



Nordic Council
of Ministers

Future Nordic Collaboration on Air Pollution

Workshop in Oslo 19-20 November 2019
organised by the Nordic Working Group
for Climate and Air (NKL)

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Summary

The Nordic Working Group for Climate and Air (NKL) organised 19–20 November 2019 a workshop with objective to outline its future directions and priorities within the field of air pollution. The new Programme for Nordic co-operation on the Environment and Climate 2019–2024 formed the basis for the discussions at the workshop.

Nordic collaboration under the Nordic Council of Ministers (NCM) has for decades been successful in developing air pollution science and policies, both for the Nordic countries themselves but not least for the development and implementation of international polices under the UNECE Convention on Long-range Transboundary Air Pollution (CLRTAP, or the Air Convention) and the European Union. Several of the successful initiatives within the Air Convention leading to emission reductions were originally discussed and outlined through Nordic projects.

Based on the discussions and presentations at the workshop, we, the coordinators of the workshop, are convinced that the Nordic collaboration will serve and develop strategies on air pollution and related issues in the future NKL should, however, take a wider responsibility given the challenges the society is facing today. In our opinion, the work should take an overarching approach based on the SDGs.

We are also convinced that the ways forward need to make use of the earth system perspective, in which monitoring and modelling covering the earth system components (air, water, soils, ecosystems and human activities, including economy) and their interactions should be included, and with the possibilities to link different spatial and time scales.

As an example, forecasts from a coupled atmosphere-land surface-hydrology model would provide

- better estimates of particle resuspension, of the moisture status of soil and vegetation and consequently of deposition of ozone and NO₂, or of the emission of biogenic gases, particles and ammonia,
- better estimates of the dispersion characteristics and precipitation close to the ground, which would improve pollution exposure forecasts and analysis.

The rationale for this is developed in the main report.

The NKL budget is limited, but NKL can and should play a wider role in outlining priorities and through collaboration with other funders.

Proposed projects and other initiatives

We propose the following projects to be considered as activities under the Nordic Working Group on Climate and Air (NKL) for the period up to 2024. Further descriptions of the project ideas are given under the section "Project Ideas for NKL".

Air pollution and health

NKL should continue to keep the health issues at a very high priority. Suggested activities:

- Synthesize current knowledge of air pollution and climate effects on health in the Nordic countries;
- New generation of health effects studies;
- Synthesize PM speciation measurements in the Nordic countries.

Air pollution and ecosystems

- The influence of nitrogen on biodiversity;
- Valuing nitrogen effects on biodiversity;
- Assessment of ozone effects to (semi)natural ecosystems.

Solid fuel combustion

- Approaching the end of health impact from small scale wood combustion in cities;
- Further improvements in ovens and combustion techniques;
- Better data on wood combustion.

Improvement of tools

- Emissions and emission inventories.

Climate change and air pollution

- Air pollution policies to meet air pollution and climate change objectives simultaneously;
- Air pollution and climate extremes;
- Air pollution and hydrological imbalances induced by climate change – Mercury;
- Air pollution and hydrological imbalances induced by climate change – Nitrogen.

Integrated assessment modelling – seamless approaches to combat air pollution

- Further development of IAM as a common Nordic tool;
- Cost-effective air pollution control for different governance levels in the Nordic countries (based on health effects).

EECCA

- How to formulate flexibility mechanisms under the Gothenburg Protocol – workshop including key representatives of the EECCA countries;
- Identification of domestic drivers in the EECCA countries for emission reductions and possible ways to meet these.

Earth system approach

- A broad Nordic initiative to analyse air pollution in an earth system context;
- N policies including dietary choices and consequences;
- Setting the agenda for a global collaboration on air pollution.

Sammanfattning

Nordiska Ministerrådets arbetsgrupp för Klimat och Luft (NKL) organiserade 19–20 november 2019 en workshop för att diskutera inriktning och prioriteringar inom luftvårdsområdet för sin verksamhet fram till 2024.

Det nordiska samarbetet inom luftområdet har under årtionden varit mycket framgångsrikt med avseende på forskning och som stöd för policy. Detta gäller frågor av gemensamt intresse inom de nordiska länderna men också när det gäller utveckling och genomförande av det internationella åtgärdsarbetet inom ramen för ECEs luftkonvention (CLRTAP) och EU. Flera av de initiativ som tagits inom luftkonventionen har sitt ursprung i nordiska projekt.

Vår slutsats från workshopen är att det nordiska samarbetet fortsatt har en mycket viktig roll att spela för att utveckla underlag och strategier för luftföroreningar och angränsande områden. NKL bör dock överväga att ta ett vidare ansvar när det gäller att koppla samman luftföroreningsproblemen med andra övergripande samhällsutmaningar som vi idag ställs inför. Fortsatt arbete bör därför i ökad utsträckning utgå från FNs hållbarhetsmål (SDG).

Vi tror också att vägen framåt för det nordiska luftvårdssamarbetet måste bygga på ett "earth system" perspektiv, där mätningar och modeller integrerar över media (luft, vatten, mark, hav) och där olika geografiska och tidsmässiga skalor kan behandlas parallellt. Utgångspunkten för vårt förslag utvecklas vidare i huvudrapporten.

NKLs budget är begränsad men vi är övertygade att NKL ändå kan spela en bredare roll än att bara bevilja de egna medlen när det gäller att sätta prioriteringar och forma samarbeten med andra anslagsbeviljande organ.

Förslag till projekt och andra initiativ

Vi föreslår nedanstående projekt och inriktningar för NKL för tidsperioden fram till 2024. Ytterligare beskrivningar och motiveringar ges i huvudrapporten.

Luftföroreningar och hälsa

NKL skall fortsatt ge hög prioritet åt hälsorelaterade frågor.

- Syntetisera befintlig kunskap om hälsoeffekter från luftföroreningar och klimat i de nordiska länderna.
- Ny generation av metoder för studier av hälsoeffekter.
- Syntes av nordiska mätningar av speciering av partiklar.

Luftföroreningar och ekosystem

- Kvävenedfallets betydelse för en förändrad biodiversitet.

- Värdering av kväveeffekter på biodiversitet.
- Sammanställning av ozons effekter på (semi)naturliga ekosystem.

Förbränning av fasta bränslen

- Hur kan man eliminera hälsoeffekterna från den småskaliga vedeldningen i städer?
- Förbättringar av ugn- och förbränningsteknik.
- Bättre underlagsdata om vedeldning.

