06	0,43	5,10	1068	100
Hurdal	NO0056R	2009	0,207	0,274	0,244	0,14	0,14	0,58	0,03	0,34	5,09	909	100
Hurdal	NO0056R	2010	0,280	0,350	0,360	0,21	0,09	0,41	0,02	0,24	4,88	809	97
Hurdal	NO0056R	2011	0,230	0,319	0,465	0,07	0,13	0,49	0,04	0,27	5,04	1299	99
Hurdal	NO0056R	2012	0,165	0,273	0,212	0,04	0,07	0,41	0,03	0,25	4,93	1130	100
Hurdal	NO0056R	2013	0,174	0,260	0,379	0,10	0,15	0,70	0,05	0,43	5,18	896	99
Hurdal	NO0056R	2014	0,237	0,279	0,250	0,12	0,17	0,70	0,06	0,43	4,88	1172	100
Hurdal	NO0056R	2015	0,140	0,253	0,241	0,13	0,10	0,58	0,05	0,35	4,98	1059	99
Hurdal	NO0056R	2016	0,184	0,314	0,325	0,13	0,13	0,45	0,04	0,29	5,01	866	100
Hurdal	NO0056R	2017	0,120	0,190	0,239	0,13	0,12	0,37	0,03	0,23	5,23	956	100
Hurdal	NO0056R	2018	0,173	0,299	0,309	0,10	0,14	0,81	0,06	0,49	5,04	901	100
Hurdal	NO0056R	2019	0,144	0,202	0,205	0,10	0,13	0,26	0,03	0,15	5,12	1260	100

Site	Code	Year	xSO4-S	NO3-N	NH4-N	K	Ca	Cl	Mg	Na	pH	mm	Capture
Hurdal	NO0056R	2020	0,103	0,201	0,192	0,07	0,10	0,56	0,04	0,34	5,20	1441	100
Hurdal	NO0056R	2021	0,158	0,283	0,312	0,09	0,16	0,52	0,05	0,33	5,18	920	100
Hurdal	NO0056R	2022	0,103	0,192	0,170	0,06	0,09	0,41	0,03	0,24	5,12	930	100
Hurdal	NO0056R	2023	0,094	0,175	0,166	0,04	0,09	0,30	0,02	0,20	4,89	1329	100
Osen	NO0041R	1987	0,577	0,268	0,209	0,08	0,11	0,30	0,02	0,19	4,45	382	100
Osen	NO0041R	1988	0,532	0,305	0,257	0,13	0,13	0,26	0,02	0,15	4,43	832	100
Osen	NO0041R	1989	0,483	0,259	0,140	0,07	0,13	0,35	0,03	0,14	4,49	734	94
Osen	NO0041R	1990	0,555	0,279	0,271	0,13	0,23	0,30	0,03	0,14	4,48	710	100
Osen	NO0041R	1991	0,343	0,259	0,200	0,10	0,08	0,29	0,02	0,15	4,58	647	100
Osen	NO0041R	1992	0,439	0,285	0,183	0,09	0,13	0,23	0,02	0,14	4,55	725	100
Osen	NO0041R	1993	0,370	0,256	0,183	0,06	0,10	0,21	0,02	0,13	4,62	764	100
Osen	NO0041R	1994	0,306	0,265	0,168	0,06	0,08	0,27	0,02	0,15	4,68	625	100
Osen	NO0041R	1995	0,441	0,273	0,254	0,10	0,12	0,26	0,03	0,13	4,59	615	100
Osen	NO0041R	1996	0,311	0,259	0,231	0,09	0,15	0,27	0,03	0,16	4,68	483	98
Osen	NO0041R	1997	0,205	0,187	0,156	0,07	0,08	0,19	0,02	0,10	4,83	655	98
Osen	NO0041R	1998	0,301	0,253	0,208	0,07	0,08	0,22	0,02	0,11	4,72	505	93
Osen	NO0041R	1999	0,233	0,231	0,166	0,07	0,06	0,28	0,02	0,15	4,81	646	96
Osen	NO0041R	2000	0,238	0,205	0,171	0,06	0,06	0,33	0,03	0,19	4,72	973	100
Osen	NO0041R	2001	0,196	0,199	0,199	0,06	0,07	0,17	0,01	0,09	4,95	767	100
Osen	NO0041R	2002	0,246	0,190	0,249	0,12	0,11	0,22	0,03	0,13	4,91	739	100
Osen	NO0041R	2003	0,204	0,221	0,202	0,09	0,09	0,23	0,02	0,14	4,87	661	99
Osen (forest)	NO1041R	1987	0,531	0,210	0,186	0,10	0,09	0,19	0,01	0,10	4,47	484	76
Osen (forest)	NO1041R	1988	0,525	0,166	0,081	0,11	0,26	0,70	0,06	0,82	4,53	483	42
Osen (forest)	NO1041R	1989	0,575	0,258	0,229	0,08	0,07	0,39	0,01	0,11	4,37	396	58
Osen (forest)	NO1041R	1990	0,523	0,266	0,342	0,17	0,05	0,38	0,02	0,16	4,51	611	96
Osen (forest)	NO1041R	1991	0,383	0,283	0,183	0,10	0,07	0,39	0,02	0,16	4,61	464	100
Osen (forest)	NO1041R	1992	0,515	0,240	0,168	0,10	0,06	0,26	0,01	0,14	4,53	565	100

Site	Code	Year	xSO4-S	NO3-N	NH4-N	K	Ca	Cl	Mg	Na	pH	mm	Capture
Osen (forest)	NO1041R	1993	0,315	0,153	0,121	0,10	0,04	0,17	0,01	0,09	4,76	575	100
Osen (forest)	NO1041R	1994	0,309	0,251	0,208	0,13	0,05	0,28	0,01	0,16	4,70	530	100
Osen (forest)	NO1041R	1995	0,536	0,333	0,268	0,13	0,10	0,39	0,02	0,26	4,56	580	100
Osen (forest)	NO1041R	1996	0,328	0,258	0,151	0,09	0,08	0,32	0,02	0,19	4,70	588	100
Osen (forest)	NO1041R	1997	0,237	0,200	0,141	0,10	0,11	0,30	0,02	0,19	4,64	643	100
Osen (forest)	NO1041R	1998	0,293	0,192	0,140	0,10	0,11	0,23	0,01	0,19	4,77	747	100
Osen (forest)	NO1041R	1999	0,259	0,206	0,103	0,09	0,11	0,27	0,02	0,17	4,79	714	100
Osen (forest)	NO1041R	2000	0,268	0,192	0,137	0,09	0,09	0,47	0,02	0,24	4,77	1003	100
Osen (forest)	NO1041R	2001	0,186	0,132	0,086	0,10	0,10	0,16	0,01	0,19	4,95	646	96
Osen (forest)	NO1041R	2002	0,218	0,144	0,139	0,11	0,10	0,14	0,01	0,18	4,99	637	100
Osen (forest)	NO1041R	2003	0,233	0,159	0,109	0,10	0,07	0,23	0,01	0,27	4,90	593	100
Osen (forest)	NO1041R	2004	0,123	0,070	0,125	0,24	0,07	0,33	0,01	0,31	5,13	550	100
Osen (forest)	NO1041R	2005	0,201	0,129	0,120	0,12	0,09	0,25	0,02	0,20	5,01	621	100
Osen (forest)	NO1041R	2006	0,135	0,082	0,114	0,09	0,07	0,27	0,01	0,17	5,15	703	100
Osen (forest)	NO1041R	2007	0,158	0,118	0,088	0,14	0,09	0,23	0,01	0,21	5,03	544	100
Osen (forest)	NO1041R	2008	0,119	0,131	0,106	0,08	0,07	0,22	0,01	0,20	5,02	669	100
Osen (forest)	NO1041R	2009	0,119	0,159	0,157	0,11	0,06	0,14	0,01	0,16	5,16	752	100
Osen (forest)	NO1041R	2010	0,149	0,123	0,082	0,22	0,06	0,21	0,01	0,17	5,15	696	100
Osen (forest)	NO1041R	2011	0,168	0,162	0,151	0,27	0,06	0,27	0,02	0,24	5,19	869	100
Osen (forest)	NO1041R	2012	0,101	0,149	0,091	0,06	0,02	0,18	0,01	0,22	5,06	977	100
Osen (forest)	NO1041R	2013	0,112	0,133	0,089	0,15	0,08	0,27	0,02	0,42	5,29	614	100
Osen (forest)	NO1041R	2014	0,167	0,148	0,133	0,08	0,06	0,37	0,01	0,26	5,12	899	100
Osen (forest)	NO1041R	2015	0,073	0,111	0,090	0,16	0,03	0,26	0,01	0,20	5,20	909	100
Osen (forest)	NO1041R	2016	0,107	0,173	0,205	0,09	0,04	0,23	0,01	0,22	5,32	686	100
Osen (forest)	NO1041R	2017	0,108	0,114	0,141	0,08	0,04	0,24	0,00	0,23	5,33	710	100
Osen (forest)	NO1041R	2018	0,185	0,240	0,190	0,10	0,08	0,57	0,02	0,34	5,23	467	100
Osen (forest)	NO1041R	2019	0,111	0,144	0,104	0,07	0,03	0,27	0,01	0,22	5,36	805	100

Site	Code	Year	xSO4-S	NO3-N	NH4-N	K	Ca	Cl	Mg	Na	pH	mm	Capture
Osen (forest)	NO1041R	2020	0,086	0,220	0,150	0,08	0,03	0,50	0,01	0,26	5,28	742	100
Osen (forest)	NO1041R	2021	0,055	0,059	0,112	0,07	0,03	0,15	0,01	0,15	5,23	698	100
Osen (forest)	NO1041R	2022	0,093	0,087	0,133	0,10	0,02	0,56	0,01	0,20	5,47	758	100
Osen (forest)	NO1041R	2023	0,121	0,119	0,124	0,05	0,05	0,29	0,01	0,14	5,21	735	100
Gulsvik	NO0752R	1977	0,774	0,393	0,348		0,13	0,32	0,03	0,17	4,35	683	100
Gulsvik	NO0752R	1978	0,947	0,402	0,381		0,16	0,33	0,03	0,16	4,22	693	100
Gulsvik	NO0752R	1979	1,281	0,536	0,619		0,23	0,35	0,04	0,16	4,10	790	100
Gulsvik	NO0752R	1980	0,786	0,248	0,273	0,16	0,13	0,24	0,02	0,13	4,33	667	100
Gulsvik	NO0752R	1981	0,860	0,350	0,402	0,15	0,13	0,35	0,03	0,19	4,30	628	96
Gulsvik	NO0752R	1982	0,901	0,444	0,524	0,19	0,22	0,45	0,05	0,24	4,38	778	92
Gulsvik	NO0752R	1983	0,938	0,396	0,579		0,25	0,37	0,05		4,39	664	91
Gulsvik	NO0752R	1984	0,864	0,404	0,579		0,25	0,26	0,04		4,41	946	99
Gulsvik	NO0752R	1985	0,729	0,350	0,718	0,47	0,16	0,26	0,04	0,35	4,54	686	94
Gulsvik	NO0752R	1986	0,893	0,474	0,508	0,14	0,15	0,43	0,04	0,26	4,30	804	100
Gulsvik	NO0752R	1987	0,741	0,368	0,460	0,16	0,14	0,29	0,03	0,18	4,42	915	100
Gulsvik	NO0752R	1988	0,669	0,411	0,377	0,12	0,09	0,27	0,03	0,14	4,33	1023	100
Gulsvik	NO0752R	1989	0,754	0,538	0,552	0,16	0,15	0,48	0,06	0,23	4,42	668	100
Gulsvik	NO0752R	1990	0,744	0,449	0,528	0,14	0,09	0,44	0,03	0,22	4,43	753	67
Gulsvik	NO0752R	1991	0,595	0,418	0,464	0,13	0,13	0,47	0,04	0,25	4,58	506	100
Gulsvik	NO0752R	1992	0,558	0,353	0,382	0,11	0,13	0,39	0,03	0,22	4,60	666	100
Gulsvik	NO0752R	1993	0,506	0,326	0,396	0,11	0,12	0,30	0,03	0,18	4,66	638	100
Gulsvik	NO0752R	1994	0,499	0,431	0,388	0,10	0,23	0,38	0,03	0,20	4,61	642	99
Gulsvik	NO0752R	1995	0,559	0,392	0,422	0,09	0,12	0,38	0,04	0,20	4,54	634	100
Gulsvik	NO0752R	1996	0,482	0,367	0,511	0,16	0,16	0,30	0,06	0,15	4,71	657	100
Gulsvik	NO0752R	1997	0,351	0,319	0,328	0,11	0,12	0,29	0,04	0,18	4,74	702	100
Brekkebygda	NO1218R	1998	0,380	0,288	0,246	0,09	0,08	0,26	0,02	0,14	4,62	886	100
Brekkebygda	NO1218R	1999	0,374	0,302	0,275	0,10	0,09	0,27	0,02	0,18	4,71	844	100

Site	Code	Year	xSO4-S	NO3-N	NH4-N	K	Ca	Cl	Mg	Na	pH	mm	Capture
Brekkebygda	NO1218R	2000	0,367	0,290	0,226	0,11	0,17	0,55	0,06	0,32	4,69	1260	100
Brekkebygda	NO1218R	2001	0,304	0,244	0,287	0,08	0,08	0,25	0,04	0,16	4,81	804	87
Brekkebygda	NO1218R	2002	0,248	0,184	0,305	0,12	0,15	0,27	0,04	0,17	5,11	845	100
Brekkebygda	NO1218R	2003	0,301	0,263	0,284	0,13	0,17	0,31	0,06	0,22	4,89	852	99
Brekkebygda	NO1218R	2004	0,256	0,187	0,211	0,10	0,22	0,33	0,07	0,21	5,03	851	100
Brekkebygda	NO1218R	2005	0,365	0,331	0,354	0,11	0,13	0,46	0,03	0,35	4,87	754	100
Brekkebygda	NO1218R	2006	0,279	0,264	0,286	0,10	0,12	0,35	0,04	0,23	4,92	935	100
Brekkebygda	NO1218R	2007	0,183	0,179	0,160	0,10	0,13	0,22	0,03	0,14	4,98	1093	100
Brekkebygda	NO1218R	2008	0,231	0,314	0,312	0,09	0,12	0,36	0,03	0,21	4,93	967	100
Brekkebygda	NO1218R	2009	0,255	0,334	0,247	0,13	0,09	0,34	0,03	0,27	4,96	924	99
Brekkebygda	NO1218R	2012	0,152	0,260	0,267	0,15	0,16	0,33	0,03	0,19	5,17	1086	96
Brekkebygda	NO1218R	2013	0,172	0,223	0,253	0,14	0,13	0,41	0,04	0,26	5,21	1205	98
Brekkebygda	NO1218R	2014	0,243	0,249	0,212	0,16	0,24	0,64	0,05	0,36	4,94	1105	100
Brekkebygda	NO1218R	2015	0,105	0,178	0,188	0,14	0,14	0,47	0,04	0,29	5,13	997	99
Brekkebygda	NO1218R	2016	0,153	0,235	0,243	0,10	0,10	0,33	0,03	0,21	5,01	892	100
Brekkebygda	NO1218R	2017	0,119	0,174	0,153	0,10	0,09	0,23	0,02	0,15	4,98	1092	100
Brekkebygda	NO1218R	2018	0,150	0,245	0,196	0,08	0,15	0,60	0,05	0,36	4,98	1003	99
Brekkebygda	NO1218R	2019	0,144	0,215	0,197	0,09	0,14	0,23	0,03	0,14	5,10	1135	100
Brekkebygda	NO1218R	2020	0,093	0,148	0,121	0,10	0,10	0,32	0,03	0,20	5,22	1420	100
Brekkebygda	NO1218R	2021	0,119	0,184	0,200	0,13	0,11	0,42	0,03	0,27	5,20	817	98
Brekkebygda	NO1218R	2022	0,078	0,156	0,098	0,07	0,08	0,32	0,02	0,20	5,13	845	100
Brekkebygda	NO1218R	2023	0,091	0,133	0,136	0,06	0,05	0,21	0,01	0,14	5,00	1299	100
Vikedal	NO0572R	1982	0,671	0,279	0,341	0,14	0,16	3,92	0,26	2,06	4,46	2038	88
Vikedal	NO0572R	1983	0,401	0,167	0,166	0,16	0,20	4,23	0,29	2,39	4,65	2822	94
Vikedal	NO0572R	1984	0,519	0,240	0,265	0,15	0,24	3,69	0,25	2,04	4,57	1930	95
Vikedal	NO0572R	1985	0,639	0,304	0,332	0,16	0,21	2,77	0,20	1,55	4,45	2224	93
Vikedal	NO0572R	1986	0,558	0,249	0,298	0,14	0,15	3,66	0,26	2,11	4,53	3016	100

