Annual magazine

2010

CO_2 capture: NILU at the forefront of research on nitramines side 18

Climate Frames protect European art s. 26

Innhold

Editorial:
Anne Nyeggen, editor.
Finn Bjørklid, Ingunn Trones, Kari Marie Kvamsdal and
Hildegunn Hammer: Contributions and adaptation.
Translation: Nancy Bazilchuk
Design: www.melkeveien.no

Photo credits: All pictures by NILU, except where other is indicated.
Front page, main picture: Wikipedia © Max Haase,
small picture below: Lady with the hermeline, Princes Czartoryski Foundation

Air pollution and ash clouds challenges

2010 started – and ended – with serious air pollution events in several of our largest cities. These episodes of bad air quality remain an ongoing problem. It is therefore a high priority for NILU to help municipalities and governmental bodies with the best knowledge available and to give them the tools they need to develop abatement strategies. NILU is following this development closely and some of the progress can be seen at luftkvalitet.info.

In April, for the first time in modern history, Europe experienced the effects of a large volcanic eruption when Iceland's Eyjafjallajøkull volcano roared to life. Interest from the media was enormous and our experts on volcanic air emissions worked around the clock to provide governmental bodies and the media with information and advice. Our strategic focus on innovation, including observation systems for ash detection, received a great deal of attention and we experienced a great demand for making these systems operational.

Over the years, NILU has been quite successful in the strong competition for EU project funding. This year several of these projects were completed with great success both in scientific results and merits. This past year was also the last year of the International Polar Year (IPY), which was celebrated with a large scientific conference to which NILU was an active contributor.

We presented our new Climate Strategy (2010–2020) in 2010. A central component of this strategy is research related to climate drivers, which is closely linked to our valuable long data series, a resource that make this effort possible. Another important part of our strategy is research on carbon capture and its environmental effects. We also want to focus on the need for developing good strategies to combat air pollution coupled with reducing emissions of greenhouse gases to cut costs and increase the probability of success.

Norway's northern regions and the Arctic are of major national importance. In September 2010 the Prime Minister inaugurated FRAM – the Centre for Climate and Environmental Research, which has as its ambition the goal of becoming a world-leading centre in selected areas of arctic research. FRAM is an expansion of the previously established "Polarmiljøsenteret", and involves several new research institutions. The centre will allow new opportunities for collaboration and research in the Arctic. NILU's group in Tromsø is expanding its portfolio to include most of our major fields of research. Our largest group at present is related to research on harmful substances. NILU holds the chair of one of the FRAM's five strategic research flagships – Harmful Substances and Climate Change.

This year was also marked by the construction of a new observatory at Andøya, which brings the number of NILU observatories to four. Our Zeppelin Mountain Observatory in Svalbard was upgraded in 2010 with new innovative equipment while our Birkenes Observatory in southern Norway was upgraded and relocated in 2009. We are currently discussing with the government the upgrade and relocation of our Troll Observatory in Antarctica in 2012.

Internationalization is both necessary and important for a research institute. NILU has a large portfolio of international projects. We also have a rapidly expanding branch office in the United Arab Emirates with an office in Abu Dhabi. We are a strategic partner of the federation's environmental authority with our main focus on research and counselling on air quality and climate change.

In 2010 we established an innovation group at NILU, which has as its goal to contribute to the development of new knowledge-based industries in Norway. This year we have participated in three new ventures, and the group continues to identify new ideas for future ventures.

Thank you to all the experts and staff that have made this possible – and welcome to exciting reading in our Yearly Magazine 2010!

Kari Nygaard
Man. Director

Troublesome ash clouds:

Better prepared for the next eruption

The volcanic eruption in Iceland in April and May of 2010 trapped millions of airline passengers in Europe as a result of airborne ash. With technology developed by NILU, airlines can be better prepared in the future.

By Bjarne Røsjø, journalist

The ash plume from the Eyjafjallajökull volcano grounded more planes than any other previous volcanic eruption, but also led to increased attention to how airlines can protect themselves against similar problems in the future. "The discussion afterwards focused mostly on how airlines can avoid economic losses due to many cancellations. That's important enough, of course, but for us at NILU it is equally important to think about the fact that planes should avoid ash clouds because it can be dangerous to fly into them," says Kjetil Tørseth, director of the Atmosphere and Climate Division at NILU.