Förbättrade verktyg

- Emissioner och verktyg för emissionsinventeringar.

Kimatändringar och luftföroreningar

- Luftvårdsplanering som möter både luftkvalitets- och klimatmål.
- Luftföroreningar och klimatextremer.
- Luftföroreningar och hydrologiska obalanser inducerade av klimatändringar – Kviksilver.
- Luftföroreningar och hydrologiska obalanser inducerade av klimatändringar – Kväve.

Integrated assessment modelling – seamless approaches to combat air pollution

- Fortsatt utveckling av IAM som ett gemensamt nordiskt verktyg.
- Kostnadseffektiv kontroll av luftföroreningar med avseende på olika beslutsnivåer i Norden (med utgångspunkt från hälsoeffekter).

EECCA

- Hur skall flexibla mekanismer formuleras under Göteborgsprotokollet? – Workshop med deltagande av nyckelpersoner från EECCA-länderna.
- Identifiering av inhemska drivkrafter inom EECCA-länderna för begränsa luftutsläppen och möjliga vägar att uppfylla dessa.

Earth System konceptet

- Ett brett nordiskt initiativ för att analysera luftföroreningar i kontexten "earth system".
- Policies för kväve i Norden inklusive val av diet och dess konsekvenser.
- Utarbeta en agenda för globalt samarbete inom luftföroreningar.

Introduction

New challenges related to the environment, air pollution and climate require innovative solutions. Only through a strategic insight, it is possible to identify the emerging issues on time and start solving them. New knowledge and innovations from science and technology offer solutions, but at the same time, new constructive policies are needed to support the utilization of the solutions and to keep us on the path towards a sustainable future.

As a common Nordic reaction to tackle the challenges in the field of climate and air pollution, the Nordic Ministers of Environment and Climate (MR-MK) have clearly stated their willingness to support joint Nordic initiatives. The work is conducted under the auspices of the Programme for Nordic co-operation on the Environment and Climate 2019–2024, among others through the activities of the Nordic Working Group for Climate and Air (NKL). The mandate of the group is to launch and manage initiatives and projects related to climate and air to identify common Nordic opportunities to reduce emissions and impacts of greenhouse gases and air pollutants.

To support the planning of future activities, the NKL working group invited in December 2019 a number of Nordic experts for a two-day workshop in Oslo to introduce and discuss current and emerging issues in the field of air pollution. The NKL commissioned prof. (emer.) Peringe Grennfelt (IVL Swedish Environmental Research Institute) and prof. (emer.) Øystein Hov (the Norwegian Meteorological Institute and the Norwegian Academy of Science and Letters) to facilitate the discussions and to compile the outcomes to a report. Professors Grennfelt and Hov have for several decades been acting as advisers to support various Nordic, European and global processes to combat air pollution.

This workshop report summarizes the issues discussed during the meeting and includes recommendations for areas of future activities by the workshop participants and the organisers/report authors. The NKL would like to thank warmly professors Grennfelt and Hov for their valuable contribution as well as all the workshop participants for their active contributions and fruitful discussions.

Kaarle Kupiainen

Chairman of the Nordic Working Group for Climate and Air (NKL)

Background and objective

Air pollution is, despite large reductions in emissions, a significant problem for the Nordic countries and its surrounding areas (including the Arctic). Epidemiological studies indicate that more than 10 000 inhabitants die due to air pollution and in many urban areas there are difficulties in achieving the limit values for the protection of human health. Ecosystems are also threatened due to high ozone levels and nitrogen deposition. Finally, air pollution emissions in Europe and elsewhere are of importance for climate effects in the Arctic.

The Nordic Council of Ministers recently published a Programme for Nordic co-operation on the Environment and Climate 2019–2024. The programme outlines priorities for the Nordic collaboration with respect to the development of common activities to support policies, both within the Nordic area and with respect to agreements, organisations and processes outside the area. For air pollution the activities are organized under the Nordic Working Group for Climate and Air (NKL).

In order to further outline the agenda for air pollution activities, the NKL group invited experts representing the main areas of the programme to a workshop in Oslo 19–20 November 2019 (see List of Participants in Appendix).

The workshop was organized along three blocks; Setting the scene, Topics for activities and Concluding discussions.

Øystein Hov and Peringe Grennfelt were commissioned to organise the workshop and compile the outcome into suggestions for projects and other activities. In the report we have done our best to summarise presentations and proposals from a general outcome of the workshop. In some places however, the views are more our own and here "we" is used in order to make it clear that it is our own views.

Setting the scene

The role of the Nordic Working Group on Climate and Air (NKL)

Kaarle Kupiainen, chair of the NKL, introduced the workshop by setting the topic in the perspective of the environmental engagements in the Nordic countries. He referred to the new Programme for Nordic co-operation on the Environment and Climate and mentioned the areas of importance with respect to air pollution:

- Promote the work under the UNECE Convention on Long-range Transboundary Air Pollution (CLRTAP, in this report named Air Convention) in order to reduce air pollution in the Nordic region, Europe, and the Arctic, and raise the level of ambition regarding the scope of its protocols and their future revisions;
- Work actively within the EU/EEA to continue reducing emissions of air

- pollutants that are harmful to the environment and health;
- Co-operate and share experiences in the development of national air quality programmes within the framework of the EU National Emissions Ceiling Directive (NECD);
- Increase knowledge on the impact of air pollution and the relationship between air and climate, as well as developing more integrated control action strategies.

He pointed to the importance of the programme for several international agreements, organisations and processes:

- The Air Convention (projects facilitating UN work on air pollution and air quality, e.g. nitrogen budgets, emission inventories, black carbon);
- EU (e.g. air pollution emission inventories – NECD);
- Bilateral co-operation with "neighbors" (Belarus, Ukraine, Russia – emission inventories);
- Arctic Council (AMAP – SLCPs, Snow Water Ice Permafrost, Adaptation, synergies climate and biodiversity etc.);
- UNFCCC (projects facilitating issues within the global climate negotiations, e.g. Paris Agreement Transparency framework, Global Climate Action Agenda etc.).

He also mentioned that the budget for the entire NKL group is determined year by year and that the budget for 2019 is approx. 9 MDKK.