Site	Code	Year	xSO4-S	NO3-N	NH4-N	K	Ca	Cl	Mg	Na	pH	mm	Capture
Vikedal	NO0572R	1987	0,545	0,267	0,342	0,12	0,13	2,56	0,18	1,45	4,51	1935	100
Vikedal	NO0572R	1988	0,434	0,264	0,254	0,09	0,13	3,29	0,24	1,86	4,51	2694	100
Vikedal	NO0572R	1989	0,531	0,317	0,235	0,09	0,14	3,99	0,26	2,09	4,46	2998	100
Vikedal	NO0572R	1990	0,443	0,217	0,310	0,11	0,15	5,27	0,35	2,93	4,58	3336	89
Vikedal	NO0572R	1991	0,433	0,257	0,268	0,13	0,14	4,67	0,32	2,61	4,60	2924	100
Vikedal	NO0572R	1992	0,401	0,221	0,240	0,10	0,12	3,29	0,22	1,81	4,70	3214	98
Vikedal	NO0572R	1993	0,405	0,236	0,267	0,17	0,21	6,91	0,46	3,80	4,70	2075	100
Vikedal	NO0572R	1994	0,466	0,285	0,303	0,13	0,15	5,00	0,36	2,97	4,64	2741	100
Vikedal	NO0572R	1995	0,347	0,230	0,231	0,09	0,13	3,38	0,24	1,93	4,72	2639	100
Vikedal	NO0572R	1996	0,305	0,230	0,281	0,07	0,16	2,15	0,16	1,18	4,78	1819	100
Vikedal	NO0572R	1997	0,360	0,204	0,276	0,13	0,24	6,35	0,39	3,13	4,75	2469	100
Vikedal	NO0572R	1998	0,325	0,240	0,252	0,09	0,11	2,99	0,21	1,66	4,77	2692	100
Vikedal	NO0572R	1999	0,270	0,222	0,218	0,10	0,12	4,28	0,27	2,30	4,82	3107	100
Vikedal	NO0572R	2000	0,255	0,221	0,216	0,10	0,12	3,96	0,26	2,22	4,82	2917	100
Vikedal	NO0572R	2001	0,263	0,225	0,278	0,09	0,11	3,08	0,20	1,71	4,96	2347	100
Vikedal	NO0572R	2002	0,291	0,255	0,393	0,11	0,14	3,60	0,24	1,98	4,94	2265	100
Vikedal	NO0572R	2003	0,256	0,253	0,288	0,08	0,11	2,74	0,21	1,55	4,86	2802	99
Vikedal	NO0572R	2004	0,173	0,189	0,291	0,10	0,12	3,14	0,23	1,81	5,08	2815	100
Vikedal	NO0572R	2005	0,210	0,213	0,292	0,12	0,15	4,66	0,31	2,75	5,07	3041	100
Vikedal	NO0572R	2006	0,181	0,219	0,245	0,13	0,15	3,54	0,28	2,04	5,10	2771	100
Vikedal	NO0572R	2007	0,138	0,169	0,275	0,17	0,22	5,07	0,40	3,31	5,24	3150	98
Vikedal	NO0572R	2008	0,145	0,170	0,205	0,15	0,22	5,26	0,42	2,95	5,24	2986	100
Vikedal	NO0572R	2009	0,169	0,196	0,264	0,09	0,10	2,92	0,20	1,74	5,33	2545	100
Vikedal	NO0572R	2010	0,284	0,276	0,310	0,17	0,28	1,84	0,12	1,01	5,26	1835	99
Vikedal	NO0572R	2011	0,108	0,184	0,369	0,14	0,16	5,11	0,34	2,78	5,33	3319	98
Vikedal	NO0572R	2012	0,105	0,167	0,283	0,10	0,12	2,96	0,21	1,65	5,34	2562	100
Vikedal	NO0572R	2013	0,119	0,183	0,411	0,13	0,21	4,17	0,29	2,42	5,48	2566	100

Site	Code	Year	xSO4-S	NO3-N	NH4-N	K	Ca	Cl	Mg	Na	pH	mm	Capture
Vikedal	NO0572R	2014	0,166	0,178	0,273	0,13	0,22	3,75	0,27	2,15	5,21	2891	100
Vikedal	NO0572R	2015	0,055	0,149	0,222	0,18	0,21	6,91	0,47	3,91	5,24	3283	97
Vikedal	NO0572R	2016	0,104	0,177	0,247	0,18	0,15	4,66	0,33	2,69	5,14	2487	100
Vikedal	NO0572R	2017	0,064	0,118	0,158	0,11	0,14	4,07	0,26	2,32	5,25	3570	100
Vikedal	NO0572R	2018	0,089	0,160	0,220	0,11	0,17	3,81	0,25	2,15	5,38	2807	100
Vikedal	NO0572R	2019	0,086	0,109	0,138	0,20	0,16	3,08	0,22	1,80	5,38	2937	100
Vikedal	NO0572R	2020	0,063	0,111	0,192	0,19	0,21	4,69	0,31	2,72	5,44	3560	93
Vikedal	NO0572R	2021	0,095	0,170	0,236	0,15	0,21	2,74	0,19	1,57	5,38	2266	100
Vikedal	NO0572R	2022	0,070	0,133	0,183	0,15	0,21	4,07	0,29	2,31	5,45	2756	100
Vikedal	NO0572R	2023	0,062	0,115	0,160	0,11	0,15	3,31	0,20	1,92	5,21	2710	100
Nausta	NO0655R	1985	0,293	0,127	0,089	0,08	0,09	1,75	0,12	0,95	4,70	1942	99
Nausta	NO0655R	1986	0,271	0,098	0,076	0,08	0,09	2,28	0,16	1,26	4,74	2315	100
Nausta	NO0655R	1987	0,267	0,120	0,108	0,09	0,09	1,62	0,11	0,92	4,72	1965	100
Nausta	NO0655R	1988	0,209	0,134	0,086	0,08	0,14	3,30	0,23	1,86	4,68	2244	100
Nausta	NO0655R	1989	0,214	0,122	0,068	0,07	0,10	3,39	0,23	1,87	4,80	3336	100
Nausta	NO0655R	1990	0,228	0,107	0,072	0,07	0,09	3,42	0,23	1,90	4,78	3551	96
Nausta	NO0655R	1991	0,189	0,121	0,091	0,11	0,11	4,15	0,29	2,35	4,83	2405	100
Nausta	NO0655R	1992	0,213	0,126	0,069	0,06	0,09	2,33	0,16	1,26	4,80	2967	100
Nausta	NO0655R	1993	0,235	0,125	0,096	0,18	0,17	6,05	0,39	3,21	4,87	2215	100
Nausta	NO0655R	1994	0,206	0,123	0,151	0,06	0,10	2,59	0,19	1,45	4,96	2743	100
Nausta	NO0655R	1995	0,181	0,113	0,128	0,07	0,08	2,46	0,17	1,38	4,91	2514	100
Nausta	NO0655R	1996	0,198	0,153	0,143	0,05	0,07	1,26	0,10	0,69	4,87	1577	100
Nausta	NO0655R	1997	0,155	0,120	0,130	0,08	0,11	3,85	0,23	1,93	5,01	2426	100
Nausta	NO0655R	1998	0,135	0,115	0,122	0,06	0,07	2,12	0,15	1,15	5,00	2582	100
Nausta	NO0655R	1999	0,139	0,104	0,079	0,05	0,07	2,56	0,16	1,37	4,99	2881	100
Nausta	NO0655R	2000	0,141	0,105	0,084	0,09	0,11	4,24	0,26	2,27	4,98	2273	100
Nausta	NO0655R	2001	0,132	0,106	0,091	0,06	0,06	2,26	0,14	1,23	5,01	2153	100

Site	Code	Year	xSO4-S	NO3-N	NH4-N	K	Ca	Cl	Mg	Na	pH	mm	Capture
Nausta	NO0655R	2002	0,154	0,132	0,131	0,11	0,08	2,25	0,16	1,29	5,00	1882	100
Nausta	NO0655R	2003	0,123	0,122	0,136	0,08	0,11	2,99	0,21	1,56	5,01	2615	100
Nausta	NO0655R	2004	0,100	0,102	0,083	0,07	0,07	1,69	0,13	0,99	5,12	2803	100
Nausta	NO0655R	2005	0,187	0,115	0,136	0,05	0,07	2,23	0,15	1,33	5,10	3200	99
Nausta	NO0655R	2006	0,113	0,132	0,111	0,06	0,07	2,20	0,16	1,22	5,09	2340	100
Nausta	NO0655R	2007	0,069	0,078	0,102	0,07	0,10	2,53	0,20	1,38	5,26	3089	100
Nausta	NO0655R	2008	0,057	0,100	0,133	0,13	0,18	5,60	0,45	3,00	5,24	2464	100
Nausta	NO0655R	2009	0,088	0,087	0,100	0,05	0,06	1,79	0,13	1,06	5,27	2074	100
Nausta	NO0655R	2010	0,096	0,135	0,160	0,06	0,03	1,01	0,05	0,50	5,23	1588	96
Nausta	NO0655R	2011	0,069	0,090	0,208	0,08	0,10	2,55	0,17	1,39	5,41	2818	98
Nausta	NO0655R	2012	0,038	0,080	0,167	0,08	0,10	2,36	0,17	1,33	5,50	2182	97
Nausta	NO0655R	2013	0,067	0,091	0,291	0,06	0,08	2,19	0,14	1,22	5,55	2292	100
Nausta	NO0655R	2014	0,103	0,098	0,189	0,09	0,15	2,51	0,18	1,41	5,24	1725	99
Nausta	NO0655R	2015	0,049	0,078	0,129	0,10	0,15	3,05	0,21	1,72	5,27	2533	80
Nausta	NO0655R	2016	0,070	0,092	0,154	0,16	0,13	4,15	0,29	2,39	5,13	1477	91
Nausta	NO0655R	2017	0,077	0,097	0,151	0,16	0,10	2,36	0,16	1,29	5,17	1293	90
Nausta	NO0655R	2018	0,046	0,087	0,129	0,07	0,08	1,88	0,13	1,09	5,40	2045	100
Nausta	NO0655R	2019	0,063	0,099	0,171	0,10	0,12	2,50	0,17	1,44	5,45	1876	100
Nausta	NO0655R	2020	0,040	0,069	0,116	0,11	0,11	3,04	0,20	1,74	5,48	3047	100
Nausta	NO0655R	2021	0,051	0,069	0,120	0,09	0,12	2,24	0,15	1,25	5,40	2013	100
Nausta	NO0655R	2022	0,047	0,074	0,110	0,09	0,13	2,58	0,17	1,46	5,43	2502	100
Nausta	NO0655R	2023	0,030	0,043	0,084	0,09	0,07	2,32	0,13	1,34	5,29	1983	98
Kårvatn	NO0039R	1978	0,158	0,051	0,090		0,11	1,84	0,13	1,00	4,98	1317	100
Kårvatn	NO0039R	1979	0,232	0,080	0,084		0,11	1,49	0,11	0,91	4,65	1197	100
Kårvatn	NO0039R	1980	0,207	0,073	0,076	0,07	0,11	1,89	0,13	1,07	4,88	1224	100
Kårvatn	NO0039R	1981	0,220	0,080	0,123	0,12	0,17	3,65	0,25	1,91	4,96	1102	100
Kårvatn	NO0039R	1982	0,259	0,078	0,109	0,10	0,15	2,31	0,16	1,30	4,87	994	100

Site	Code	Year	xSO4-S	NO3-N	NH4-N	K	Ca	Cl	Mg	Na	pH	mm	Capture
Kårvatn	NO0039R	1983	0,138	0,052	0,055		0,18	2,84	0,20		5,08	1911	100
Kårvatn	NO0039R	1984	0,234	0,099	0,181		0,22	2,47	0,18		5,04	920	100
Kårvatn	NO0039R	1985	0,202	0,068	0,100	0,15	0,15	1,57	0,11	1,48	5,00	1462	100
Kårvatn	NO0039R	1986	0,206	0,070	0,127	0,11	0,10	1,61	0,11	0,89	4,95	1267	99
Kårvatn	NO0039R	1987	0,244	0,088	0,120	0,12	0,15	2,54	0,17	1,36	4,87	1465	100
Kårvatn	NO0039R	1988	0,106	0,060	0,091	0,10	0,12	2,63	0,19	1,55	5,08	1480	99
Kårvatn	NO0039R	1989	0,108	0,062	0,061	0,13	0,13	4,02	0,26	2,13	5,11	1524	97
Kårvatn	NO0039R	1990	0,102	0,043	0,066	0,08	0,07	2,03	0,14	1,11	5,07	1512	99
Kårvatn	NO0039R	1991	0,110	0,063	0,105	0,13	0,12	3,11	0,23	1,82	5,14	1617	100
Kårvatn	NO0039R	1992	0,098	0,070	0,058	0,12	0,11	2,92	0,19	1,68	5,17	1622	100
Kårvatn	NO0039R	1993	0,102	0,061	0,119	0,10	0,12	2,49	0,18	1,43	5,16	1422	100
Kårvatn	NO0039R	1994	0,116	0,068	0,081	0,09	0,12	2,03	0,15	1,14	5,12	1473	100
Kårvatn	NO0039R	1995	0,082	0,048	0,064	0,08	0,10	2,03	0,15	1,16	5,17	1663	100
Kårvatn	NO0039R	1996	0,074	0,067	0,092	0,09	0,10	1,66	0,13	0,96	5,16	1153	99
Kårvatn	NO0039R	1997	0,093	0,057	0,110	0,12	0,12	3,56	0,23	1,81	5,22	1822	99
Kårvatn	NO0039R	1998	0,080	0,056	0,110	0,08	0,09	2,80	0,19	1,50	5,22	1417	99
Kårvatn	NO0039R	1999	0,085	0,068	0,071	0,06	0,06	1,98	0,13	1,10	5,21	1242	97
Kårvatn	NO0039R	2000	0,090	0,051	0,084	0,09	0,10	3,57	0,23	1,99	5,26	1243	100
Kårvatn	NO0039R	2001	0,069	0,047	0,074	0,08	0,07	3,18	0,21	1,84	5,31	1513	100
Kårvatn	NO0039R	2002	0,104	0,067	0,101	0,09	0,08	1,62	0,11	0,90	5,26	1304	100
Kårvatn	NO0039R	2003	0,092	0,077	0,115	0,09	0,12	3,30	0,23	1,82	5,19	1668	99
Kårvatn	NO0039R	2004	0,055	0,037	0,065	0,08	0,11	2,12	0,16	1,22	5,40	2001	100
Kårvatn	NO0039R	2005	0,093	0,054	0,080	0,10	0,11	2,74	0,19	1,64	5,33	1733	100
Kårvatn	NO0039R	2006	0,079	0,076	0,138	0,08	0,09	1,68	0,13	0,94	5,29	1218	100
Kårvatn	NO0039R	2007	0,049	0,038	0,114	0,09	0,11	2,85	0,22	1,52	5,40	1930	100
Kårvatn	NO0039R	2008	0,052	0,074	0,081	0,10	0,13	2,60	0,22	1,49	5,37	1422	99
Kårvatn	NO0039R	2009	0,052	0,052	0,078	0,08	0,06	1,40	0,09	0,79	5,46	1315	100