Senior scientist Fred Prata has developed an infrared camera that can detect ash clouds from volcanoes. Foto: NILU

Two alternative solutions

NILU has researched the spread of volcanic ash clouds over the past several years and was well-positioned when Eyjafjallajökull spewed enormous amounts of ash into the atmosphere during a period of several weeks in the spring of 2010. "We have worked with two alternative solutions to the ash problem. One approach is to use data from satellites in a new mathematical diffusion model we have developed. The model works very much like a weather forecast: It is based on how the cloud looks at a given time, and will 'figure out' the trajectory of where the cloud will move," says Tørseth.

Although both satellites and warning centers on the ground can monitor the spread of ash clouds, there is also a need for a detection system that can detect dangerous situations in the path of each aircraft. Therefore, NILU developed an infrared camera that can be mounted on aircraft and detect volcanic ash up to 100 kilometres away.

"Using this camera, combined with satellite data and algorithms that convert data from satellites, aircraft will be able to get the warning they need every time they approach a volcanic ash cloud. The aircraft will then be able to steer clear of the cloud and can continue on its journey, rather than like what happens today – to be grounded indefinitely," says NILU senior scientist Fred Prata.

International interest

NILU's technology has attracted a great deal of interest internationally. Prata held a press conference in June 2010 in London with representatives of British aviation authorities and the airline EasyJet, which has helped to fund the development of the camera. Nicarnica, a company of which NILU is part owner, was established in 2009 to raise capital for the development of the camera. The idea for such an instrument was published by Prata as early as 1991, in the respected scientific journal Nature.

"We assume that this camera will become a standard instrument on board commercial aircraft, just as today they

NILU has researched the spread of volcanic ash clouds over the past several years and was well-positioned when Eyjafjallajökull spewed enormous amounts of ash into the atmosphere during a period of several weeks in the spring of 2010.
Photo: Wikipedia © Max Haase

have weather radar and a host of other instruments," explains Tørseth. The infrared camera is both easy to use and affordable.

Satellite ash cloud monitoring a must

Modern earth observation satellites peer down on the planet with a variety of instruments, including those that can measure reflections in the infrared range. The European Space Agency ESA and Eumetsat are constantly striving to develop new instruments for satellite monitoring, but a European instrument to detect volcanic ash has never been developed. As a result, scientists have used data from different instruments, including one that is specially designed to monitor regular clouds. NILU has suggested that a special instrument for satellite monitoring of volcanic ash clouds should also be developed.

But until that happens, NILU will focus on exploiting data from the instruments that are already found on the satellites. "NILU's main contribution has been to use existing information in better ways. In 2010, for the first time, we demonstrated the use of mathematical models that can employ observational data directly and provide a description of how the ash cloud has spread," says Tørseth. The research has been funded by ESA, and a scientific article about the models was published in the spring 2011 edition of the scientific journal *Atmospheric Chemistry and Physics Discussions*. This effort was led by senior scientist Andreas Stohl.

THE PROBLEM WITH ASH CLOUDS

Volcanic ash clouds contain silicon-rich particles with a melting point that is lower than the operating temperature of the combustion chamber of a modern jet engine. This means that the particles readily melt in the engine and stick to the turbine blades and other engine parts, which can cause the engine to shut down. Even without engine failure, exposing an airplane to an ash cloud can result in significant maintenance costs.

The ash can also clog the airplane's pitot tube, which acts as the plane's speedometer. If the pitot tube reads the wrong speed it is impossible to adjust the motors and controls in the aircraft. In addition, the ash can actually sand-blast the cockpit windows, making it impossible for the pilots to see out.

Pollutants from Russia end up in Finnmark

High concentrations of sulphur dioxide and heavy metals have been measured at the Russian-Norwegian border. Emissions of sulphur dioxide from the Russian nickel smelting towns of Nikel and Zapolyarny have slowed considerably since the 1980s, but emissions of nickel and cobalt seem to have increased after 2004.

By Bjarne Røsjø

A report produced by NILU on behalf of the Norwegian Climate and Pollution Agency (Klif) in the autumn of 2010 showed high levels of pollutants in the air at the Norwegian border with Russia. These environmental pollutants are a result of industrial emissions from the mining towns of Nikel and *Zapolyarny* in Russia, near the Norwegian border. "The results show that it made sense to reopen the measurement station in Karpdalen in 2008," says Tore Flatlandsmo Berglen, a researcher at NILU.

NILU has a comprehensive programme to measure pollutants in Finnmark. The agency maintains a measurement station in Svanvik in Pasvikdalen, which monitors levels of airborne sulphur dioxide (SO_2) and heavy metals, as well as heavy metal levels in precipitation and meteorological data. North of the Russian mining town of Nikel in the valley Karpdalen, the agency measures SO_2 and meteorological data, and in Karpbukt, 4 km further north, a station monitors a number of common substances found in precipitation. SO_2 amounts are also measured at Viksjøfjell, north of Zapolyarny.