The wider perspective – policy requests

Over recent years additional organisations and processes (in addition to those mentioned above, Air Convention, EU etc.) have appeared on the international air pollution scene. These include CCAC, WHO and UN Environment but also initiatives in relation to the Sustainable Development Goals (SDGs) and the 2030 Agenda for the Sustainable Development. There is no specific SDG goal for air pollution. Instead air pollution is embedded in several of the goals. Those of importance include:

- **Goal 3: Good Health and Well-Being for people**, "Ensure healthy lives and promote well-being for all at all ages.";
- **Goal 7: Affordable and Clean Energy**, "Ensure access to affordable, reliable, sustainable and modern energy for all.";
- **Goal 11: Sustainable Cities and Communities**, "Make cities and human settlements inclusive, safe, resilient and sustainable.";
- **Goal 15: Life on Land**, "Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat and halt and reverse land degradation and halt biodiversity loss.";
- **Goal 13: Climate Change**, "Take urgent action to combat climate change and its impacts by regulating emissions and promoting developments in renewable energy."

The Air Convention recently approved a long term strategy. In relation to this strategy the chair of the Air Convention, Anna Engleryd, highlighted the role of the Nordic countries in supporting international air pollution policies and processes:

- Joint work/information sharing on implementation of the Gothenburg Protocol and the EU National Emissions Ceilings Directive (NECD);

- Continue the support to EECCA countries with respect to ratification of the Gothenburg Protocol and the implementation of control measures;
- Deliver scientific and technical input to the upcoming review of the Gothenburg Protocol;
- Follow and when appropriate deliver input to the EU process on ambient air quality;
- Participate in the recently established "Forum for international cooperation on clean air" (coordinated by the Air Convention);
- Increased interest from the Air Convention on urban air quality through an Expert Panel on Clean Air in Cities.

One additional input to the discussions at the NKL workshop was the outcome of the Saltsjöbaden VI workshop held in March 2018.¹ The workshop was attended by representatives from several international organisations with interest in air pollution science and policy. The workshop set out five priority areas (Topics) for further research and policy development:

Clean Air for cities – the importance of transboundary air pollution and international collaboration for achieving air quality standards. Among recommendations of relevance for NKL were: Assessment of the impact of local emission reduction strategies at the regional scale and the impact of long range transport at the city scale; further evaluation of the effects of particles (e.g. BC vs PM_{2.5}); development of policies based on IAM approaches

Clean Air Globally – needs and options for scientific support and policy cooperation. Among recommendations mentioned were: development of a global harmonized monitoring and modelling network (earth system observation concept); improvement in emission inventories (e.g. wood combustion) and with respect to modelling, earth system modelling and linkages to climate models were mentioned (Arctic). On the policy side the workshop recommended the Air Convention to establish a platform for collaboration on a broader geographic scale including organisations such as UN Environment, WMO, WHO and others.

Clean Air in the East – Speed up ratification and implementation of the Air Convention protocols in the EECCA countries for instance taking into account a stepwise approach; capacity building including finding motivation for taking action within the countries.

Clean Air, Ecosystems and Climate – future monitoring of the air pollution impact on ecosystems. Recommendations that were made included coordination and harmonization of monitoring and reporting activities between EU and the Air Convention; assessment of critical levels for ozone and nitrogen with respect to biodiversity and the harmonization of air pollution and climate policies to avoid negative effects on ecosystems of intensified forestry for biomass production.

Clean Air – Sectors and Solutions; Three areas were included: shipping, solid fuel combustion and agriculture. For shipping priorities were given to the establishment of maritime emission control areas (SECA/NECA) in Europe and in the Arctic: the promotion of PM/BC emissions standards for shipping and ensure cleaner fuels as well as on-shore power supply in larger ports. For agriculture the relation to food and dietary issues were brought up as an area of importance.

1. Engleryd, A. and P. Grennfelt (2018). Saltsjöbaden VI Workshop. Clean Air for a Sustainable Future – Goals and Challenges. Nordic Council of Ministers. TemaNord 2018:540, ISSN 0908-6692. Copenhagen, p. 88.

The wider perspective – directions in supporting science

NKL has for many years been in the forefront in setting the agenda for air pollution science in support of policy. Key initiatives from the last century were the critical loads concept, the use of gap closure in integrated assessment modelling and the multi-pollutant, multi-effect approach for the Gothenburg protocol. After 2000, NKL has been active through taking initiatives and promoting i.a. the broader focus on nitrogen (Saltsjöbaden 2007), the introduction of the SLCP concept (Saltsjöbaden 2009) and recently in initiating a more global approach on air pollution (Saltsjöbaden 2018).

We now see an option for the NKL to take a new lead based on the SDGs and on a deepening of the scientific support and interaction. The introduction of the SDGs requires a holistic approach to the traditional environmental problems. Present and earlier approaches built on technical solutions are still relevant but if the society should meet the requirements of sustainability, there is a need to approach the fundamental issues that make up the SDGs. In addition, traditional technologies have also in many cases reached their limits of their performance.

It may now be time to extend the scope and see air pollution as an integral component of the SDGs. A thematic approach is therefore required to arrive at the measures needed to reach air quality objectives in various societal sectors.

It is also time to see air pollution in the earth system perspective, where the methodology required for finding solutions, requires a broad approach in observations and in model development and application (atmosphere, ocean, land, ice, biogeochemistry, ecosystems). To analyse and assess air pollution, it is necessary to consider the underlying mechanisms that cause the pollution, and how these mechanisms are integrated with biodiversity, climate, water quality and availability, estuaries and lakes, food production systems, health, urban livelihood etc. An earth system approach does not have to be global, a regional scale or even a local scale orientation is often the appropriate scale. Agriculture and the ammonia problem are examples, where the local and regional scales are appropriate – and even used today. Another is high pressure cells in the summer, where several air pollution and other environmental problems are linked, and the consequences and solutions are difficult to foresee without a broad systems approach.

This wider approach is more and more being taken, for instance in climate projections and analysis, in weather and water forecasting (both on a 5–10 days' time scale and on the sub-seasonal to seasonal time scale), and in the analysis of living resources in the oceans.

Summing up of presentations

In this section we are briefly summing up the presentations given at the workshop. The summing up reflects our own views and the content is to some extent biased with respect to what we see as relevant and important for Nordic cooperation.

An Earth System Approach to air pollution

NKL-funded projects are typically translational, there is a close coupling between the science and the applications, which can be described as a value cycle. Some scientists work not only in the discovery part of the value cycle, but also to a large extent in the translation and application parts for instance in the "honest broker" role. An honest broker engages actively with policymakers and societal sectors to solve problems by developing policy alternatives (Pielke Jr, 2007). The development of international air pollution strategies, e.g. within the Air Convention, has benefitted from scientists and activities that have translated science to useful policy advice but also understood the policy needs. NKL has traditionally supported translational scientific activities.