Site	Code	Year	xSO4-S	NO3-N	NH4-N	K	Ca	Cl	Mg	Na	pH	mm	Capture
Kårvatn	NO0039R	2010	0,074	0,051	0,120	0,06	0,03	1,07	0,06	0,61	5,36	1465	96
Kårvatn	NO0039R	2011	0,054	0,046	0,172	0,09	0,10	3,03	0,20	1,60	5,48	1500	100
Kårvatn	NO0039R	2012	0,056	0,060	0,118	0,09	0,12	2,83	0,21	1,60	5,42	1526	99
Kårvatn	NO0039R	2013	0,040	0,056	0,127	0,15	0,14	3,54	0,22	1,96	5,45	1432	99
Kårvatn	NO0039R	2014	0,175	0,113	0,099	0,16	0,21	2,16	0,16	1,24	5,03	1099	100
Kårvatn	NO0039R	2015	0,059	0,083	0,088	0,14	0,15	2,57	0,18	1,49	5,20	1343	99
Kårvatn	NO0039R	2016	0,069	0,102	0,105	0,12	0,10	2,29	0,16	1,30	5,19	1543	99
Kårvatn	NO0039R	2017	0,050	0,043	0,063	0,08	0,09	1,77	0,11	0,99	5,26	1758	98
Kårvatn	NO0039R	2018	0,055	0,081	0,093	0,11	0,11	2,24	0,16	1,29	5,34	1196	100
Kårvatn	NO0039R	2019	0,051	0,071	0,091	0,11	0,13	2,66	0,19	1,53	5,30	1508	97
Kårvatn	NO0039R	2020	0,038	0,042	0,094	0,11	0,11	2,97	0,20	1,67	5,49	1773	100
Kårvatn	NO0039R	2021	0,064	0,062	0,073	0,10	0,14	2,62	0,18	1,46	5,34	1893	100
Kårvatn	NO0039R	2022	0,038	0,061	0,102	0,13	0,15	3,47	0,23	1,97	5,52	1552	84
Kårvatn	NO0039R	2023	0,050	0,069	0,090	0,08	0,10	2,35	0,13	1,35	5,13	1610	100
Høylandet	NO0478R	1987 (from 1 febr.)	0,338	0,155	0,363	0,15	0,14	2,49	0,18	1,39	4,97	802	95
Høylandet	NO0478R	1988	0,217	0,113	0,171	0,13	0,16	2,79	0,20	1,59	5,00	1307	100
Høylandet	NO0478R	1989	0,176	0,102	0,138	0,18	0,20	7,46	0,45	3,71	5,11	1594	100
Høylandet	NO0478R	1990	0,204	0,101	0,133	0,10	0,14	3,94	0,26	2,21	4,92	1606	100
Høylandet	NO0478R	1991	0,229	0,112	0,195	0,12	0,21	3,96	0,31	2,24	5,10	1309	100
Høylandet	NO0478R	1992	0,156	0,086	0,152	0,14	0,16	5,23	0,36	2,95	5,16	1418	100
Høylandet	NO0478R	1993	0,203	0,121	0,204	0,14	0,17	5,04	0,35	2,77	5,10	1145	100
Høylandet	NO0478R	1994	0,149	0,092	0,224	0,11	0,12	3,25	0,24	1,79	5,23	1182	100
Høylandet	NO0478R	1995	0,173	0,102	0,220	0,12	0,17	3,63	0,27	2,04	5,20	1506	100
Høylandet	NO0478R	1996	0,161	0,102	0,204	0,11	0,16	3,86	0,26	2,04	5,11	816	100
Høylandet	NO0478R	1997	0,141	0,101	0,217	0,14	0,17	5,18	0,32	2,61	5,25	1418	100
Høylandet	NO0478R	1998	0,119	0,084	0,217	0,10	0,13	2,72	0,19	1,48	5,46	1456	100
Høylandet	NO0478R	1999	0,144	0,104	0,273	0,10	0,13	2,79	0,19	1,54	5,41	1195	100

Site	Code	Year	xSO4-S	NO3-N	NH4-N	K	Ca	Cl	Mg	Na	pH	mm	Capture
Høylandet	NO0478R	2000	0,128	0,080	0,210	0,15	0,18	5,60	0,35	2,97	5,36	1183	100
Høylandet	NO0478R	2001	0,135	0,083	0,246	0,17	0,17	6,25	0,38	3,42	5,37	1280	100
Høylandet	NO0478R	2002	0,142	0,116	0,283	0,13	0,16	3,63	0,25	2,02	5,40	971	100
Høylandet	NO0478R	2003	0,111	0,101	0,234	0,16	0,22	4,63	0,37	2,74	5,25	1536	100
Høylandet	NO0478R	2004	0,063	0,076	0,215	0,16	0,22	4,70	0,35	2,77	5,57	1391	100
Høylandet	NO0478R	2005	0,147	0,101	0,263	0,14	0,16	4,42	0,29	2,51	5,44	1790	100
Høylandet	NO0478R	2006	0,111	0,135	0,322	0,15	0,17	4,55	0,33	2,50	5,47	1182	100
Høylandet	NO0478R	2007	0,080	0,118	0,381	0,17	0,25	6,55	0,49	3,58	5,88	1071	100
Høylandet	NO0478R	2008	0,113	0,106	0,328	0,21	0,32	6,44	0,51	3,44	5,78	1030	98
Høylandet	NO0478R	2009	0,074	0,106	0,274	0,10	0,11	2,80	0,18	1,62	5,68	1153	100
Høylandet	NO0478R	2010	0,112	0,090	0,307	0,12	0,07	2,36	0,10	1,10	5,68	927	99
Høylandet	NO0478R	2011	0,055	0,068	0,488	0,18	0,19	5,38	0,35	2,87	5,86	1633	100
Høylandet	NO0478R	2012	0,045	0,114	0,323	0,18	0,21	4,75	0,33	2,59	5,82	1361	91
Høylandet	NO0478R	2013	0,060	0,077	0,341	0,15	0,17	3,65	0,24	2,08	5,67	1551	98
Høylandet	NO0478R	2014	0,197	0,109	0,338	0,19	0,29	3,58	0,25	1,97	5,28	999	99
Høylandet	NO0478R	2015	0,027	0,055	0,142	0,12	0,13	3,06	0,21	1,68	5,46	1148	71
Høylandet	NO0478R	2016	0,052	0,054	0,166	0,13	0,14	3,90	0,27	2,24	5,47	1283	100
Høylandet	NO0478R	2017	0,043	0,043	0,185	0,14	0,14	3,82	0,25	2,13	5,47	1502	100
Høylandet	NO0478R	2018	0,056	0,053	0,178	0,14	0,16	4,16	0,28	2,28	5,63	948	100
Høylandet	NO0478R	2019	0,062	0,073	0,204	0,15	0,16	4,93	0,33	2,79	5,51	1221	99
Høylandet	NO0478R	2020	0,017	0,044	0,172	0,14	0,16	5,08	0,33	3,05	5,61	1207	98
Høylandet	NO0478R	2021	0,042	0,035	0,212	0,15	0,16	3,43	0,24	1,92	5,67	951	100
Høylandet	NO0478R	2022	0,042	0,046	0,307	0,14	0,31	3,78	0,28	2,16	5,77	960	100
Overhalla	NO0240R	2023	0,046	0,069	0,182	0,15	0,17	4,51	0,27	2,62	5,25	1120	100
Tustervatn	NO0015R	1972	0,325				0,14		0,15	0,81	4,74	1070	100
Tustervatn	NO0015R	1973	0,261						0,17		4,91	1340	100
Tustervatn	NO0015R	1974	0,284						0,09		4,86	693	100

Site	Code	Year	xSO4-S	NO3-N	NH4-N	K	Ca	Cl	Mg	Na	pH	mm	Capture
Tustervatn	NO0015R	1975	0,254						0,23		4,89	1260	100
Tustervatn	NO0015R	1976	0,281						0,17		4,96	819	100
Tustervatn	NO0015R	1977	0,292	0,069	0,100		0,17		0,15		4,91	1111	100
Tustervatn	NO0015R	1978	0,221	0,076	0,101		0,16		0,16		4,84	1128	100
Tustervatn	NO0015R	1979	0,277	0,084	0,127		0,15		0,11		4,73	1168	100
Tustervatn	NO0015R	1980	0,266	0,083	0,144	0,16	0,47	2,25	0,16	1,20	4,98	858	100
Tustervatn	NO0015R	1981	0,189	0,068	0,096	0,12	0,22	2,17	0,15	1,15	5,00	1099	100
Tustervatn	NO0015R	1982	0,168	0,079	0,085	0,21	0,21	7,23	0,47	3,77	4,98	1385	100
Tustervatn	NO0015R	1983	0,197	0,059	0,083		0,16	3,30	0,22		4,82	1677	100
Tustervatn	NO0015R	1984	0,233	0,089	0,083		0,12	1,44	0,10		4,85	1060	100
Tustervatn	NO0015R	1985	0,220	0,080	0,098	0,15	0,12	2,11	0,15	0,89	4,93	1344	100
Tustervatn	NO0015R	1986	0,258	0,086	0,116	0,15	0,11	2,11	0,15	1,12	4,89	1033	99
Tustervatn	NO0015R	1987	0,218	0,084	0,114	0,13	0,12	1,80	0,12	1,01	4,89	1162	100
Tustervatn	NO0015R	1988	0,125	0,072	0,091	0,11	0,13	2,00	0,15	1,16	5,04	1155	100
Tustervatn	NO0015R	1989	0,188	0,074	0,095	0,17	0,18	6,10	0,40	2,98	5,00	1790	94
Tustervatn	NO0015R	1990	0,164	0,088	0,141	0,12	0,11	3,31	0,21	1,84	4,99	1500	99
Tustervatn	NO0015R	1991	0,172	0,098	0,141	0,15	0,14	3,12	0,21	1,69	5,04	1399	100
Tustervatn	NO0015R	1992	0,148	0,083	0,146	0,19	0,19	5,47	0,37	3,03	5,12	1507	100
Tustervatn	NO0015R	1993	0,132	0,083	0,156	0,23	0,24	7,55	0,50	4,09	5,19	1339	100
Tustervatn	NO0015R	1994	0,101	0,077	0,128	0,13	0,12	2,13	0,15	1,19	5,24	1119	100
Tustervatn	NO0015R	1995	0,094	0,063	0,122	0,13	0,13	3,05	0,21	1,70	5,22	1515	100
Tustervatn	NO0015R	1996	0,110	0,082	0,153	0,13	0,15	2,32	0,18	1,27	5,15	1073	100
Tustervatn	NO0015R	1997	0,088	0,064	0,177	0,17	0,17	4,60	0,30	2,30	5,34	1529	100
Tustervatn	NO0015R	1998	0,071	0,063	0,164	0,12	0,11	2,77	0,19	1,50	5,39	1395	99
Tustervatn	NO0015R	1999	0,090	0,077	0,163	0,09	0,07	1,33	0,08	0,70	5,38	1121	99
Tustervatn	NO0015R	2000	0,095	0,061	0,146	0,14	0,11	3,20	0,20	1,76	5,33	1313	100
Tustervatn	NO0015R	2001	0,075	0,065	0,154	0,12	0,10	3,03	0,19	1,72	5,36	1448	100

Site	Code	Year	xSO4-S	NO3-N	NH4-N	K	Ca	Cl	Mg	Na	pH	mm	Capture
Tustervatn	NO0015R	2002	0,089	0,071	0,136	0,11	0,11	2,59	0,17	1,42	5,38	1158	100
Tustervatn	NO0015R	2003	0,073	0,074	0,181	0,16	0,16	3,55	0,26	2,02	5,32	1517	100
Tustervatn	NO0015R	2004	0,044	0,068	0,170	0,15	0,20	3,05	0,23	1,81	5,50	1427	100
Tustervatn	NO0015R	2005	0,124	0,083	0,184	0,16	0,15	2,84	0,20	1,74	5,39	1308	100
Tustervatn	NO0015R	2006	0,080	0,098	0,127	0,11	0,12	2,74	0,20	1,60	5,30	1207	100
Tustervatn	NO0015R	2007	0,071	0,082	0,134	0,10	0,13	3,65	0,26	1,98	5,28	1298	100
Tustervatn	NO0015R	2008	0,069	0,080	0,087	0,07	0,16	2,79	0,22	1,51	5,33	1162	100
Tustervatn	NO0015R	2009	0,054	0,062	0,109	0,05	0,06	1,60	0,10	0,80	5,40	1158	100
Tustervatn	NO0015R	2010	0,107	0,082	0,154	0,09	0,06	1,21	0,08	0,77	5,35	913	99
Tustervatn	NO0015R	2011	0,107	0,063	0,146	0,09	0,12	3,02	0,20	1,66	5,35	1430	94
Tustervatn	NO0015R	2012	0,025	0,073	0,135	0,10	0,12	3,50	0,24	1,89	5,41	775	98
Tustervatn	NO0015R	2013	0,043	0,052	0,142	0,06	0,09	1,56	0,10	0,86	5,39	1152	94
Tustervatn	NO0015R	2014	0,143	0,083	0,105	0,14	0,19	3,55	0,25	2,01	5,06	893	100
Tustervatn	NO0015R	2015	0,045	0,073	0,093	0,15	0,17	3,51	0,24	1,96	5,26	1444	97
Tustervatn	NO0015R	2016	0,053	0,070	0,090	0,11	0,09	1,88	0,13	1,06	5,24	1031	100
Tustervatn	NO0015R	2017	0,038	0,054	0,095	0,11	0,10	2,51	0,16	1,44	5,34	1318	100
Tustervatn	NO0015R	2018	0,049	0,068	0,090	0,09	0,09	1,54	0,10	0,87	5,36	1192	100
Tustervatn	NO0015R	2019	0,122	0,070	0,127	0,13	0,15	3,84	0,26	2,23	5,18	1133	100
Tustervatn	NO0015R	2020	0,032	0,046	0,105	0,10	0,12	2,98	0,20	1,72	5,49	1360	99
Tustervatn	NO0015R	2021	0,055	0,079	0,085	0,09	0,12	1,68	0,12	0,94	5,34	1119	100
Tustervatn	NO0015R	2022	0,035	0,055	0,094	0,07	0,10	1,84	0,12	1,03	5,47	1305	100
Tustervatn	NO0015R	2023	0,040	0,053	0,101	0,10	0,09	2,57	0,16	1,46	5,23	1002	100
Svanvik	NO0047R	1986	0,629	0,141	0,187	0,14	0,14	1,98	0,14	1,01	4,61	101	93
Svanvik	NO0047R	1987	0,677	0,115	0,209	0,13	0,13	1,23	0,10	0,70	4,49	365	100
Svanvik	NO0047R	1988	0,565	0,134	0,129	0,05	0,18	1,53	0,13	0,92	4,49	390	100
Svanvik	NO0047R	1989	0,723	0,118	0,100	0,05	0,19	1,19	0,12	0,64	4,47	424	100
Svanvik	NO0047R	1990	0,478	0,135	0,082	0,06	0,11	1,70	0,13	0,89	4,50	266	100