The monitors showed that during the period from April 2009 to March 2010, Karpdalen and Viksjøfjell as a whole experienced the greatest environmental impact from the mining town emissions. Svanvik receives a great deal of pollution from Nikel when the winds blow from the east. Karpdalen a little further north is affected by both Nikel and Zapolyarny, but is most vulnerable when the wind blows from a southerly direction.

High sulphur measurements

NILU measurements show that SO_2 values in parts of Finnmark can exceed values set by the World Health Organization (WHO). The WHO's hourly limits were exceeded once in Svanvik and 19 times in Karpdalen during the measurement period. Most incidents occurred during the winter. The WHO's daily limit value for SO_2 was not exceeded in Svanvik, but was exceeded five times in Karpdalen.

The measurements also show that

Our measurements results show that it made sense to reopen the station in Karpdalen in 2008, says Tore Flatlandsmo Berglen, scientist at NILU.

SO_2 emissions from Nikel and Zapolyarny have slowed considerably since the early 1980s, but it appears that emissions of some heavy metals, specifically nickel and cobalt, have increased since 2004.

Hoping for closer cooperation

At the end of the 1980s, the Norwegian and Russian governments signed an agreement to monitor air quality and precipitation chemistry in the border area, but the extent of this agreement has gradually diminished over time. Now, under the auspices of the bilateral environmental cooperative programme with Russia, Norway would again like to take up the issue of cooperation on local air quality affected by emissions from the Russian smelters.

The Nikel smelter and the city, seen from a hill in Pasvikdalen on 19 June 2008. Winds from the east transport pollution from Nikel to Pasvikdalen, while winds from the south make Karpdalen more vulnerable to the pollution.
Photo: Christoffer Aalerud, County Government of Finnmark.

By halfway through January 2010,both Bergen and Oslo had used up their yearly quota for exceedances of limits for nitrogen dioxide (NO_2)
Photo: Helge Sunde / Bergens Tidende

Cold winter weather led to poor air quality in Norwegian cities

Cold and sunny winter weather contributed to poor air quality in major Norwegian cities both at the beginning and the end of 2010. Traffic and heating emissions are the principle contributors to poor air quality in weather conditions such as these. The good news is that it is possible to limit emissions from both sources.

By Anne Nyeggen, Communications Manager

Very poor air quality was measured on 8 January 2010 in Danmarksplass in Bergen, with poor air quality also measured at the Bergen City Hall, in Manglerud and Smestad in Oslo, and at Vestre Strandgate in Kristiansand. In these conditions, the recommendation is that allergy sufferers, asthmatics and people with other serious heart or respiratory ailments should avoid spending time in the affected areas. Poor air quality can cause even healthy people to experience temporary irritation and discomfort.

The start of the year was actually so bad that by halfway through January, both Bergen and Oslo had used up their yearly quota for exceedances of limits for nitrogen dioxide (NO_2), a toxic pollutant that can have negative health effects. "In these kinds of emergency situations, it is important to introduce immediate measures. But what is equally important is to take long-term measures to reduce both air pollution and greenhouse gases," says NILU director Kari Nygaard.

Traffic and lighting

Air pollution in major cities has two main sources, traffic and heating emissions, and it is possible to limit emissions from both sources. "When air pollution is as severe as it can be in Bergen on the worst days, I would recommend restrictions on driving in combination with, for example, a free bus ticket," says NILU senior scientist Dag Tønnesen. "In addition, it is best to heat homes at these times as much as possible with electricity. And if you must use wood, make sure it is clean and dry, and avoid at all costs burning milk cartons and other trash," the researcher adds.

Cold weather returned to Norway towards the end of the year, which brought poor air quality back with a vengeance. From 17 to 24 November, for example, there were exceedances for particulate matter every day in Danmarksplass in Bergen. But the picture is not completely bleak, because several pollutants have shown a steady decline over the past 15–20 years.

Measures that work

Oslo has made good progress when it comes to implementing measures to improve air quality, according to Tønnesen. He highlights as particularly good measures the use of a studded tire tax, expansion of public transport, reduced speed limits on roads and especially the phasing out of old and highly polluting wood stoves.

NILU's analysis shows that NO_2 emissions will increase in the coming years, probably until 2015, because of growth in the use of diesel cars. Newer diesel engines have low CO_2 emissions and filters that reduce particulate emissions, but NO_2 emissions from these engines are higher than their older counterparts.