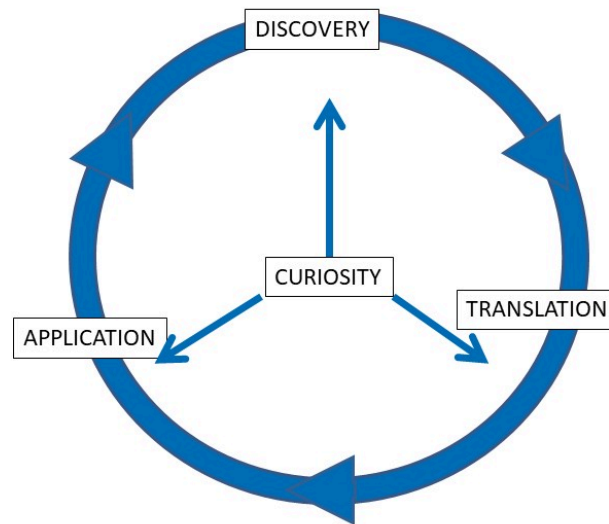


Figure 1: Value cycle in translational science

In NKL-funded projects the applied mode, close to the policy interface, has priority. The Programme for Nordic co-operation on the Environment and Climate 2019–2024 could, however, benefit from a more conscious discussion of the value cycle for a given policy issue or application, and evaluate where research efforts are needed in order to advance. Also, it is important to reflect on the character of the research effort required. Are the essential links between causes and effects and ways to solve the problems understood? It can also be explained as to what extent the problem is part of a well functioning value cycle/value chain or a less developed one.

An example of a well functioning value chain could be "better data on the emission factors for wood combustion" leading from characterization of PM concentrations and composition during cold winter nights in Nordic cities to the exposure calculations and coupling to the health of individuals.

An example of a less known but important value chain is "the nitrogen cycle in land ecosystems" and the response to the question "How are changes in temperature and precipitation patterns affecting the nitrogen cycle in land surface regions traditionally considered as important sinks?"

In the first case a specialized, short term project could be helpful, in the second case more long term and broad research activities are needed, where NKL could not act alone, but where NKL represent a unique Nordic perspective and community of researchers, which could make a real difference if put in motion in the right way.

In the earth system sciences (atmosphere, ocean, land surface, water, ice, biogeochemical cycles, ecosystems, climate) the trend is towards more unified, seamless approaches both in terms of observations and modelling. In this way boundary conditions, which today often constrain and limit the quality of essential information for a given problem, become an integral part of the description. WMO has taken the lead in the development and establishment of a Seamless Global Data Processing and Forecasting System (WWOSC, 2015; WMO, 2018), that requires collaboration across organizational boundaries between WMO and a series of other global organisations and initiatives.

It is not to be expected that a change to an earth system approach will give improvements in applications for policies overnight, but NKL should consider the new approaches for establishing long term support to air pollution policies, which are expected to dramatically improve the analysis of air pollution problems in a more holistic way. NKL already to some extent covers atmosphere and land surface research (reactive nitrogen cycle, ecosystem deposition) but the water cycle is less emphasized. It is recommended to consider the water cycle as a very important, integrative element of the earth system approach to policy making (water is the carrier of biogeochemical substances essential for water quality and runoff to rivers and estuaries, precipitation patterns regulate ecosystem growth and change and determine changes in the carbon and nitrogen budgets etc.). NKL could not act alone, but the Nordic Council represents a unique Nordic perspective and community of researchers which could make a real difference if put in motion in the right way.

An important component of the science to service journey is the valuation of impacts and optimization of mitigation options to minimize the economic losses. Even if this component is well known and exercised in the national and international work to reduce air pollution emissions through integrated assessment calculations, there are large needs to further develop this component in a holistic societal perspective going

beyond monetary valuation.

From the NKL perspective there are several scientific areas, where understanding is lacking, and scientific breakthroughs may result in significant improvements for setting policy objectives and control priorities. These areas include health effects of particles, background ozone effects on biodiversity, forest growth and carbon sequestration, the global and regional nitrogen cycles in view of climate change, and long term risks related to air emitted POPs and HMs.

In some areas, tools are available to shed light and quantify processes that are of direct relevance for the air pollution control. These areas include transcontinental transport of air pollution (increased importance in the UNECE region), the importance of long-range transport of air pollutants for air quality in cities, verifying bottom-up emission inventories through inverse modelling and how to design policies that are optimal with respect to governance levels.

Air pollution and health

Health effects are the main driver of air pollution policies all over the world. Despite the emission reductions, threats to health are still significant in the Nordic countries as well as in the rest of Europe. For Europe air pollution is estimated to cause more than 300,000 extra deaths annually by 2020. Most of them are due to cardiovascular diseases and the main cause is fine particles (PM_{2.5}). The scientific understanding is built on epidemiological studies. There are many new studies published and the knowledge of the extent and causes are continuously increasing.

A key parameter for estimating health effects is the Exposure Response Function (ERF), through which the number of additional deaths that occur due to an increase in air pollution exposure can be estimated. The ERF value used mostly for policy development today is 1.06, which means an additional increase in mortality of 6% for an increase in exposure of 10 µg m⁻³. More recent studies with refined methodologies have, however, resulted in a significantly higher ERF. These higher values are often associated with low concentrations of PM. Studies also indicate effect thresholds at values below 5 µg m⁻³. At the workshop it was concluded that it is not possible to define a safe level with respect to exposure to particles.

In general, the understanding of the mechanisms for effects from particles is poor. Although experimental studies have shown that some components in the mixture of compounds and fractions that make up the exposure have detrimental effects on humans (e.g. PAHs), there is a lack of common understanding that can be used for setting priorities to certain fractions. Black Carbon has been considered a key component, but recent views from WHO, is not underpinning this.

Studies in the Nordic countries have shown that road dust significantly contributes to health effects.

Nitrogen

Effects on ecosystems have formed the basis for the 1988 NO_x protocol, 1994 second sulphur protocol and 1999 Gothenburg-protocol. In the second sulphur protocol and the Gothenburg protocol critical loads were used as the criteria for effects. While

sulphur deposition is relevant for acidification, nitrogen deposition is relevant for acidification, eutrophication and biodiversity change. So far, air pollution control has managed to reduce the exceedance of critical loads for acidity substantially, but the problems with nitrogen remains with exceedances in large parts of Europe.