Site	Code	Year	xSO4-S	NO3-N	NH4-N	K	Ca	Cl	Mg	Na	pH	mm	Capture
Svanvik	NO0047R	1991	0,560	0,143	0,158	0,07	0,08	1,11	0,09	0,61	4,55	389	100
Svanvik	NO0047R	1992	0,510	0,123	0,215	0,06	0,11	1,35	0,10	0,78	4,71	432	99
Svanvik	NO0047R	1993	0,622	0,158	0,234	0,08	0,16	1,65	0,14	0,93	4,66	331	100
Svanvik	NO0047R	1994	0,579	0,176	0,349	0,13	0,12	1,07	0,12	0,61	4,71	379	100
Svanvik	NO0047R	1995	0,592	0,114	0,187	0,10	0,13	1,29	0,13	0,73	4,62	395	100
Svanvik	NO0047R	1996	0,437	0,162	0,216	0,08	0,22	1,60	0,17	0,86	4,73	352	100
Svanvik	NO0047R	1997	0,481	0,140	0,294	0,09	0,20	1,70	0,14	0,91	4,79	278	100
Svanvik	NO0047R	1998	0,499	0,129	0,267	0,10	0,13	1,89	0,15	1,02	4,74	346	100
Svanvik	NO0047R	1999	0,358	0,129	0,179	0,07	0,08	0,72	0,07	0,38	4,86	463	100
Svanvik	NO0047R	2000	0,518	0,145	0,243	0,09	0,11	1,19	0,10	0,68	4,69	436	100
Svanvik	NO0047R	2001	0,647	0,133	0,305	0,11	0,15	1,63	0,14	0,91	4,90	374	100
Svanvik	NO0047R	2002	0,447	0,105	0,303	0,16	0,20	3,28	0,24	1,87	4,96	427	100
Svanvik	NO0047R	2003	0,327	0,126	0,268	0,12	0,17	1,85	0,16	1,10	4,97	371	100
Svanvik	NO0047R	2004-2008											
Svanvik	NO0047R	2009	0,821	0,141	0,164	0,08	0,13	0,86	0,09	0,59	4,40	313	92
Svanvik	NO0047R	2010-2011											
Svanvik	NO0047R	2012	0,324	0,090	0,081	0,07	0,10	0,87	0,08	0,51	4,86	522	100
Svanvik	NO0047R	2015	0,581	0,121	0,235	0,13	0,15		0,10	0,60	4,64	321	86
Svanvik	NO0047R	2016-2017											
Svanvik	NO0047R	2018	0,329	0,119	0,081	0,17	0,12	0,79	0,11	0,46	4,83	356	82
Svanvik	NO0047R	2019											
Svanvik	NO0047R	2020	0,098	0,158	0,042	0,04	0,14	1,31	0,10	0,74	5,10	26	100
Svanvik	NO0047R	2021	0,144	0,076	0,166	0,11	0,21	1,28	0,10	0,73	5,27	459	98
Svanvik	NO0047R	2022	0,158	0,082	0,063	0,06	0,12	1,18	0,08	0,65	5,00	398	93
Svanvik	NO0047R	2023	0,122	0,106	0,150	0,10	0,15	1,70	0,10	0,98	5,07	344	98
Ny-Ålesund	NO0057R	1983	0,520	0,044	0,020		0,39	4,62	0,56		5,11	220	82
Ny-Ålesund	NO0057R	1984	0,652	0,171			0,71	12,98	0,93		4,60	365	100

Site	Code	Year	xSO4-S	NO3-N	NH4-N	K	Ca	Cl	Mg	Na	pH	mm	Capture
Ny-Ålesund	NO0057R	1985	0,606	0,138			0,71	18,95	1,28		4,72	237	100
Ny-Ålesund	NO0057R	1986	0,397	0,065			0,55	6,97	0,58		4,98	306	99
Ny-Ålesund	NO0057R	1987	0,700	0,118			0,64	12,11	0,91		4,63	390	97
Ny-Ålesund	NO0057R	1988	0,275	0,068	0,209		0,54	6,85	0,58	3,85	5,18	307	100
Ny-Ålesund	NO0057R	1989	0,087	0,052	0,063		0,87	20,50	1,47	9,82	5,55	295	100
Ny-Ålesund	NO0057R	1990	0,328	0,073	0,064		0,52	11,22	0,79	6,10	4,92	410	100
Ny-Ålesund	NO0057R	1991	0,336	0,110	0,103	0,43	0,80	14,33	1,13	8,09	4,96	424	100
Ny-Ålesund	NO0057R	1992	0,413	0,100	0,108	0,36	0,79	13,40	1,02	7,64	5,10	271	95
Ny-Ålesund	NO0057R	1993	0,162	0,096	0,085	0,32	0,52	13,13	0,92	6,85	5,03	491	100
Ny-Ålesund	NO0057R	1994	0,297	0,078	0,286	0,27	0,59	8,40	0,63	4,57	5,34	280	100
Ny-Ålesund	NO0057R	1995	0,295	0,098	0,152	0,33	0,89	10,43	0,79	5,63	5,26	238	100
Ny-Ålesund	NO0057R	1996	0,359	0,125	0,320	0,32	0,56	12,01	0,89	6,82	4,92	504	100
Ny-Ålesund	NO0057R	1997	0,339	0,101	0,435	0,52	1,46	52,42	2,98	21,80	5,60	320	99
Ny-Ålesund	NO0057R	1998	0,139	0,127	0,186	0,44	0,78	16,10	1,19	8,48	5,24	192	98
Ny-Ålesund	NO0057R	1999	0,433	0,219	0,220	0,35	0,87	9,63	0,78	5,19	4,95	189	85
Ny-Ålesund	NO0057R	2000	0,157	0,076	0,098	0,18	0,47	6,25	0,49	3,42	5,37	422	98
Ny-Ålesund	NO0057R	2001	0,154	0,077	0,068	0,26	0,56	11,75	0,83	6,62	5,35	357	98
Ny-Ålesund	NO0057R	2002	0,096	0,096	0,109	0,39	1,28	16,44	1,35	8,68	5,41	564	100
Ny-Ålesund	NO0057R	2003	0,258	0,111	0,120	0,59	1,67	26,50	2,22	13,95	5,50	207	91
Ny-Ålesund	NO0057R	2004	0,226	0,116	0,098	0,28	0,93	12,27	1,01	7,28	5,14	253	96
Ny-Ålesund	NO0057R	2005	0,189	0,092	0,087	0,25	1,29	10,45	0,89	5,91	5,45	212	96
Ny-Ålesund	NO0057R	2006	0,205	0,081	0,179	0,38	1,21	15,59	1,19	8,18	5,43	341	97
Ny-Ålesund	NO0057R	2007	0,193	0,047	0,121	0,43	0,79	15,00	1,11	8,18	5,89	304	93
Ny-Ålesund	NO0057R	2008	0,083	0,090	0,224	0,33	0,94	10,78	0,81	5,42	5,69	346	100
Ny-Ålesund	NO0057R	2009	0,127	0,091	0,066	0,15	0,36	6,63	0,44	3,37	5,45	221	98
Ny-Ålesund	NO0057R	2010	0,080	0,106	0,198	0,37	0,51	35,48	1,21	10,10	5,23	211	88
Ny-Ålesund	NO0057R	2011	0,074	0,081	0,301	0,32	0,56	14,28	1,00	7,53	5,51	294	100

Site	Code	Year	xSO4-S	NO3-N	NH4-N	K	Ca	Cl	Mg	Na	pH	mm	Capture
Ny-Ålesund	NO0057R	2012	0,061	0,058	0,046	0,14	0,30	6,10	0,46	3,50	5,51	373	99
Ny-Ålesund	NO0057R	2013	0,100	0,068	0,090	0,20	0,47	7,72	0,63	4,57	5,38	268	98
Ny-Ålesund	NO0057R	2014	0,467	0,093	0,082	0,22	0,44	7,46	0,60	4,37	4,78	311	100
Ny-Ålesund	NO0057R	2015	0,113	0,102	0,086	0,28	0,55	11,01	0,79	6,25	5,12	356	100
Ny-Ålesund	NO0057R	2016	0,074	0,056	0,078	0,17	0,30	6,53	0,48	3,66	5,49	490	100
Ny-Ålesund	NO0057R	2017	0,128	0,085	0,072	0,18	0,37	7,31	0,53	4,02	5,20	313	100
Ny-Ålesund	NO0057R	2018	0,101	0,068	0,064	0,13	0,29	6,46	0,46	3,63	5,39	484	100
Ny-Ålesund	NO0057R	2019	0,197	0,114	0,193	0,21	0,56	8,83	0,73	5,16	5,61	162	100
Ny-Ålesund	NO0057R	2020	0,109	0,069	0,085	0,23	0,88	10,18	0,83	5,92	5,75	228	100
Ny-Ålesund	NO0057R	2021	0,121	0,076	0,067	0,25	0,58	10,46	0,80	6,06	5,43	227	100
Ny-Ålesund	NO0057R	2022	0,074	0,065	0,121	0,18	0,50	7,45	0,56	4,25	5,43	340	100
Ny-Ålesund	NO0057R	2023	0,065	0,086	0,211	0,33	0,48	12,07	0,85	6,95	5,32	350	100

Table C.2: Annual mean concentrations of sulfur and nitrogen components in air at Norwegian background stations in 1973-2023. Units µg S/m³ and µg N/m³.

Site	Code	Year	SO2-S	SO4-S	NO2-N	NO3-N	sNO3-N	NH4-N	sNH4	K	Ca	Cl	Mg	Na
Birkenes	NO0001R	1972	2,377	1,101										
Birkenes	NO0001R	1973	2,746	0,807										
Birkenes	NO0001R	1974	2,988	1,105										
Birkenes	NO0001R	1975	2,566	1,074										
Birkenes	NO0001R	1976	4,447											
Birkenes	NO0001R	1977												
Birkenes	NO0001R	1978	1,738	1,089										
Birkenes	NO0001R	1979	1,115	1,329										
Birkenes	NO0001R	1980	1,419	1,415										
Birkenes	NO0001R	1981	0,754	0,967										
Birkenes	NO0001R	1982	0,977	1,146										
Birkenes	NO0001R	1983	0,535	0,946										
Birkenes	NO0001R	1984	0,648	1,271	1,12									
Birkenes	NO0001R	1985	0,695	0,875	0,83									
Birkenes	NO0001R	1986	0,695	0,828	1,07		0,359		0,66					
Birkenes	NO0001R	1987	0,719	0,778	1,12		0,295		0,65					
Birkenes	NO0001R	1988	0,628	0,753	1,27		0,284		0,63					
Birkenes	NO0001R	1989	0,481	0,671	1,11		0,259		0,63					
Birkenes	NO0001R	1990	0,495	0,761	1,01		0,275		0,78					
Birkenes	NO0001R	1991	0,536	0,905	0,93		0,264		0,76					
Birkenes	NO0001R	1992	0,397	0,649	0,69	0,234	0,241	0,32	0,53					
Birkenes	NO0001R	1993	0,397	0,596	0,59	0,139	0,233	0,43	0,55	0,05	0,05	0,37	0,05	0,39
Birkenes	NO0001R	1994	0,399	0,647	0,66	0,158	0,283	0,46	0,63	0,05	0,06	0,46	0,05	0,44
Birkenes	NO0001R	1995	0,313	0,576	0,66	0,165	0,296	0,44	0,54	0,05	0,05	0,45	0,05	0,45
Birkenes	NO0001R	1996	0,400	0,664	0,68	0,156	0,286	0,47	0,58	0,04	0,05	0,21	0,04	0,28