Heavy metals can "fly"

We have waved goodbye to another winter of polluted city air. The debate over air quality in Norway has been great - over new and stringent measures, driving dates and an environmental speed limit. Oddly enough, some would eliminate this last measure, despite its documented positive effect. It would be quite a stretch to eliminate these measures if we actually want air pollution to decrease, not increase. Now that the dust is beginning to settle, both literally from the road and figuratively in the heated debate, it is time to clarify some issues. What exactly is it that causes the pollution? What are the sources and which measures are most effective?

By Ingrid Sundvor, scientist

NOx and particulate matter - increases and decreases

Nitrogen dioxide (NO_2) and particulate matter are two pollutants that particularly affect our health, which is why the Norwegian government sets clear emission limits.

Technically speaking, particulate matter is referred to as PM10, which means that it is composed of particles with a diameter of less than 10 microns. Under the category of PM10, there are two smaller sizes, called PM2.5 and PM1, which signify a diameter less than 2.5 and 1 micrometre, respectively. A human hair will be five to ten times greater in diameter than the very largest of these airborne particles. Thus, when we talk about particulate matter, we are talking about particles that are no bigger than the sizes of bacteria and the cells in our body. This small size enables the particles to be suspended in the air for a long time, which also makes it easy for us to breathe them in. This means that they can damage our health, which is the basis for the legal limits for PM10 and PM2.5.

Particulate matter is linked to diseases such as asthma, COPD, heart disease and possibly also brain diseases such as Alzheimer's. There has been a great deal of research to determine which particles are the most harmful. One thing is clear: It is not necessarily the same particles that cause all of the different diseases.

Levels of both PM 10 and PM 2.5 have shown a decline in recent years, and even during the "troublesome" winter this year and last year in Norway, levels of these pollutants have remained more or less below the maximum limits for particulate matter.

Sources of particulate matter

Particulate matter can have many sources, but in most cities in Norway, the two biggest sinners are automobiles and oil and wood heating.

Traffic exhaust contributes a great deal to the smallest particles. In addition, particles are formed from the wear and tear on tyres, road and brakes. Wear produces particles that are slightly larger, but also contributes some to the smallest particles. In the Nordic countries where studded tires are in wide use, this "non-exhaust" component of particulate matter pollution is quite large, and will continue to be important in the future because there are stringent requirements on exhaust emissions. There is, however, no basis for saying that the particles that come from the wear and tear on tyres and roads are any less dangerous than other particulates, as has been stated in the media.

Wood burning is also a substantial source of particulates. Much like automobile exhaust, particles from burning wood make up some of the smallest particles in airborne dust. And as a backdrop to particulate pollution from both heating and traffic, we have particles that drift in from afar. A large forest fire in Sweden, for example, will have an effect on particulate measurements of Oslo.

NO_2 – a worrying trend

Nitrogen dioxide, NO_2, is a component of NOx that is emitted by cars and boats, particularly those that run on diesel. Unfortunately, Norway has seen a sig-

The best outcome for improving all kinds of air pollution would be if even more people choose to leave their cars in the garage and use public transport, says the author of the article, researcher Ingrid Sundvor from NILU.

nificant increase in the number of diesel automobiles on the roads in recent years as a result of tax law changes. Even more unfortunate is that the proportion of NO_2 in the NOx exhaust appears to be increasing in new cars. We have not seen the same positive decreasing trend for NO_2 as for particulate matter. This is worrying.

The saving grace - weather

Weather is an important factor in explaining air quality. Because wind and rain cleanse the air for us, we often have good air in cities. The weather ends up being our saving grace. But during some periods, the air over cities may be pinned in place, leading to a build-up of pollution to levels that can quickly exceed health limits.

Regardless of meteorological conditions, it is important to remember that there would be no bad air if there were no sources of pollution. So what you burn to keep yourself warm, what you put in your automobile's tank, what kind of tyres you have and how fast you drive all determine what and how much you contribute to air pollution.

Coping with pollution

Low emission zones, street maintenance, salting with magnesium chloride, scrapping old cars, an environmental speed limit, fuel charges, a studded tire fee: The list of measures that can reduce harmful emissions is long. Measures such as an environmental speed limit and road tax are among the less popular approaches to controlling pollution, yet they work. Particulate matter pollution in Oslo last year remained below the statutory limits. We should be very pleased. To revoke the environmental speed limit, as has been advocated by some, is a very bad idea.

We have also had measures that are first and foremost aimed at reducing greenhouse gas emissions, but this unfortunately has a direct negative impact on air quality locally. The greenhouse gas reduction measures include a tax break for diesel vehicles.