Biodiversity effects from nitrogen deposition have received increased attention for a couple of reasons. It is of interest politically and easy to relate to by non-experts. Further, there are well-established links between reactive nitrogen and biodiversity, which offer potential for political use. The issue is however complicated with respect to factors such as site history, time lag and relations to climate change. More work is needed on defining, mapping and communicating negative effects of N on ecosystems. Finally, there are needs to further develop the critical loads concept, both with respect to underlying science and modelling.

The main air pollution source of reactive nitrogen is ammonia from agriculture. In order to understand the wider needs for control of nitrogen, it is important to take into account the flows of nitrogen and their links to farming practices, dietary choices, and other environmental threats such as pollution of aquatic systems. Nitrogen links in this way to several of the SDGs. Further, nitrogen is together with land use change one of the most important factors with respect to the EU habitat directive. Some countries have developed nitrogen budgets on a national level in order to get an overview of the entire nitrogen problem.

Since much of the problems occur close to the sources, the fragmented structure in emissions as well as in some of the effects need to be considered when developing control strategies.

Integrated assessment modelling (IAM) and cost-benefit analysis (CBA)

The role of IAM in developing air pollution strategies is increasing because of the needs of considering the costs of control in relation to benefits. The EU has taken a central position and requests CBAs for all environmental regulations. This has also increased the needs to apply CBAs in the Nordic countries.

The Nordic Welfare Project is an ongoing collaboration between the Nordic countries on integrated assessment of air pollution effects to human health. The objective of the project is to evaluate ways for setting priorities for air pollution control in the Nordic countries. Several research groups are involved, and the key results will be presented at an event in 2020.² The project is financed by Nordforsk and is expected to finish in 2021. The Nordic collaboration has generated substantial benefits both for national and international policies. There are good reasons for coordinating such activities between the Nordic countries even in the future.

Arctic issues

Air pollution is shown to play a significant role for the climate in the Arctic. Even if it is not much black carbon (BC) in the Arctic, it dominates the radiative forcing during spring. A significant share of the appearance of BC may originate from gas flaring and bush and forest fires in Russia in the spring and early summer. Black carbon emissions from sources in Europe and Asia warm the Arctic lower atmosphere, while

2. The event will be held as a web conference 10–11 June 2020. For information see <http://www.scac.se>

the pollution originating from the energy sector cools the Arctic. NKL has funded scientific development, and AMAP has published expert assessments with Nordic input.

Important collaborative work is carried out among some of the Nordic countries on the climate response following the reduction of pollutant emissions in Europe and elsewhere. These studies include how the Arctic climate responded to the SO₂ emission reductions in Europe from its peak level in 1980 through a drop by more than a factor four around the turn of the century. It is very likely that even though the net radiative forcing reduction is largest above the emission regions in Europe, the climate change impact has been strongest in the European Arctic.

The Arctic domain and particularly the European part plays an important political, economic, environmental and social role in the Nordic countries. This role is voiced jointly in particular through Arctic Council. It is important that NKL pay considerable attention to the interaction between environmental (including climate changes in the Arctic) and changes in weather and environment at mid latitude and in the wider Boreal region, and vice versa. As the political pressures in the European Arctic grow, it is essential that the Nordic countries exercise a knowledge-based, forward-looking governance of the Arctic, where issues that are connected are analysed through an earth system approach coupled to socio-economic understanding.

Tools – emission inventories

Development of methods for emission inventories and harmonizing between Nordic countries have been a topic for Nordic collaboration and support from the Nordic Council of Ministers for many years. Through this support, present inventories are state-of-the-art and adjusted to reflect Nordic conditions. The support has also been used to contribute to improvements of the EMEP/EEA Guidebook. For the future there is a need to further improve accuracy of inventories through methods that better reflect Nordic (country specific) emissions. Circumstances different in the Far North that are needed to be considered are legislation, source details, techniques, raw material, use practices, geographical conditions. There is also a need to present air pollutant and greenhouse gas emissions together in order to achieve the benefits of integrated policies and assessments for air pollutants and greenhouse gases.

EECCA countries and the Air Convention

With a few exceptions, EECCA parties have not ratified any of the protocols stipulating emission control.³ The situation is embarrassing both for the convention and for the countries themselves, which in different ways have been active in the work under the convention for decades.

The Nordic countries have over several years supported the EECCA countries with respect to capacity building, in particular on emission inventories and integrated assessments including cost estimates. At the Saltsjöbaden VI workshop there was a session with a broad representation of experts from the EECCA countries. Obstacles

3. Some parties ratified the first sulphur and the NO_x protocol. In addition, Moldavia has ratified the POPs and HMs protocols.

and needs for a more active participation in the ratification and implementation process were thoroughly discussed. From these discussions it was concluded that there is a need to increase the public awareness, to improve basic data (in particular on emissions), and to support capacity building. The EECCA countries also want to see a more flexible way to approach ratification and one recommendation was that the convention should consider the option of a stepwise approach. Nordic countries could and should still promote awareness and ratification through targeted projects.

It was also mentioned that the air pollution awareness is increasing in many countries. In Russia, a decree was put forward by president Putin in 2018, which included a request of reducing air pollution by 20% by 2024 in 12 cities (mostly in the Asian part of Russia). The decree also includes a request for more efficient air quality programmes including air quality monitoring.

Sector policies – Energy

There are large co-benefits between climate and air pollution policies within the energy sector and these benefits are expected to remain for years to come. The outcome of a combined approach is that costs for control will be reduced. The tradeoff between an increased use of wood for climate mitigation and PM emissions are well known and needs to be considered, in particular when wood is used for heating in small stoves.

There is an ongoing integration of the Nordic energy sector leading to a decarbonization of the energy production. For the coming years it is important to consider new options for decarbonizing of the industry. One such development is the replacement of coke with hydrogen for the production of steel. If realized at the steel manufacturing plant in Luleå, a cut of the present sulphur dioxide emissions by almost 50% will occur.

Sector policies – Shipping

The relative importance of emissions from shipping has increased in parallel with the decrease in emissions from land-based sources and new regulations are slowly introduced in order to cut these emissions.