Site	Code	Year	SO2-S	SO4-S	NO2-N	NO3-N	sNO3-N	NH4-N	sNH4	K	Ca	Cl	Mg	Na
Birkenes	NO0001R	1997	0,225	0,531	0,69	0,144	0,236	0,37	0,54	0,05	0,05	0,46	0,05	0,43
Birkenes	NO0001R	1998	0,157	0,458	0,62	0,131	0,189	0,31	0,41	0,04	0,03	0,39	0,04	0,35
Birkenes	NO0001R	1999	0,136	0,490	0,53	0,143	0,201	0,33	0,51	0,04	0,04	0,45	0,05	0,40
Birkenes	NO0001R	2000	0,121	0,443	0,57	0,167	0,204	0,31	0,43	0,05	0,04	0,54	0,05	0,45
Birkenes	NO0001R	2001	0,162	0,435	0,47	0,141	0,209	0,31	0,45	0,05	0,03	0,31	0,04	0,33
Birkenes	NO0001R	2002	0,151	0,497	0,46	0,193	0,265	0,43	0,53	0,06	0,06	0,34	0,04	0,35
Birkenes	NO0001R	2003	0,150	0,498	0,58	0,185	0,260	0,38	0,50	0,05	0,04	0,29	0,05	0,37
Birkenes	NO0001R	2004	0,127	0,349	0,46	0,181	0,259	0,30	0,40	0,05	0,05	0,35	0,05	0,37
Birkenes	NO0001R	2005	0,194	0,458	0,46	0,245	0,334	0,40	0,60	0,05	0,06	0,39	0,06	0,46
Birkenes	NO0001R	2006	0,179	0,531	0,48	0,302	0,397	0,32	0,62	0,05	0,13	0,44	0,08	0,44
Birkenes	NO0001R	2007	0,064	0,277	0,32	0,127	0,170	0,17	0,29	0,04	0,05	0,37	0,05	0,36
Birkenes	NO0001R	2008	0,067	0,279	0,34	0,153	0,194	0,14	0,34	0,04	0,08	0,50	0,07	0,48
Birkenes	NO0001R	2009	0,055	0,304	0,44	0,177	0,255	0,20		0,04	0,04	0,36	0,04	0,38
Birkenes II	NO0002R	2010	0,122	0,295	0,31	0,150	0,228	0,20		0,04	0,03	0,26	0,03	0,30
Birkenes II	NO0002R	2011	0,108	0,333	0,44	0,268	0,371	0,32	0,63	0,08	0,04	0,53	0,08	0,53
Birkenes II	NO0002R	2012	0,073	0,272	0,39	0,306	0,460	0,28	0,61	0,07	0,05	0,35	0,06	0,43
Birkenes II	NO0002R	2013	0,087	0,248	0,28	0,209	0,285	0,23	0,46	0,06	0,06	0,57	0,06	0,51
Birkenes II	NO0002R	2014	0,167	0,373	0,31	0,283	0,378	0,34	0,62	0,08	0,07	0,64	0,07	0,52
Birkenes II	NO0002R	2015	0,070	0,286	0,30	0,265	0,319	0,27	0,44	0,06	0,07	0,81	0,08	0,61
Birkenes II	NO0002R	2016	0,055	0,204	0,30	0,208	0,250	0,23	0,40	0,06	0,04	0,53	0,05	0,42
Birkenes II	NO0002R	2017	0,059	0,222	0,28	0,115	0,147	0,13	0,27	0,05	0,03	0,51	0,05	0,40
Birkenes II	NO0002R	2018	0,096	0,261	0,32	0,186	0,238	0,25	0,47	0,06	0,05	0,54	0,06	0,45
Birkenes II	NO0002R	2019	0,070	0,205	0,32	0,117	0,149	0,16	0,32	0,06	0,05	0,50	0,06	0,42
Birkenes II	NO0002R	2020	0,060	0,190	0,30	0,130	0,165	0,15	0,40	0,07	0,06	0,87	0,08	0,66
Birkenes II	NO0002R	2021	0,070	0,187	0,25	0,094	0,120	0,13	0,27	0,04	0,04	0,46	0,05	0,37
Birkenes II	NO0002R	2022	0,056	0,175	0,25	0,129	0,153	0,14	0,31	0,04	0,05	0,68	0,06	0,52
Birkenes II	NO0002R	2023	0,050	0,159	0,23	0,085	0,104	0,10	0,28	0,03	0,03	0,49	0,04	0,39

Site	Code	Year	SO2-S	SO4-S	NO2-N	NO3-N	sNO3-N	NH4-N	sNH4	K	Ca	Cl	Mg	Na
Nordmoen	NO0044R	1986	0,472	0,876	2,01				0,59					
Nordmoen	NO0044R	1987	0,617	0,816	3,26				0,73					
Nordmoen	NO0044R	1988	0,701	0,851	3,01				0,61					
Nordmoen	NO0044R	1989	0,399	0,557	2,64				0,70					
Nordmoen	NO0044R	1990	0,365	0,717					0,67					
Nordmoen	NO0044R	1991	0,298	0,770	2,58				0,61					
Nordmoen	NO0044R	1992	0,212	0,562	2,43				0,52					
Nordmoen	NO0044R	1993	0,253	0,593	2,09			0,42	0,54					
Nordmoen	NO0044R	1994	0,227	0,583	2,57			0,45	0,62					
Nordmoen	NO0044R	1995	0,191	0,540	2,25			0,44	0,54					
Nordmoen	NO0044R	1996	0,158	0,576	2,48			0,48	0,60					
Hurdal	NO0056R	1997	0,183	0,408	1,10			0,29	0,53		0,06		0,03	0,19
Hurdal	NO0056R	1998	0,138	0,332	1,12			0,21	0,42		0,04		0,02	0,14
Hurdal	NO0056R	1999	0,095	0,391	1,04			0,27	0,39		0,04		0,02	0,16
Hurdal	NO0056R	2000	0,076	0,346	1,00			0,25	0,37		0,04		0,02	0,19
Hurdal	NO0056R	2001	0,095	0,328				0,21	0,25		0,03		0,02	0,15
Hurdal	NO0056R	2002	0,084	0,380		0,048	0,179	0,25	0,29		0,04	0,04	0,02	0,14
Hurdal	NO0056R	2003	0,113	0,428		0,097	0,235	0,27	0,38	0,06	0,04	0,15	0,03	0,27
Hurdal	NO0056R	2004	0,108	0,306	0,59	0,104	0,184	0,18	0,36	0,04	0,05	0,08	0,02	0,15
Hurdal	NO0056R	2005	0,121	0,397	0,84	0,142	0,245	0,29	0,51	0,06	0,05	0,09	0,02	0,20
Hurdal	NO0056R	2006	0,127	0,428	0,78	0,173	0,258	0,24	0,51	0,06	0,10	0,11	0,04	0,19
Hurdal	NO0056R	2007	0,056	0,221	0,78	0,095	0,165	0,15	0,30	0,04	0,05	0,07	0,02	0,13
Hurdal	NO0056R	2008	0,039	0,210	0,73	0,111	0,164	0,11	0,29	0,03	0,09	0,12	0,03	0,17
Hurdal	NO0056R	2009	0,043	0,207	0,71	0,092	0,171	0,12		0,04	0,03	0,07	0,02	0,14
Hurdal	NO0056R	2010	0,068	0,210	0,66	0,107	0,157	0,18		0,04	0,02	0,07	0,01	0,11
Hurdal	NO0056R	2011	0,097	0,261	0,79	0,247	0,344	0,41	0,71	0,08	0,04	0,10	0,03	0,19
Hurdal	NO0056R	2012	0,063	0,219	0,76	0,183	0,301	0,19	0,49	0,07	0,04	0,10	0,03	0,16

Site	Code	Year	SO2-S	SO4-S	NO2-N	NO3-N	sNO3-N	NH4-N	sNH4	K	Ca	Cl	Mg	Na
Hurdal	NO0056R	2013	0,042	0,170	0,70	0,117	0,176	0,15	0,37	0,06	0,05	0,14	0,02	0,17
Hurdal	NO0056R	2014	0,089	0,286	0,55	0,146	0,218	0,25	0,49	0,06	0,05	0,13	0,02	0,16
Hurdal	NO0056R	2015	0,050	0,142	0,65	0,240	0,269	0,24	0,42	0,05	0,05	0,14	0,02	0,16
Hurdal	NO0056R	2016	0,030	0,172	0,61	0,125	0,163	0,15	0,30	0,06	0,03	0,14	0,02	0,16
Hurdal	NO0056R	2017	0,041	0,145	0,64	0,070	0,093	0,09	0,20	0,05	0,02	0,10	0,01	0,11
Hurdal	NO0056R	2018	0,042	0,180	0,60	0,093	0,126	0,13	0,29	0,05	0,04	0,14	0,02	0,16
Hurdal	NO0056R	2019	0,036	0,141	0,50	0,065	0,086	0,10	0,24	0,04	0,04	0,14	0,02	0,14
Hurdal	NO0056R	2020	0,027	0,102	0,35	0,062	0,080	0,08	0,18	0,05	0,04	0,20	0,02	0,17
Hurdal	NO0056R	2021	0,022	0,121	0,40	0,059	0,074	0,09	0,22	0,03	0,03	0,11	0,02	0,12
Hurdal	NO0056R	2022	0,022	0,102	0,32	0,067	0,082	0,07	0,25	0,03	0,03	0,15	0,02	0,15
Hurdal	NO0056R	2023	0,032	0,103	0,26	0,052	0,068	0,06	0,24	0,02	0,02	0,11	0,01	0,12
Kårvatn	NO0039R	1979	0,478	0,479										
Kårvatn	NO0039R	1980	0,541	0,546										
Kårvatn	NO0039R	1981	0,509	0,470										
Kårvatn	NO0039R	1982	0,292	0,402										
Kårvatn	NO0039R	1983	0,188	0,384										
Kårvatn	NO0039R	1984	0,427	0,536										
Kårvatn	NO0039R	1985	0,436	0,453										
Kårvatn	NO0039R	1986	0,393	0,433										
Kårvatn	NO0039R	1987	0,316	0,384										
Kårvatn	NO0039R	1988	0,338	0,397	0,56		0,069		0,44					
Kårvatn	NO0039R	1989	0,171	0,302	0,34		0,081		0,42					
Kårvatn	NO0039R	1990	0,122	0,319	0,39		0,063		0,35					
Kårvatn	NO0039R	1991	0,141	0,310	0,26		0,063		0,36					
Kårvatn	NO0039R	1992	0,123	0,298	0,19		0,062		0,37					
Kårvatn	NO0039R	1993	0,151	0,296	0,16	0,029	0,066	0,17	0,38			0,30		
Kårvatn	NO0039R	1994	0,124	0,301	0,22	0,038	0,101	0,18	0,48			0,26		

Site	Code	Year	SO2-S	SO4-S	NO2-N	NO3-N	sNO3-N	NH4-N	sNH4	K	Ca	Cl	Mg	Na
Kårvatn	NO0039R	1995	0,158	0,221	0,26	0,029	0,095	0,13	0,36			0,24		
Kårvatn	NO0039R	1996	0,080	0,273	0,24	0,035	0,084	0,18	0,46			0,16		
Kårvatn	NO0039R	1997	0,054	0,219	0,25	0,036	0,072	0,14	0,50	0,02	0,03	0,33	0,03	0,22
Kårvatn	NO0039R	1998	0,045	0,152	0,27	0,025	0,047	0,08	0,33	0,02	0,02	0,19	0,02	0,14
Kårvatn	NO0039R	1999	0,031	0,200	0,23	0,028	0,049	0,12	0,45	0,02	0,02	0,14	0,01	0,12
Kårvatn	NO0039R	2000	0,033	0,167	0,32	0,036	0,052	0,09	0,56	0,02	0,02	0,27	0,02	0,19
Kårvatn	NO0039R	2001	0,060	0,163	0,19	0,054	0,077	0,11	0,37	0,02	0,02	0,19	0,02	0,16
Kårvatn	NO0039R	2002	0,071	0,205	0,26	0,059	0,091	0,13	0,69	0,03	0,03	0,18	0,02	0,16
Kårvatn	NO0039R	2003	0,069	0,218	0,30	0,064	0,092	0,13	0,85	0,03	0,04	0,27	0,03	0,22
Kårvatn	NO0039R	2004	0,070	0,203	0,21	0,043	0,075	0,10	0,34	0,02	0,05	0,21	0,03	0,21
Kårvatn	NO0039R	2005	0,069	0,185	0,22	0,089	0,143	0,15	0,50	0,03	0,03	0,18	0,02	0,18
Kårvatn	NO0039R	2006	0,056	0,245	0,24	0,107	0,145	0,13	0,73	0,06	0,08	0,16	0,04	0,16
Kårvatn	NO0039R	2007	0,032	0,127	0,17	0,044	0,064	0,06	0,61	0,02	0,04	0,20	0,03	0,16
Kårvatn	NO0039R	2008	0,029	0,139	0,20	0,045	0,070	0,06	0,55	0,02	0,08	0,26	0,03	0,18
Kårvatn	NO0039R	2009	0,025	0,136	0,17	0,029	0,058	0,06		0,03	0,03	0,15	0,02	0,15
Kårvatn	NO0039R	2010	0,031	0,139	0,25	0,054	0,077	0,10		0,02	0,02	0,13	0,01	0,13
Kårvatn	NO0039R	2011	0,068	0,131	0,26	0,121	0,166	0,15	0,88	0,05	0,03	0,24	0,03	0,21
Kårvatn	NO0039R	2012	0,041	0,141	0,22	0,155	0,256	0,16	0,71	0,05	0,03	0,25	0,03	0,19
Kårvatn	NO0039R	2013	0,022	0,094	0,16	0,085	0,128	0,09	0,57	0,04	0,04	0,16	0,02	0,15
Kårvatn	NO0039R	2014	0,124	0,196	0,14	0,106	0,175	0,17	0,63	0,03	0,05	0,17	0,02	0,17
Kårvatn	NO0039R	2015	0,031	0,088	0,11	0,124	0,144	0,13	0,51	0,03	0,03	0,21	0,02	0,16
Kårvatn	NO0039R	2016	0,026	0,109	0,15	0,044	0,066	0,06	0,44	0,03	0,02	0,17	0,02	0,15
Kårvatn	NO0039R	2017	0,060	0,093	0,17	0,021	0,035	0,03	0,36	0,02	0,02	0,19	0,02	0,14
Kårvatn	NO0039R	2018	0,030	0,119	0,18	0,036	0,055	0,06	0,60	0,03	0,04	0,18	0,02	0,15
Kårvatn	NO0039R	2019	0,027	0,104	0,16	0,023	0,042	0,06	0,46	0,03	0,03	0,18	0,02	0,14
Kårvatn	NO0039R	2020	0,027	0,073	0,15	0,022	0,035	0,04	0,46	0,03	0,03	0,21	0,02	0,18
Kårvatn	NO0039R	2021	0,028	0,104	0,14	0,022	0,034	0,05	0,69	0,02	0,03	0,20	0,02	0,15

Site	Code	Year	SO2-S	SO4-S	NO2-N	NO3-N	sNO3-N	NH4-N	sNH4	K	Ca	Cl	Mg	Na
Kårvatn	NO0039R	2022	0,022	0,087	0,13	0,023	0,035	0,03	0,55	0,03	0,04	0,30	0,03	0,22
Kårvatn	NO0039R	2023	0,032	0,084	0,12	0,022	0,034	0,04	0,53	0,02	0,03	0,20	0,02	0,15
Tustervatn	NO0015R	1979	0,875	0,676										
Tustervatn	NO0015R	1980	0,630	0,702										
Tustervatn	NO0015R	1981	0,668	0,522										
Tustervatn	NO0015R	1982	0,441	0,517										
Tustervatn	NO0015R	1983	0,256	0,475										
Tustervatn	NO0015R	1984	0,706	0,728										
Tustervatn	NO0015R	1985	0,597	0,585										
Tustervatn	NO0015R	1986	0,477	0,426										
Tustervatn	NO0015R	1987	0,724	0,594										
Tustervatn	NO0015R	1988	0,668	0,538										
Tustervatn	NO0015R	1989	0,156	0,231	0,29		0,076		0,52					
Tustervatn	NO0015R	1990	0,288	0,356	0,37		0,079		0,53					
Tustervatn	NO0015R	1991	0,255	0,384	0,32		0,075		0,68					
Tustervatn	NO0015R	1992	0,149	0,277	0,26		0,061		0,54					
Tustervatn	NO0015R	1993	0,178	0,310	0,19	0,035	0,072	0,16	0,66			0,57		
Tustervatn	NO0015R	1994	0,161	0,287	0,19	0,036	0,085	0,14	0,71			0,42		
Tustervatn	NO0015R	1995	0,156	0,280	0,16	0,032	0,090	0,15	0,62			0,44		
Tustervatn	NO0015R	1996	0,120	0,286	0,11	0,041	0,105	0,17	0,72			0,36		
Tustervatn	NO0015R	1997	0,087	0,269	0,18	0,035	0,072	0,15	1,15	0,03	0,05	0,52	0,05	0,36
Tustervatn	NO0015R	1998	0,098	0,205	0,18	0,030	0,060	0,11	1,03	0,02	0,02	0,35	0,03	0,23
Tustervatn	NO0015R	1999	0,084	0,231	0,14	0,033	0,052	0,12	0,99	0,02	0,02	0,31	0,02	0,21
Tustervatn	NO0015R	2000	0,041	0,181	0,17	0,044	0,060	0,10	0,88	0,02	0,02	0,35	0,03	0,27
Tustervatn	NO0015R	2001	0,137	0,201	0,15	0,057	0,082	0,12	0,84	0,03	0,02	0,38	0,03	0,26
Tustervatn	NO0015R	2002	0,091	0,208	0,18			0,11	0,73	0,03	0,04	0,36	0,03	0,28
Tustervatn	NO0015R	2003	0,094	0,222	0,18	0,093	0,121	0,15	1,04	0,03	0,04	0,56	0,05	0,39

Site	Code	Year	SO2-S	SO4-S	NO2-N	NO3-N	sNO3-N	NH4-N	sNH4	K	Ca	Cl	Mg	Na
Tustervatn	NO0015R	2004	0,093	0,212	0,17	0,055	0,086	0,12	0,78	0,02	0,04	0,37	0,04	0,30
Tustervatn	NO0015R	2005	0,077	0,215	0,14	0,064	0,098	0,12	0,85	0,02	0,04	0,36	0,03	0,28
Tustervatn	NO0015R	2006	0,092	0,225	0,15	0,102	0,133	0,11	0,95	0,02	0,07	0,33	0,04	0,25
Tustervatn	NO0015R	2007	0,059	0,145	0,11	0,056	0,091	0,08	0,79	0,03	0,05	0,42	0,04	0,29
Tustervatn	NO0015R	2008	0,029	0,152	0,14	0,066	0,088	0,07	0,84	0,02	0,10	0,40	0,05	0,29
Tustervatn	NO0015R	2009	0,049	0,155	0,11	0,049	0,074	0,06		0,02	0,04	0,26	0,03	0,21
Tustervatn	NO0015R	2010	0,080	0,153	0,12	0,071	0,096	0,11		0,02	0,01		0,01	0,15
Tustervatn	NO0015R	2011	0,078	0,131	0,14	0,194	0,246	0,23	0,94	0,05	0,03	0,32	0,03	0,25
Tustervatn	NO0015R	2012	0,046	0,123	0,18	0,168	0,249	0,16	1,07	0,06	0,03	0,23	0,03	0,18
Tustervatn	NO0015R	2013	0,034	0,082	0,13	0,094	0,129	0,09	0,69	0,03	0,04	0,25	0,02	0,20
Tustervatn	NO0015R	2014	0,084	0,098	0,10	0,087	0,119	0,10	0,59	0,02	0,03	0,16	0,02	0,14
Tustervatn	NO0015R	2015	0,025	0,083	0,08	0,119	0,140	0,11	0,61	0,04	0,03	0,37	0,03	0,25
Tustervatn	NO0015R	2016	0,036	0,127	0,11	0,052	0,074	0,07	0,43	0,03	0,02	0,34	0,03	0,25
Tustervatn	NO0015R	2017	0,038	0,121	0,11	0,025	0,039	0,04	0,27	0,02	0,02	0,39	0,03	0,26
Tustervatn	NO0015R	2018	0,039	0,128	0,11	0,028	0,044	0,06	0,35	0,04	0,02	0,37	0,03	0,25
Tustervatn	NO0015R	2019	0,045	0,137	0,14	0,045	0,064	0,08	0,37	0,03	0,03	0,38	0,03	0,26
Tustervatn	NO0015R	2020	0,028	0,076	0,14	0,019	0,034	0,03	0,33	0,02	0,02	0,42	0,03	0,28
Tustervatn	NO0015R	2021	0,027	0,108	0,13	0,019	0,030	0,05	0,40	0,02	0,02	0,26	0,02	0,18
Tustervatn	NO0015R	2022	0,021	0,081	0,08	0,019	0,030	0,04	0,41	0,02	0,02	0,35	0,03	0,23
Tustervatn	NO0015R	2023	0,035	0,108	0,10	0,024	0,035	0,05	0,34	0,02	0,02	0,41	0,03	0,29
Gruvebadet	NO0618R	1980	0,323											
Gruvebadet	NO0618R	1981	0,358											
Gruvebadet	NO0618R	1982	0,289											
Gruvebadet	NO0618R	1983	0,423											
Gruvebadet	NO0618R	1984	0,245											
Gruvebadet	NO0618R	1985	0,361											
Gruvebadet	NO0618R	1986	0,273											

Site	Code	Year	SO2-S	SO4-S	NO2-N	NO3-N	sNO3-N	NH4-N	sNH4	K	Ca	Cl	Mg	Na
Gruvebadet	NO0618R	1987	0,532											
Gruvebadet	NO0618R	1988	0,321											
Gruvebadet	NO0618R	1989	0,213				0,054							
Zeppelin	NO0042G	1990	0,213	0,224			0,040		0,09					
Zeppelin	NO0042G	1991	0,236	0,193	0,01		0,045		0,09					
Zeppelin	NO0042G	1992	0,194	0,189	0,02		0,036		0,08					
Zeppelin	NO0042G	1993	0,172	0,199	0,03	0,017	0,056	0,05	0,09	0,02	0,04	0,27	0,03	0,22
Zeppelin	NO0042G	1994	0,164	0,154	0,05	0,016	0,057	0,04	0,09	0,01	0,03	0,22	0,02	0,17
Zeppelin	NO0042G	1995	0,149	0,167		0,021	0,083	0,05	0,10	0,02	0,05	0,30	0,04	0,22
Zeppelin	NO0042G	1996	0,104	0,151		0,021	0,083	0,05	0,11	0,01	0,04	0,25	0,03	0,19
Zeppelin	NO0042G	1997	0,131	0,189		0,020	0,070	0,06	0,13	0,02	0,04	0,31	0,04	0,23
Zeppelin	NO0042G	1998	0,207	0,174		0,016	0,042	0,05	0,13	0,01	0,03	0,26	0,03	0,19
Zeppelin	NO0042G	1999	0,129	0,186		0,016	0,032	0,08	0,19	0,02	0,03	0,46	0,05	0,32
Zeppelin	NO0042G	2000	0,120	0,142		0,014	0,028	0,03	0,11	0,01	0,02	0,31	0,03	0,21
Zeppelin	NO0042G	2001	0,144	0,177		0,033	0,055	0,04	0,08	0,02	0,02	0,42	0,03	0,30
Zeppelin	NO0042G	2002	0,158	0,136				0,02	0,13	0,03	0,04	0,34	0,04	0,28
Zeppelin	NO0042G	2003	0,226	0,175		0,019	0,037	0,04	0,17	0,02	0,05	0,28	0,04	0,23
Zeppelin	NO0042G	2004	0,118	0,164		0,052	0,078	0,04	0,11	0,01	0,04	0,21	0,04	0,20
Zeppelin	NO0042G	2005	0,133	0,184		0,094	0,151	0,10	0,27	0,02	0,06	0,29	0,04	0,27
Zeppelin	NO0042G	2006	0,104	0,126		0,073	0,107	0,03	0,28	0,02	0,07	0,34	0,05	0,25
Zeppelin	NO0042G	2007	0,085	0,113		0,030	0,052	0,04	0,13	0,01	0,05	0,30	0,04	0,23
Zeppelin	NO0042G	2008	0,070	0,145		0,076	0,099	0,06	0,19	0,02	0,05	0,28	0,05	0,25
Zeppelin	NO0042G	2009	0,091	0,153		0,030	0,048	0,04		0,02	0,03	0,23	0,03	0,19
Zeppelin	NO0042G	2010	0,072	0,132		0,037	0,055	0,05		0,02	0,02	0,25	0,02	0,19
Zeppelin	NO0042G	2011	0,099	0,115		0,075	0,108	0,07	0,39	0,04	0,04	0,35	0,04	0,26
Zeppelin	NO0042G	2012	0,064	0,120		0,148	0,216	0,11	0,36	0,05	0,03	0,26	0,04	0,23
Zeppelin	NO0042G	2013	0,091	0,156		0,128	0,179	0,11	0,28	0,04	0,04	0,32	0,04	0,25

Site	Code	Year	SO2-S	SO4-S	NO2-N	NO3-N	sNO3-N	NH4-N	sNH4	K	Ca	Cl	Mg	Na
Zeppelin	NO0042G	2014	0,139	0,201		0,121	0,158	0,11	0,33	0,03	0,05	0,32	0,04	0,27
Zeppelin	NO0042G	2015	0,058	0,114		0,095	0,121	0,09	0,22	0,03	0,04	0,39	0,04	0,26
Zeppelin	NO0042G	2016	0,060	0,106		0,029	0,048	0,03	0,17	0,05	0,03	0,33	0,04	0,23
Zeppelin	NO0042G	2017	0,122	0,141		0,021	0,036	0,03	0,16	0,05	0,05	0,38	0,04	0,26
Zeppelin	NO0042G	2018	0,036	0,097		0,012	0,028	0,02	0,11	0,03	0,02	0,35	0,03	0,23
Zeppelin	NO0042G	2019	0,077	0,111		0,012	0,027	0,03	0,12	0,05	0,03	0,32	0,04	0,24
Zeppelin	NO0042G	2020	0,069	0,109		0,014	0,025	0,02	0,16	0,05	0,05	0,42	0,05	0,28
Zeppelin	NO0042G	2021	0,054	0,094		0,013	0,024	0,03	0,17	0,03	0,03	0,39	0,04	0,25
Zeppelin	NO0042G	2022	0,083	0,130		0,015	0,025	0,04	0,24	0,04	0,03	0,37	0,03	0,26
Zeppelin	NO0042G	2023	0,080	0,102		0,013	0,024	0,03	0,25	0,02	0,02	0,34	0,03	0,22

Table C.3: Annual mean concentrations of PM_{10}, $PM_{2.5}$ and OC, EC, TC in PM_{10} and $PM_{2.5}$ as well as levoglucosan in PM_{10} at Norwegian background stations in 2000-2023.

Name	Code	Year	PM_{10}	$PM_{2.5}$	PM_{10}-$PM_{2.5}$	OC in PM_{10}	OC in PM_{25}	OC in PM_{10}-$PM_{2.5}$	EC in PM_{10}	EC in $PM_{2.5}$	TC in PM_{10}	TC in $PM_{2.5}$	Levoglucos an
Birkenes	NO0001R	2000	6,76										
Birkenes	NO0001R	2001	6,08	4,04	2,02	1,13	1,00	0,08	0,130	0,156	1,26	1,15	
Birkenes	NO0001R	2002	7,15	4,78	2,27	1,03	0,92	0,19	0,140	0,123	1,17	1,04	
Birkenes	NO0001R	2003	6,66	4,40	2,22	1,06	0,86	0,24	0,110	0,119	1,17	0,98	
Birkenes	NO0001R	2004	5,35	3,28	2,07	0,84	0,59	0,27	0,095	0,085	0,94	0,68	
Birkenes	NO0001R	2005	6,77	4,06	2,67	0,92	0,63	0,29	0,153	0,117	1,08	0,75	
Birkenes	NO0001R	2006	8,06	4,95	3,36	1,16	0,87	0,33	0,132	0,128	1,29	1,00	
Birkenes	NO0001R	2007	5,63	3,33	2,50	0,84	0,63	0,21	0,141	0,121	0,98	0,75	
Birkenes	NO0001R	2008	5,88	3,00	2,68	0,80	0,57	0,24	0,087	0,080	0,89	0,65	10,9
Birkenes	NO0001R	2009	5,93	3,53	2,30	0,79	0,58	0,23	0,101	0,087	0,89	0,67	10,6
Birkenes II	NO0002R	2010	5,13	3,40	2,24	0,90	0,67	0,24	0,107	0,101	1,00	0,77	17,4
Birkenes II	NO0002R	2011	6,99	4,12	3,17	0,92	0,68	0,26	0,112	0,113	0,98	0,79	11,7
Birkenes II	NO0002R	2012	4,88	3,06	2,03	0,57	0,50	0,10	0,080	0,083	0,64	0,58	10,5
Birkenes II	NO0002R	2013	4,90	2,92	2,18	0,76	0,57	0,21	0,086	0,080	0,84	0,65	9,6
Birkenes II	NO0002R	2014	6,10	3,44	2,69	0,91	0,65	0,29	0,087	0,083	1,00	0,73	12,8
Birkenes II	NO0002R	2015	5,39	2,70	2,56	0,72	0,52	0,19	0,092	0,080	0,81	0,60	10,5
Birkenes II	NO0002R	2016	4,34	2,46	1,88	0,73	0,54	0,21	0,064	0,062	0,80	0,60	7,5
Birkenes II	NO0002R	2017	3,77	1,99	1,74	0,72	0,52	0,25	0,054	0,053	0,78	0,58	8,2
Birkenes II	NO0002R	2018	5,44	2,98	2,49	0,96	0,73	0,26	0,075	0,072	1,03	0,80	9,8
Birkenes II	NO0002R	2019	4,61	2,74	2,08	0,93	0,63	0,30	0,079	0,078	1,01	0,71	8,3
Birkenes II	NO0002R	2020	5,17	2,45	2,69	0,82	0,57	0,27	0,078	0,064	0,90	0,63	7,7
Birkenes II	NO0002R	2021	4,07	2,30	1,72	0,77	0,58	0,19	0,056	0,052	0,83	0,64	9,0
Birkenes II	NO0002R	2022	4,29	2,23	2,09	0,75	0,55	0,20	0,063	0,056	0,81	0,61	8,8
Birkenes II	NO0002R	2023	4,18	2,60	1,92	0,80	0,56	0,23	0,054	0,050	0,85	0,61	7,8
Hurdal	NO0056R	2010	4,85	3,86	1,26								
Hurdal	NO0056R	2011	5,87	4,35	1,46	1,28	0,89		0,171	0,165	1,46	1,05	