Knowledge about emissions is central for both legislation and for the control of applied measures. There are several annual emission inventories running including Copernicus, TFEIP, ESSF, EMEP etc. These are based on different methodologies and covering different regions and needs. Thanks to good statistics on the marine traffic, air emissions can be estimated with relatively good accuracy, mostly better than for other traffic sectors. The methodology for emission inventories has gone through a development from simple estimates from fuel sold to today's methodology which is based on vessel-specific data. The emission inventories are now at the doorstep of even more advanced methodologies "Tier 4", including specification of i.a. engine data, propulsion, abatement techniques etc.

There are continuously needs for improvements in the understanding of those factors determining emissions including emission measurements of marine engines using various fuels. These measurements should also include other components such as BC, abatement techniques etc. Modelling of emissions and atmospheric consequences needs experimental data and verified fuel data. In the future it is also

important to consider new fuels such as LNG, methane, methanol, low sulphur residuals, renewables etc.

Local air quality

The increased concern for air pollution and health has also increased the needs for updated information on actual air pollution situations. One example was shown from Norway, where authorities together have developed an air quality forecast system, which is available over Internet (yr.no). Through the underlying modelling system, regional models are linked to local model systems down to scales of 50–250 meters. The system will give forecasts of high relevance for both the general population and for air quality planners.

Monitoring

The EMEP system has generated several long term series of air quality data of large importance for assessments of air quality and its trends. The system covers however only Europe and parts of North America with an acceptable degree of density. The EMEP database includes approx. 350 stations and some sites started their data series close to 50 years ago. There are however challenges with respect to present and future strategies.

One challenge is the lack of data from the EECCA countries, even if improvements are made. Another related issue is the lack of monitoring stations in the Arctic. The increased attention to BC will require data on BC concentrations to improve/validate models. Much of the monitoring is done on project and research initiatives. In order to generate long term data of importance for evaluating trends and outcome of control measures, there is a need to convert these projects and research initiatives into parts of long term monitoring programmes. In addition, quality assurance is an issue that always need attention.

Atmospheric modelling

Atmospheric modelling is key for the understanding of source-receptor relationships and the origin of pollutants. Even if models have increased their performance, there are still significant uncertainties with respect to PM concentrations and composition. Uncertainties are particularly large for wood burning and road dust, two sources of significant importance for the Nordic countries.

The Copernicus initiative offers several services of importance for atmospheric modelling such as boundary conditions, emission data etc. But the initiative is of no or limited use when it comes to local scale modelling and it can not be used for process understanding or IAM.

Among areas that need additional research was mentioned modelling of so called condensables.

Project ideas for the Nordic Working Group on Climate and Air

Under this headline we have identified several areas, which we find of priority for the NKL group. Some of them are short-term hands-on projects, inside well established science for policy contexts, and which rapidly can be included in ongoing policy development. Others are of a more long term nature with the purpose to establish readiness for the Nordic countries to include air pollution in integrated control strategies and policies related to the Sustainable Development Goals. We also include a broader, long term recommendation for NKL to establish an expert team to plan and become an advocate for a broad Nordic initiative for a regional earth system approach to environmental problems, realizing that air pollution is an integral component of a range of the sustainable development goals.

There are certainly other areas and needs that would be of interest to consider by the NKL group, especially when seen over a period up to 2024. These may include further needs with respect to the Air Convention and may be directed towards monitoring and model development and application.

Health

Synthesize current knowledge of air pollution and climate effects on health in the Nordic countries. Health risk estimates in the Nordic countries have so far mainly been based on data from other parts of the world. Data from Nordic studies are now emerging, providing a better basis for the assessment of effects. Available data should be evaluated and their influence on present health effect estimates should be assessed. A short term project could show how exposures to air pollution close to or below present limit values can affect health risk estimates.

SDG 3
Short term

New generation of health effects studies. New epidemiological studies in the Nordic countries may offer new ways to determine how fine time and spatial scales in exposure affect health risks. Personal monitors and activity-based health parameters could be key ingredients. Such studies may provide new data on relative risks, including zero-effect levels.

New epidemiological studies could be combined with new studies of PM chemical composition and the distribution on the most important size ranges for health effect impact, including ultrafine particles. This research area is too large to be financed by NKL only but NKL could serve as an initiator and a facilitator for Nordic collaboration.

SDG 3
Long term

Synthesize PM speciation measurements in the Nordic countries. Data will be used for the assessment of model performance and emission inventories. Data may also serve future needs with respect to health risk studies. PM speciation may also be of importance for experimental effect studies (health and ecosystems).

SDG 3
Short term

Air pollution and ecosystems

The influence of Nitrogen on biodiversity. Finding common methods for assessing critical loads for nitrogen and for the habitat directive. The most important concern with respect to N emissions is its influence on biodiversity. A Nordic collaboration will offer additional value to already ongoing national activities in the Nordic countries to meet requests from the EU habitat directive. Interaction

SDG 15
Short term

with climate change and other factors should be considered.

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SDG 15
Short term

Valuing N effects on biodiversity. Cost benefit analyses are of increasing interest as a basis for abatement strategies. Even if there are large problems associated with valuing ecosystems effects, there is a need to make best approaches. A Nordic collaboration would be beneficial.

SDG 15
Short and long term

Assessment of ozone effects to (semi)natural ecosystems. Ozone episodes have almost entirely disappeared in Europe following regional emission control. Background ozone concentrations have become the primary threat for ecosystems and human health. The increased background concentrations that were observed towards the end of the last century are stabilized and have decreased in some places. But background ozone is still a threat to ecosystems and human health, and ozone concentrations may even increase if methane emissions increase. The impact of background ozone on ecosystems is not so well known, and an assessment of current knowledge with respect to Northern ecosystems would be useful.

SDG 15
Short term

Solid fuel combustion

Approaching the end of health impact from small scale wood combustion in cities.

In order to achieve satisfactory air pollution levels in cities, the long term goal should be to get rid of local wood combustion or to develop new technologies for small scale combustion. Even if combustion performances are improving, wood combustion in densely populated areas will, unless completely new techniques are developed, significantly contribute to PM exposure and health effects. An intermediate objective should be further improvements in stove standards for new equipment, and in stove operation. A Nordic project may investigate options for voluntary actions and local regulations.

SDG 3
Short term

Further improvements in ovens and combustion techniques. This is an important area but probably not within the scope of NKL. NKL could however highlight the importance in order to engage other organisations under NMR.

SDG 3
Short term

Better data on wood combustion. There are generally large problems in getting good and reliable data regarding the overall extraction of wood for domestic use, on how the wood is used in various applications and the resulting emissions. Activities to further develop methodologies are always a priority. Project ideas should however be considered in the light of their applicability for control policies including phasing out urban wood combustion in the Nordic countries.