Name	Code	Year	PM_{10}	$PM_{2.5}$	PM_{10}-$PM_{2.5}$	OC in PM_{10}	OC in PM_{25}	OC in PM_{10}-$PM_{2.5}$	EC in PM_{10}	EC in $PM_{2.5}$	TC in PM_{10}	TC in $PM_{2.5}$	Levoglucosan
Hurdal	NO0056R	2012	4,08	2,77	1,29	0,86	0,60		0,130	0,126	0,99	0,73	
Hurdal	NO0056R	2013	4,55	3,12	1,44	1,05	0,76		0,139	0,138	1,19	0,90	
Hurdal	NO0056R	2014	5,73	3,79	1,94	1,30	0,82		0,114	0,112	1,42	0,93	
Hurdal	NO0056R	2015	4,15	2,75	1,50	0,99	0,73		0,141	0,134	1,14	0,86	
Hurdal	NO0056R	2016	4,00	2,61	1,37	0,94	0,66	0,30	0,098	0,097	1,04	0,76	
Hurdal	NO0056R	2017	3,87	2,36	1,56	1,15	0,74	0,50	0,101	0,093	1,25	0,83	
Hurdal	NO0056R	2018	4,93	3,23	1,81	1,27	0,88	0,41	0,115	0,108	1,39	0,99	
Hurdal	NO0056R	2019	4,58	2,65	1,92	1,23	0,71	0,52	0,103	0,095	1,34	0,81	
Hurdal	NO0056R	2020	4,07	2,23	1,88	0,95	0,58	0,38	0,080	0,070	1,03	0,65	
Hurdal	NO0056R	2021	4,04	2,74	1,65	1,14	0,73	0,41	0,090	0,084	1,23	0,81	
Hurdal	NO0056R	2022	4,15	2,36	1,82	1,12	0,67	0,44	0,092	0,082	1,22	0,75	
Hurdal	NO0056R	2023	3,80	2,28	1,52	1,14	0,71	0,44	0,078	0,078	1,21	0,79	
Kårvatn	NO0039R	2010	3,90	3,20	0,75								
Kårvatn	NO0039R	2011	3,72	2,65	1,03	0,91	0,68		0,068	0,068	0,98	0,75	
Kårvatn	NO0039R	2012	3,42	2,52	0,92	0,72	0,56		0,053	0,053	0,78	0,62	
Kårvatn	NO0039R	2013	3,11	2,22	0,88	0,75	0,53		0,058	0,061	0,81	0,59	
Kårvatn	NO0039R	2014	4,23	3,23	1,00	0,94	0,66		0,052	0,055	1,00	0,71	
Kårvatn	NO0039R	2015	2,31	1,51	0,89	0,64	0,47		0,043	0,046	0,68	0,52	
Kårvatn	NO0039R	2016	2,52	1,64	0,95	0,70	0,49	0,23	0,038	0,038	0,74	0,53	
Kårvatn	NO0039R	2017	2,14	1,45	0,73	0,66	0,50	0,21	0,033	0,036	0,69	0,53	
Kårvatn	NO0039R	2018	3,20	2,26	1,05	0,85	0,65	0,22	0,046	0,050	0,89	0,69	
Kårvatn	NO0039R	2019	2,93	1,91	1,23	0,69	0,53	0,18	0,045	0,048	0,74	0,57	
Kårvatn	NO0039R	2020	2,87			0,68			0,033		0,71		
Kårvatn	NO0039R	2021	3,28	2,14	1,14	0,78	0,53	0,27	0,042	0,045	0,82	0,57	
Kårvatn	NO0039R	2022	2,60	1,25	1,39	0,64	0,42	0,23	0,036	0,036	0,68	0,45	
Kårvatn	NO0039R	2023	2,62	1,54	1,12	0,73	0,49	0,24	0,039	0,040	0,77	0,53	
Zeppelin	NO0042G	2017				0,12			0,012		0,13		0,47
Zeppelin	NO0042G	2018				0,09			0,007		0,10		0,33

Name	Code	Year	PM_{10}	$PM_{2.5}$	PM_{10}-$PM_{2.5}$	OC in PM_{10}	OC in PM_{25}	OC in PM_{10}-$PM_{2.5}$	EC in PM_{10}	EC in $PM_{2.5}$	TC in PM_{10}	TC in $PM_{2.5}$	Levoglucosan
Zeppelin	NO0042G	2019				0,10			0,013		0,11		0,55
Zeppelin	NO0042G	2020				0,20			0,016		0,21		0,92
Zeppelin	NO0042G	2021				0,09			0,008		0,09		0,32
Zeppelin	NO0042G	2022				0,15			0,015		0,17		0,42
Zeppelin	NO0042G	2023				0,12			0,011		0,14		0,45

Appendix D

Detailed information of the monitoring programme

Table D.1: Site locations and station keepers for the background sites in 2023.

Stasjon	Fylke	m.o.h.	Bredde N	Lengde E	Start dato	Stasjonsholder	Adresse
Birkenes	Aust-Agder	190	58° 23'	8° 15'	nov-71	Olav Lien	4760 Birkeland
Birkenes II		219					
Grungedal	Vestfold og Telemark	800	59° 42'	7° 45'	nov-22	Sondre Hustveit	3895 Edland
Treungen		270	59° 01'	8° 32'	sep-74	Per Ø. Stokstad	4860 Treungen
Haukenes		20	59° 12'	9° 31'	apr-79		
Prestebakke	Østfold	160	59° 00'	11° 32'	nov-85	NILU	2027 Kjeller
Løken	Akershus	135	59° 48'	11° 27'	mar-72	Anne Mørch	1960 Løken
Hurdal		300	60° 22’	11° 04’	jan-97	Thomas Sørlien	2090 Hurdal
Osen (forest)*	Innlandet	560	61° 17’	11° 51’	May-1987	NIBIO	2060 Osen
Brekkebygda	Buskerud	390	60° 18'	9° 44'	des-97	Anton Brekka	3534 Sokna
Vikedal II	Rogaland	60	59° 32'	5° 58'	jan-84	Harald Leifsen	4210 Vikedal
Sandve		40	59° 12'	5° 12'	jun-96	Jan M. Jensen	4272 Sandve
Nausta	Vestland	230	61° 34'	5° 53'	des.84	Sverre Ullaland	6043 Naustdal
Kårvatn	Møre og Romsdal	210	62° 47'	8° 53'	feb-78	Erik Kårvatn	6645 Todalen
Overhalla	Trøndelag	60	64° 28'	11° 52’	dec-2022	Andreas Fiskum	7864 Overhalla
Tustervatn	Nordland	439	65° 50'	13° 55'	des-71	Are Tustervatn	8647 Bleikvassli
Svanvik	Finnmark	30	69°27'	30°02’	aug-86	NIBIO	9900 Kirkenes
Ny-Ålesund	Svalbard	8	78° 55'	11° 55'	1974	NP forskningsst.	9173 Ny-Ålesund
Zeppelin		474	78° 54'	11° 53'	sep-89	NP forskningsst.	9173 Ny-Ålesund

* Osen (forest) is part of the national forest damage monitoring conducted by NIBIO

Table D.2: Measurement programme at Norwegian background stations in 2022, including the environmental contaminants reported in Halvorsen et al. (2023) and observations from Osen (forest) which is part of the forest damage monitoring programme done by NIBIO.

	Air							Precipitation			
	Hourly		Daily		Weekly		2d per week	Daily	Weekly		monthly
Stasjon	Metr.	Ozone	main	NO_2	$PM_{2,5}$, PM_{10} + EC/OC	HM.	POPs	main	main	HM	POPs
Birkenes	X	X	X	X	X	X[b]	X[d]	X		X[b]	X[e]
Grungedal									X		
Treungen									X		
Haukenes		X									
Prestebakke		X									
Løken									X		
Hurdal	X	X	X	X	X			X		X[a]	
Osen (forest)									X		
Brekkebygda									X		
Vikedal									X		
Sandve		X									
Nausta									X		
Kårvatn		X	X	X	X			X		X[a]	
Overhalla									X		
Tustervatn		X	X	X				X			
Svanvik		X							X	X	
Zeppelin, Ny-Ålesund	X	X	X		EC/OC	X[c]	X[g]		X		
Total number	3	8+1	5	4	3+1	2	2	4	10	4	1

Metr. = meteorology
main.precip = amount (mm), pH, conductivity, SO_4, NO_3, Cl, NH_4, Ca, K, Mg, Na
main air = SO_2, SO_4, HNO_3 + NO_3 ; NH_4+ NH_3, Ca, K, Mg, Na, Cl
HM [a] = Pb, Cd and Zn
[b] = Pb, Cd, V, Cr, Co, Ni, Cu, Zn, As and Hg
[c] = Pb, Cd, V, Cr, Mn, Co, Ni, Cu, Zn, As
POPs [d] = α- og γ-HCH, HCB, DDTs, Chlordanes, PCBs, PBDE, HBCD, PAHs, PFAS
[e] = α- og γ-HCH, HCB, PCB
[f] = α- og γ-HCH, HCB, HCHs, DDTs, PCBs, PBDEs, PFAS
[g] = α- og γ-HCH, HCB, DDTs, Chlordanes, PCBs, BDE, HBCDs, PAHs, PFAS, Siloxanes, SCCP, MCCP

Appendix E

Sampling and chemical analysis (incl. background information on PM and EC/OC and levoglucosan)

Main components in precipitation

For precipitation sampling, a NILU Precipitation Collector (funnel + bucket type) is used (P.no. 9713,RS1). The bucket has a size of 2.5 litre, and the diameter of the collecting surface is 200 mm. The collector is placed 2 meters above ground. In winter, during snow conditions, the bulk + funnel collector is exchanged with a so-called Particulate Fallout Collector (P.no. 9711, SF1), see figure on the right of the two bulk collector types. The material used for the collectors is high density polyethylene.

The precipitation sampler is emptied and cleaned with distilled water between each sampling period (daily or weekly), also in periods when there has been no precipitation. The precipitation amount is measured by volume at the site, and an aliquot of the sample is sent to NILU for chemical analysis.

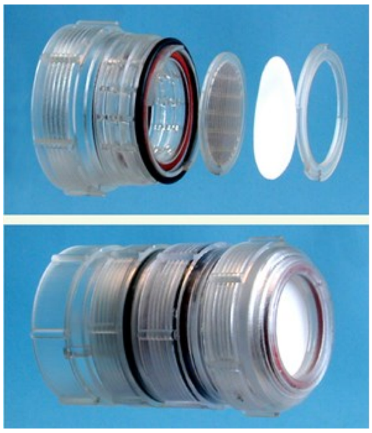
pH is measured with potentiometric method and conductivity with a conductivity meter. Anions and cations are measured with an ion chromatograph. The detection limit for the different ions are given in the table below:

Parameter	Detection limit (unit)
SO_4^{2-}	0.01 (mg S/l)
NO_3^-	0.01 (mg N/l)
NH_4^+	0.01 (mg N/l)
Na^+	0.01 (mg Na/l)
Cl^-	0.01 (mg Cl/l)
K^+	0.01 (mg K/l)
Ca^{2+}	0.01 (mg Ca/l)
Mg^{2+}	0.01 (mg Mg/l)

Main components in air

The main ions in air is sampled with a three stage filterpack using the NILU filter holder system designed for sampling of particles and gaseous compounds, see figure below. The first filter in the air stream is an aerosol filter (Zeflour 2 µm) for collecting the airborne particles containing SO_4^{2-}, NH_4^+, NO_3^-, Ca^{2+}, K^+, Cl^-, Na^+. This is followed by an alkaline (KOH) impregnated filter (Whatman 40), which will collect HNO_3, SO_2, HNO_2, HCl, and other volatile acidic substances. Nitric acid and sulfur dioxide will react with potassium hydroxide on this impregnated filter to give potassium nitrate and potassium sulphite. Oxidizing species in air e.g. ozone are believed to convert most of the sulphite to sulfate during the sampling. The third filter (Whatman 40) is acid-impregnated (oxalic acid) for absorbing alkaline air component such as NH_3. The filter pack method is biased in separating gaseous nitrogen compounds from aerosols and therefore the sum is reported. In other words, the concentration of nitrates in air equals the sum of the nitrate found on the aerosol filter and nitrate found on the alkaline impregnated filter. The same for ammonium, where the sum of ammonium concentration equals the sum of ammonium collected on the aerosol front filter and ammonia collected on the acid impregnated filter.

The filterpack samplers does not have a pre-impactor, but the air intake has a cylindrical vertical plastic section covering the filter holder – about 15 cm wide and 25 cm high. This air intake reduces the sampling efficiency for large particles such as soil dust particles, large sea spray droplets, large pollen, and fog droplet, thus the size cut off is approximately PM_{10} except for strong sea salt episodes when larger particles are collected.



After exposure, the filter holders are sent to NILU for chemical analysis. The filters are put into a test tubes with additions of extraction solution. Hydrogen peroxide solution is used for the alkaline filter in order to oxidize any remaining sulphite to sulfate. An HNO_3 is added to the acid impregnated filter. The aerosol Teflon© filters are given an ultrasonic treatment before analysis in order to obtain a complete extraction. The ions are analysed using an ion chromatograph, and the detection limits are given below:

Parameter	Detection limit (unit)
SO_2	0.01 (µg S/m^3)
SO_4^{2-}	0.01 (µg S/m^3)
Sum (NO_3^-+HNO_3)	0.01 (µg N/m^3)
Sum (NH_4^++NH_3)	0.05-0.1 (µg N/m^3)
Na^+	0.02 (µg Na/m^3)
Cl^-	0.02 (µg Cl/m^3)
K^+	0.02 (µg K/m^3)
Ca^{2+}	0.02 (µg Ca/m^3)
Mg^{2+}	0.02 (µg Mg/m^3)

Nitrogen dioxide

NO_2 is determined with the manual NaI glass sinter method. Ambient air with a flow rate of about 0.5 l/min is drawn through an air intake (inverted funnel) and a glass filter impregnated with sodium iodide (NaI) and sodium hydroxide (NaOH). Nitrogen dioxide is absorbed in the filter, and the iodide reduces NO_2 to nitrite. The nitrite formed on the glass filter is extracted with deionized water. After extraction the nitrite concentration can be determined spectrophotometrically at 540 nm after a reaction with sulphanilamide and N-(1-naphthyl)-ethylenediamine (NEDA). The detection limit for this method is 0.03 µg N/m^3.

Ozone

Ozone (O_3) is determined with the UV-absorption method (UV light at 254 nm) using a monitor with continuous measurements. The results are given in hourly resolution.

Particles (Mass, EC/OC, and levoglucosan)

Background

Size is the most fundamental parameter describing an aerosol, being decisive for transport and removal, and essential for understanding the effects of the ambient aerosol. Aerosol are most commonly defined by their equivalent aerodynamic diameter, defined as, that of a spherical particle of unit density (1 g cm^{-3}), having a settling velocity equal to that of the particle in question. The size distribution of the tropospheric aerosol is commonly divided into three major modes (Whitby, 1978); the nuclei mode, the accumulation mode and the coarse mode, all having different formation processes, leading to different characteristics of the aerosol. Tropospheric aerosols are either emitted directly (primary) or formed in the trophosphere by oxidation of precursor gases (secondary) (Seinfeld and Pandis, 1998). The sources of tropospheric aerosols are both natural (e.g. windborne dust, sea spray, volcanic activity, wild fires) and anthropogenic (fuel combustion, industrial processes, non-industrial fugitive sources and transportation sources), and hence its chemical composition is highly diverse, including amongst others: sulfate (SO_4^{2-}), nitrate (NO_3^-), ammonium (NH_4^+), organic carbon (OC), which is a bulk fraction of numerous organic molecules, light absorbing/refractory carbon (BC/EC), aluminum and silicon (major constituents of mineral dust), inorganic cations (e.g., K^+, Na^+, Ca^{2+} Mg^{2+}) and anions (e.g., Cl^-).

The adverse health effects of the ambient aerosol are well recognized (e.g., Dockery et al., 1993; Schwarz et al., 1996), causing various types of cardiopulmonary diseases, e.g., chronical obstructive pulmonary disease, ischemic heart disease, lung cancer and pneumonia. Although the statistical evidence between ambient air particulate mass (e.g., PM_{10} and $PM_{2.5}$) and adverse health effects are well documented, there is considerable doubt concerning the causal relationship. Thus, other relevant parameters such as the particle number size distribution, the surface and the chemical composition of the aerosol must be considered when addressing this issue. There is strong evidence that fine particles are more hazardous than coarse ones (Schwartz et al., 1996, Schwartz and Neas, 2000), although coarse particles are associated with adverse health effects as well (Castillejos et al., 2000; Ostro et al., 2000). An increasing number of experimental studies have been dedicated to the number of ultrafine particles (d_p< 100 nm), which potentially play a role in the cardiovascular effects commonly associated with exposure to particulate matter (Donaldson et al., 2001). Concerning the chemical composition, WHO has given the general advice that that primary combustion derived particles are particularly important as they "*are often rich in transition metals and organic compounds, and also have a relatively high surface area*". However, more knowledge is needed concerning the ambient aerosol chemical composition and its contribution to the adverse effects seen on human health.

The tropospheric aerosol has an influence on the radiation budget both directly, by scattering and absorption of sunlight and terrestrial radiation, and indirectly, by influencing cloud reflectivity and lifetime. Both effects lead to a mostly cooling effect for the Earth's surface. The particle size distribution is essential for quantifying the magnitude of both direct and indirect aerosol climate effect, whereas particle chemical composition influences aerosol absorption and the lower size limit of particles acting as cloud condensation nuclei.

The tropospheric aerosol also plays an important role when it comes to acidification and eutrophication of water bodies. This is attributed to the content of secondary inorganic species such as SO_4^{2-}, NO_3^- and NH_4^+, which typically are associated with accumulation mode particles, enabling long-range transport and deposition in regions far from where the precursors where emitted.

Elemental (EC) and organic (OC) carbon are important fractions of the ambient aerosol particle, contributing to the aerosol particle influence on the radiation budget both directly, by scattering and absorption of sunlight, and indirectly, by cloud formation. Likewise does the carbonaceous fraction contribute to the adverse health effects observed, i.e., respiratory and cardiovascular diseases. EC enters the atmosphere exclusively as a primary (i.e., direct particulate) emission, whereas OC includes both primary aerosol particles and secondary aerosol particles, of which the latter is formed from gaseous precursors oxidized in the atmosphere. The carbonaceous fraction can be of both anthropogenic and natural origin, e.g., EC and OC from incomplete combustion of fossil fuel (e.g., vehicular tailpipe emissions) and biomass (residential wood burning and wildfires), OC from oxidation of gaseous emissions from coniferous and deciduous trees, and OC associated with primary biological aerosol particles (PBAP). EC and OC are typically associated with the fine aerosol particle, although OC can appear in the coarse fraction as well, e.g., the PBAPs or due to condensation of OC on coarse aerosol particles. Despite the importance of the carbonaceous aerosol, detailed apportionment and quantification of its sources is still difficult due to the large number of sources, the complexity of atmospheric formation and the vast number of organic compounds associated with the aerosol.

EC and OC are simply operational definitions, and do not provide information about the source *pr. se*, thus additional measurements to EC and OC are required to provide information about the carbonaceous aerosol sources and their relative share. Source apportionment studies (Yttri et al., 2011a, b; Yttri et al.., 2021) including both ^{14}C and organic tracers show that natural sources dominate OC in PM_{10} at Norwegian rural background sites in summer, of which OC associated with the biogenic secondary organic aerosol (BSOA) is the major source followed by OC associated with PBAP. In winter, anthropogenic sources dominates OC in PM_{10}, i.e., emissions from fossil fuel combustion and residential wood burning. The picture is rather similar for OC in PM_1, except that OC associated with PBAP is of much less importance in summer than seen for PM_{10}. Combustion of fossil fuel appears to be the major source of EC regardless of season and size fraction, but EC from residential wood burning increases substantially in winter.

Levoglucosan is a thermal degradation product of cellulose with a low vapor pressure and a high emission factor from combustion of biomass (Locker, 1988; Simoneit et al., 1999; Oja and Suuberg, 1999), and thus well suited to trace biomass-burning aerosol in the ambient atmosphere. Aqueous-phase reaction with OH radical in deliquescent particles appears to be the most efficient pathway causing depletion of levoglucosan in the atmosphere. The ½ values (the time until half of the levoglucosan has been degraded) for levoglucosan in the atmosphere is debated and likely to vary with photochemical activity and OH concentrations, being a function of temperature and season (Hennigan et al., 2010; Yttri et al., 2014).

Levoglucosan is considered the most robust and reliable tracer of biomass burning, and is commonly used to trace biomass burning aerosol, not only qualitatively, but also quantitatively by combining ambient concentrations with emission ratios, or as input along with other species to e.g. positive matrix factorization (PMF). For studies using levoglucosan as biomass burning tracer in Norway, see Yttri et al., 2005, 2007a, b, 2009, 2011a, b, 2014, 2021, 2024. Although levoglucosan appears to be best suited to trace biomass burning emissions in winter and on a local to regional scale, conservative estimates of the biomass burning aerosol concentration can still be provided for the remote environment. Emission ratios used to convert observed ambient concentrations of levoglucosan to OC and EC from biomass burning, are associated with great uncertainty. In the present report, we use an OC/levoglucosan ratio of 12.7 for PM_{10} and 11.1 for $PM_{2.5}$ and an EC/levoglucosan ratio of 2. These ratios are based on positive matrix factorization (PMF) analysis results for PM and PM species observed at Birkenes (Yttri et al., 2021), which are consistent with results presented in the scientific literature e.g., by Zotter et al. (2017). A factor of 2 was used to convert biomass burning OC to OM, and a factor of 1.1 for biomass burning EC.

Sampling and chemical analysis

PM_{10} and $PM_{2.5}$ are obtained using Kleinfiltergerät samplers (one sampler pr. size faction), collecting filter samples on a weekly basis. The ambient aerosol particles are collected on prefired (850 °C; 3 h) quartz fibre filters (Whatman QM-A, 47 mm). The quartz fibre filters are conditioned (20 °C; 50% RH; 48 h) prior to and after being exposed. The mass concentration of the quartz fibre filters is determined gravimetrically. The uncertainty of the PM mass concentrations obtained for PM_{10} and $PM_{2.5}$ is estimated to be around 0.1 – 0.15 µg/m^3 for a sampling volume of 386 m^3.

Number concentration measurements at Birkenes dates back to 2010. The number concentration of ultrafine particles (D_p <0.1 µm), accumulation mode particles (0.1 µm < D_p < 1.0 µm) and coarse mode particles (D_p = 1.0 - 10 µm) are obtained by combined measurements of a Differential Mobility Particle Spectrometer (DMPS) and an Optical Particle Spectrometer (OPS). The DMPS measures the particle number size distribution ranging from 0.01 – 0.8 µm particle diameter, whereas the OPS covers the range from 0.25 µm to 30 µm. The DMPS and the OPS provide method specific measures of the particle diameter, i.e., the electrical mobility particle diameter and the optical particle diameter, respectively. Thus, when merging these two measures into one particle number size distribution (PNSD) time series, the PNSD must agree within 25% in particle diameter in their overlapping size range. For comparability of long-term measurements, the 0.01 – 0.02 µm size range is not reported.

In May 2017, a continuous, direct aerosol mass instrument was installed at Birkenes, a so-called tapered element oscillating microbalance (TEOM) instrument with a size cut off to measure PM_{10} mass. The TEOM Monitor draws (then heats) ambient air through a filter at constant flow rate, continuously weighing the filter and calculating near real-time mass concentrations of particulate matter. The mass is corrected with a factor 1.1 and -2.8 µg m^{-3} based on intercomparison with gravimetric measurements, which is the reference method.

Thermal-Optical Analysis of EC, OC, and TC in PM_{10} and $PM_{2.5}$ are performed on the same filter samples as the mass concentration of PM_{10} and $PM_{2.5}$ are obtained from at the three rural background sites. For the remote site Zeppelin, analysis is performed on prefired (850 °C; 3 hrs) quartz fibre filters (PALLFLEX Tissuequartz 2500QAT-UP; 150 mm in diameter) obtained from a Digitel high-volume sampler with a PM_{10} inlet, operating at a flowrate of 40 m^3 h^{-1}, collecting aerosol filter samples on a weekly basis. The T-O analysis is performed according to the EUSAAR-2 protocol (Cavalli *et al*., 2010). The analytical detection limit of the TOA instruments is 0.2 µg C/cm^2. This corresponds to a methodological detection limit of 0.007 µg C m^{-3} for a sampling volume of 386 m^3 and an exposed filter area of 13.4 cm^2 for the rural background sites and, and a methodological detection limit of 0.005 µg C m^{-3} for a sampling volume of 6720 m^3 and an exposed filter area of 153.9 cm^2 for the remote site.

Concentrations of the biomass burning tracers levoglucosan, mannosan and galactosan are determined from the same PM_{10} filter samples as the mass concentration, OC, EC, and TC at the rural background sites and from the same PM_{10} filter samples as OC, EC, and TC at the remote site. Analysis is performed using ultra-performance liquid chromatography (UPLC) (Vanquish UHPLC, Thermo Fisher Scientific) in combination with Q Exactive™ Plus Orbitrap (Thermo Fisher Scientific) operated in the negative electrospray ionization (ESI) mode (Yttri et al. 2024). The methodological detection limit is approximately 1-20 pg m^{-3} for the rural background sites and 1-4 pg m^{-3} for the remote site.

References:

Dye, C. and Yttri, K.E. (2005) Determination of monosaccharide anhydrides in atmospheric aerosols by use of high-resolution mass spectrometry combined with high performance liquid chromatography. *Anal. Chem., 77,* 1853-1858.

Hennigan, C. J., Sullivan, A. P., Collett Jr., J. L., and Robinson, A. L. (2010) Levoglucosan stability in biomass burning particles exposed to hydroxyl radicals. *Geophys. Res. Lett., 37,* L09806, doi:10.1029/2010GL043088.

Oja, V. and Suuberg, E. M. (1999) Vapor Pressures and Enthalpies of Sublimation of D-glucose, D-xylose, Cellobiose, and Levoglucosan. *J. Chem. Eng. Data, 33,* 26–29.

Simoneit, B. R. T., Schauer, J. J., Nolte, C. G., Oros, D. R., Elias, V.O., Fraser, M. P., Rogge,W. F. and Cass., G. R. (1999) Levoglucosan, a tracer for cellulose in biomass burning and atmospheric particles. *Atmos. Environ., 33, 173–182*.

Yttri, K. E., Dye, C., Slørdal, L. H. and Braathen, O.-A. (2005) Quantification of monosaccharide anhydrides by negative electrospray HPLC/HRMS-TOF – Application to aerosol samples from an urban and a suburban site influenced by small scale wood burning. *J. Air Waste Manage. Assoc., 55,* 1169–1177.

Yttri, K.E., Dye, C. and Kiss, G. (2007a) Ambient aerosol concentrations of sugars and sugar-alcohols at four different sites in Norway. *Atmos. Chem. Phys., 7,* 4267-4279. doi:10.5194/acp-7-4267-2007.

Yttri, K.E., Aas, W., Bjerke, A., Cape, J.N., Cavalli, F., Ceburnis, D., Dye, C., Emblico, L., Facchini, M.C., Forster, C., Hanssen, J.E., Hansson, H.C., Jennings, S.G., Maenhaut, W., Putaud, J.P. and Tørseth, K. (2007b) Elemental and organic carbon in PM_{10}: a one year measurement campaign within the European Monitoring and Evaluation Programme EMEP. *Atmos. Chem. Phys., 7,* 5711–5725, doi:10.5194/acp-7-5711-2007.

Yttri, K. E., Dye, C., Braathen, O.-A., Simpson, D. and Steinnes, E. (2009) Carbonaceous aerosols in Norwegian urban sites. *Atmos. Chem. Phys., 9,* 2007–2020, doi:10.5194/acp-9-2007-2009.

Yttri, K.E., Simpson, D., Stenström, K., Puxbaum, H. and Svendby, T. (2011a) Source apportionment of the carbonaceous aerosol in Norway - quantitative estimates based on 14C, thermal-optical and organic tracer analysis. *Atmos. Chem. Phys., 11,* 9375-9394. doi:10.5194/acp-11-9375-2011.

Yttri, K.E., Simpson, D., Nøjgaard, J.K., Kristensen, K., Genberg, J., Stenström, K., Swietlicki, E., Hillamo, R., Aurela, M., Bauer, H., Offenberg, J.H., Jaoui, M., Dye, C., Eckhardt, S., Burkhart, J.F., Stohl, A. and Glasius, M. (2011b) Source apportionment of the summer time carbonaceous aerosol at Nordic rural background sites. *Atmos. Chem. Phys., 11,* 13339-13357. doi:10.5194/acp-11-13339-2011.

Yttri, K.E., Myhre, C.L., Eckhardt, S., Fiebig, M., Dye, C., Hirdman, D., Ström, J., Klimont, Z. and Stohl, A. (2014) Quantifying black carbon from biomass burning by means of levoglucosan – a one-year time series at the Arctic observatory Zeppelin. *Atmos. Chem. Phys., 14,* 6427-6442. doi:10.5194/acp-14-6427-2014.

Yttri, K. E., Canonaco, F., Eckhardt, S., Evangeliou, N., Fiebig, M., Gundersen, H., Hjellbrekke, A.-G., Lund Myhre, C., Platt, S. M., Prévôt, A. S. H., Simpson, D., Solberg, S., Surratt, J., Tørseth, K., Uggerud, H., Vadset, M., Wan, X., and Aas, W. (2021) Trends, composition, and sources of carbonaceous aerosol at the Birkenes Observatory, northern Europe, 2001–2018. *Atmos. Chem. Phys., 21*, 7149–7170. doi:10.5194/acp-21-7149-2021.

Yttri K.E., Bäcklund A., Conen F., Eckhardt S., Evangeliou N., Fiebig M., Kasper-Giebl A., Gold A., Gundersen H., Myhre C.L., Platt S.M., Simpson D., Surratt J.D., Szidat S., Rauber M., Tørseth K., Ytre-Eide M.A., Zhang Z., and Aas W. (2024) Composition and sources of carbonaceous aerosol in the European Arctic at Zeppelin Observatory, Svalbard (2017 to 2020). *Atmos. Chem. Phys.,* 24, 2731–2758, doi: 10.5194/acp-24-2731-2024.

Zotter, P., Ciobanu, V. G., Zhang, Y. L., El-Haddad, I., Macchia, M., Daellenbach, K. R., Salazar, G. A., Huang, R.-J., Wacker, L., Hueglin, C., Piazzalunga, A., Fermo, P., Schwikowski, M., Baltensperger, U., Szidat, S., and Prévôt, A. S. H. (2014) Radiocarbon analysis of elemental and organic carbon in Switzerland during winter-smog episodes from 2008 to 2012 – Part 1: Source apportionment and spatial variability. *Atmos. Chem. Phys., 14,* 13551–13570. doi:10.5194/acp-14-13551-2014.

NILU is a Norwegian, non profit and independent climate and environmental research institute founded in 1969.

We started as an institute for air research but have now expanded to research almost all aspects of how people, climate, and the environment affect each other.

Our goal is to attain a better quality of life for everyone! We contribute to this through our research into the composition of the atmosphere, climate change, air quality, environmental toxins, health effects, sustainable systems, circular economy, and digitalization. Together, we enable sustainable solutions for current societal and business challenges.

www.nilu.no

nilu