SDG 3
Short term

Improvement of tools

Emissions and emission inventories. NKL has traditionally through several projects supported research and development in order to improve data on emissions. These projects are generally aimed to improve data that should be reported to the Air Convention and the EU. At the workshop the issue of emissions was brought up in two presentations; one general and one specifically on shipping.

Short term

We see even in the future needs for a Nordic support but are not at this moment in a position to outline specific activities. We will however point to the needs for further harmonization of emission reporting between UNFCCC and the Air Convention.

There may also be needs for projects directed towards emissions from shipping in

order to strengthen the policy development in relation to IMO.

Climate change and air pollution

Air pollution policies to meet air pollution and climate change objectives

simultaneously. There is a need for further investigate the co-benefits and tradeoffs for climate which follows the mitigation of air pollution. For the longer term, a broad Nordic earth system approach is recommended, relevant for this topic (see below).

SDG 13
Short and long term

Air pollution and climate extremes. Models and observations indicate that climate extremes are becoming more frequent (droughts, floods, heat waves, heavy precipitation events) and will continue in this direction into the future. Such extremes also influence the occurrence and impact of air pollution. Wildfires and persistent high pressure situations in summers have already shown to cause severe air pollution situations. A Nordic project should as a first step analyse risks for both occurrence and impact on health and environment. In a longer perspective, we see a need for a more advanced joint programme with an earth system approach (see recommendation below).

SDG 3
SDG 15
SDG 13
Short term and long term

Air pollution and hydrological imbalances induced by climate change

Mercury. It is well known that methyl mercury release from soils will increase due to high water regimes (flooding, hydropower dams). A study should analyse the risk for increased mercury content in fish in the Nordic countries due to increased precipitation.

SDG 3 (Hg)
SDG 13

Nitrogen leaching after drought periods. The dry summer 2018 showed that leaching of nitrate and ammonium increased when it started to rain. This should be followed up with a broader assessment.

SDG 13

Integrated assessment modelling – seamless approaches to combat air pollution

Further development of IAM as a common Nordic tool. Development and application of integrated assessment models have progressed substantially in the Nordic countries over the last years. The Nordic Welfair Project has played an important role in this development. The project will however end within the next two years. We see a need to keep the Nordic collaboration running and continue to harmonize and use the set-up of models for further scenarios and for the assessment of various policies (particularly those related to SDGs). The further development of IAM in an earth system perspective is a long term recommendation for NKL to initiate, see below.

SDG 3
Short and long term

Cost-effective air pollution control for different governance levels in the Nordic countries (based on health effects). PM pollution in urban areas is complex and varies with sources even on very fine scales (streets, blocks, urban districts). The population health risks will correspond to the complexity of the PM distribution and composition. Air pollution modelling on many spatial and temporal scales in conjunction with IAM can be done to arrive at cost effective mitigation strategies for health risk reductions at the municipality, regional, national and international levels. Typical municipality measures are replacement of old, polluting stoves, restrictions on the use of studded tires, speed reductions. Typical measures at the international level are regulations of emissions from the power industry, exhaust gas regulations from motor vehicles. Questions to assess are: Which measures and on which scale would be optimal for a certain health risk reduction? How much can be done on the local level, and where is cooperation needed?

SDG 3
Short and long term

EECCA

How to formulate flexibility mechanisms under the Gothenburg Protocol –

Saltsjöbaden VI

workshop including key representatives at the EECCA countries. The EECCA countries find it difficult to achieve all requests under the Gothenburg protocol. There should be a way to fulfil the requirements in steps. This idea needs to be further developed before it can be presented as a proposal for the Executive Body of the Convention. A workshop should be initiated by NKL in close collaboration with the Air Convention.

topic 3
Short term

Identification of domestic drivers in the EECCA countries for emission reductions and possible ways to meet these. Current air pollution collaborations between Nordic countries and EECCA countries are mainly focused on capacity building with respect to monitoring, emission inventories, and integrated assessment modelling. There are other major barriers to EECCA ratification of the Air Convention protocols, however, such as low domestic knowledge about the possibility to improve domestic air quality through international agreements, separated national and international policy tracks, insufficient domestic funding. An NKL project should aim at identifying which air pollution related problems that are high on the domestic agenda in the EECCA countries, and clarify how international cooperation and funding mechanisms can help to reduce these problems.

Saltsjöbaden VI
topic 3
Short term

Earth system approach

A broad Nordic initiative to analyse air pollution in an earth system context. Air pollution is influencing earth systems on various scales and would benefit if seen in the earth system perspective. The methodology required for finding solutions for sustainable food production (SDG 1), health and wellbeing (SDG 2), clean water (SDG 6), clean energy (SDG 7), industries and infrastructure (SDG 9), cities (SDG 11), climate (SDG 13), life below water (SDG 14), life on land (SDG 15), requires the support of a comprehensive earth system approach in observations and model development, coupling atmosphere, ocean, land, ice, biogeochemistry and ecosystems. The earth system mechanisms that cause air pollution are integrated with biodiversity, climate, water quality and availability, estuaries and lakes, food production systems, energy supply, health, urban livelihood, production of goods and services, and transportation infrastructure. The earth system approaches need to be both global and in the same time cover the regional and even local scales. In addition, the earth system perspective needs to be coupled with a socio-economic perspective, allowing for integrated assessment analysis of the optimal routes to reduce complex environmental impacts to acceptable levels. NKL has long traditions in this direction.

Several SDGs
Short and long term

NKL should establish an expert team to plan and become an advocate for a Nordic initiative for a regional earth system approach to environmental problems. This should be done in partnership with other groups under NMR, Nordic research councils, Arctic Council; in dialogue with WMO, UN Environment, UNESCO (IHP and IOC) and other global organisations. The initiative should take into account the methodological approach in Copernicus, and research across Nordic academia and applied research institutions and involve research in i.a. meteorology, hydrology, marine and terrestrial ecosystems including ecosystem services. An example of a specific topic is "How and how much does air pollutants in a climate perspective, affect and is affected by, precipitation – amount, spatial and seasonal patterns and extreme events as dry spells and floods." Another example is "the evolution of the carbon storage of high latitude soils and in the boreal forest as temperatures increase (including the changes in soil and forest fires)".

N policies including dietary choices and consequences. Far reaching ammonia emission reductions can not be achieved without including the wider perspective of nitrogen. The Nordic countries have through their initiatives in establishing N budgets and in a recently finished project updated N policies, measures and techniques for reduction of N in agriculture*. These activities and experiences could be taken one step further and in a holistic way include the future dietary needs and options and their role in reducing N emissions. Climate aspects should also be

SDG 2 and SDG 3
Short term

taken into account.

Setting the agenda for a global collaboration on air pollution. The recent initiative by the Air Convention to widen the collaboration to regions outside the UNECE area and collaborate with global organisations will be an additional challenge for the Convention. The capabilities and experience developed in Europe and the Nordic countries would certainly be beneficial for this collaboration. But should the Nordic countries engage in this work and should it involve NKL money? We believe they should for a couple of reasons. Here we just want to mention two: First air pollution is today of global concern. Pollutants are transported between continents and sometimes significantly influence the air pollution and climate in other parts of the world (e.g. climate in the Arctic). Second, similar air pollution legislation enables a playing field on the regional level for industries and prevent countries from competing at the expense of environment and health.

SDG 17
Short and long
term

* *S. Hellsten et al. (2017) Nordic nitrogen and agriculture Policy, measures and recommendations to reduce environmental impact. TemaNord 2017:547.*

Workshop programme

19 November 2019

- 12.00 Lunch
- 13.00 Välkommen. Mål med workshopen. Allmän information. *Eli Åsen*
Setting the scene
- 13.15 Det nordiska samarbetet inom luftvårdsområdet. NKL-gruppens roll. Nordiska samarbetsprogrammet Erfarenheter, prioriteringar, projekt. *Kaarle Kupiainen*
- 13.30 Vart är det internationella luftvårdsarbetet på väg? Vilken roll har Norden? Hur passar Nordens luftvårdsarbete in i den internationella agendan inom UNECE och andra organisationer? *Anna Engleryd*
- 13.50 Rekommendationer från Saltsjöbaden VI i ett nordiskt perspektiv *Peringe Grennfelt*
- 14.00 Vad innebär globala initiativ inom forskning, mätningar och modellutveckling för nordiskt samarbete kring luftföroreningar? *Øystein Hov*
- 14.20 Luftkvalitet og mulige fælles nordiske opsamlingspunkter. *Katja Assmusen (ersatt med Thomas Ellermann)*
- 14.40 Frågor, diskussion
- 15.00 Paus
Topics
- 15.30 Hälsoeffekter av luftföroreningar i Norden. Nya resultat med relevans för Norden. *Leo Stockfelt, Marit Låg*
- 16.30 Ekosystem samt kväve. Policy för jordbrukssektorn. Kopplingen till SDG.
- *Kväve Filip Moldan, Jesper Bak (Martin Forsius).*
- (Ozon).
- 17.30 Sammanfattning av dag 1 (max 15 min) *Øystein/Peringe*
- 19.00 Aperitif: Luftkonventionen 40 år – en liten resumé av några decenniers miljöhistoria.
- 19.45 Middag

20 November 2019

- Nordens närområde (speciellt Arktis)
- 08.30 - Luftföroreningars betydelse för framtida klimatförändringar – modellresultat och tillämpning för Norden. *Maria Sand (Kaarle Kupianinen)*.
- Ratificering av protokoll för EECCA-länderna. *Stefan Åström*.
- Strategier för åtgärder: Klimat – luft. Sektorsstrategier. Koppling till SDGs
- 09.30 - Energi *Stefan Åström*
- Transporter, speciellt sjöfart *Jukka-Pekka Jalkanen*
- (Jordbruk läggs under kväve)
- Luftföroreningar och SDGs mm *HC Hansson*
- 10.50 Kort paus
- Verktyg. Vilka verktyg kommer att behövas för luftvårdsarbetet i framtiden? Vad kan forskningen erbjuda?
- 11.00 - Modeller – atmosfär. *Hilde Fagerli**
- Emissioner: *Kristina Saarinen Silje Bratland***
- IAM: *Camilla Geels (Niko Karvosenoja)*
- Mätningar: *Kjetil Tørseth*
- Lokal luftkvalitet: *Silje Bratland****
- Datapolicy och datatillgänglighet
- 12.15 Lunch
- Inriktningar och projektidéer (Setting priorities)
- 13.00 Diskussion om projekt och prioriteringar *Øystein/Peringe* - Kort sikt (utlysning 2020/21) - Lång sikt (utlysning 2022/23)
- 14.30 Paus
- 15.00 Sammanfattning. Rekommendationer till NKL-gruppen *Øystein/Peringe, NKL-gruppen*
- 16.00 Avslutning *Eli*

* *Modelling air pollution in Europe and the Nordic countries – uncertainties and opportunities.*

** *Method for measuring PM emissions from solid fuel space heaters.*

*** *Information on air quality to citizens.*

Abbreviations

AMAP	Arctic Monitoring and Assessment Programme, a working group under the Arctic Council
BC	Black Carbon
CBA	Cost Benefit Analysis
CCAC	The Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants (SLCPs)
CLRTAP	The UNECE Convention on Long-range Transboundary Air Pollution, in this report called Air Convention
EEA	European Environment Agency
EECCA	Eastern Europe, Caucasus and Central Asia
EMEP	European Monitoring and Evaluation Programme under the UNECE Air Convention
EU	European Union
ERF	Exposure Response Function
ESSF	European Sustainable Shipping Forum
GP	Gothenburg Protocol under the UNECE Convention
HMs	Heavy Metals
IAM	Integrated Assessment Modelling
IHP	International Hydrological Programme
IOC	Intergovernmental Oceanographic Commission
ICPs	International Cooperative Programmes under WGE
IEA	International Energy Agency
IMO	International Maritime Organisation
NECD	National Emissions Ceilings Directive (EU)
NKL	Nordic Climate and Air Group under the Nordic Council of Ministers
NMR	Nordic Council of Ministers
PM	Particulate Matter
PAHs	Plyaromatic Hydrocarbons
POPs	Persistent Organic Pollutants
SDGs	Sustainable Development Goals

SECA/NECA	Sulphur Emission Control Area and NOx Emission Control Area (Regulation under IMO)
SLCP	Short-Lived Climate Pollutants
TFEIP	Task Force on Emission Inventories and Projections (UNECE Air Convention)
UNECE	United Nations Economic Commission for Europe
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
WHO	World Health Organisation
WMO	World Meteorological Organisation
WWOSC	World Weather Open Science Conference

About this publication

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