New fuels, such as biodiesel and bioethanol, are in the future. These fuel types are certainly better for the climate, but are not automatically better for local air quality. The net benefits and drawbacks remain to be researched. Bioethanol can result in greater emissions of aldehydes, for example, and biodiesel can cause emissions of PAHs, which are carcinogens. The future will also certainly offer even more options for transportation, fuel and energy sources. Then it will be important to make sure that when we solve one problem that we don't create another.

The best outcome for improving all kinds of air pollution would be if even more people choose to leave their cars in the garage and use public transport. We need to be encouraged – or perhaps forced – to make the effort to reduce pollution by purchasing vehicles that emit the least amounts of harmful pollutants and greenhouse gases. If you heat your house with wood, make sure that your woodstove is the most modern possible. And by all means: Do not defeat measures that actually work - respect the environmental speed limit! And while we can be pleased that the airborne dust is actually taken seriously in many municipalities, it is now time to introduce effective measures to reduce NO_2 as well. For one thing is certain: It's a bad idea to assume that the weather will solve our problems for us. Instead, we need pollution control measures - popular or not – to be in place. We hope that responsible politicians will follow up.

Record levels of methane in

The latest results from 2009 show an increase totalling 1.6 per cent since 2005, which is quite a lot, says NILU senior scientist Cathrine Lund Myhre.

NILU measurements taken in Svalbard confirm that the concentrations of greenhouse gases in the atmosphere are continuing to increase. Researchers are most concerned about the latest developments with methane concentrations, which reached a new record level in 2009.

By Anne Nyeggen

NILU monitors the atmospheric content of methane (CH_4) and 22 other greenhouse gases and ozone-depleting

GREENHOUSE GASES

NILU is the only institute in Norway that continuously measures greenhouse gases in the atmosphere. These measurements are conducted primarily at the Birkenes and Zeppelin observatories, but also at Andøya. The amount of greenhouse gases in the atmosphere affects the temperature of the Earth; global warming results when the amount of greenhouse gases in the atmosphere increases. The increased concentrations of greenhouse gases in the atmosphere since the Industrial Revolution are the main cause of current observed changes in temperature and climate. The major greenhouse gases emitted by human activities are CO_2, methane (CH_4), a combined group of gases known as halocarbons, and nitrous oxide (N_2O). The concentrations of all of these gases have increased significantly since 1750.

CARBON DIOXIDE: CO_2 is the most important anthropogenic greenhouse gas and has increased by about 2 ppm per year in recent years, to a global record level in 2009 of 386.8 ppm (WMO, 2010).

the atmosphere

substances on Zeppelin Mountain in Ny-Ålesund on Svalbard, in cooperation with the Norwegian Climate and Pollution Agency (Klif). The Zeppelin Mountain Observatory is well suited to monitoring global levels and trends of greenhouse gases and ozone-depleting substances, because there are few local sources of contamination on Svalbard.

"The content of methane in the atmosphere was stable for many years but began to increase again in 2005. The latest results from 2009 show an increase totalling 1.6 per cent since 2005, which is quite a lot," says NILU senior scientist Cathrine Lund Myhre. She is the project manager for greenhouse gas monitoring on Svalbard.

Possible methane emissions from Siberia

Climate scientists have long been worried that rising methane emissions from thawing permafrost and the Arctic seabed will contribute to accelerating the greenhouse effect.

"There is currently little to indicate that the methane that seeps up from the seabed winds up in the atmosphere, but recent unpublished studies indicate that the increase in methane concentrations from 2006-2007 was partly due to high temperatures in Siberia and the Arctic that year. High temperatures can cause areas of permafrost to be transformed into wetlands, which then result in an increase in methane emissions. Methane gas also leaks from Russian pipelines. It is important that we find the causes of the recent increases in methane concentrations. The increase may not be due to a change in emissions, but may be due to a change in the breakdown of methane in the atmosphere," Lund Myhre explains.

"If there is a warming of the Arctic leading to emissions, it will be difficult to limit them. We are therefore following these developments very closely," said Ellen Hambro, Klif's director, when the 2008 numbers for Svalbard were presented in June 2010.

Carbon dioxide (CO_2) remains the greenhouse gas that contributes most to global man-made warming, but methane is in second place. Measurements from Zeppelin Mountain led NILU to apply for and receive funding in 2010 for two new research projects. NORKLIMA, a large-scale programme run by the Research Council of Norway, funded a NILU project entitled "Causes and effects of global and Arctic changes in the methane budget", while another NILU project, "Greenhouse gases in the north: From local to regional scale" has been supported by the Research Council as a strategic priority.

METHANE

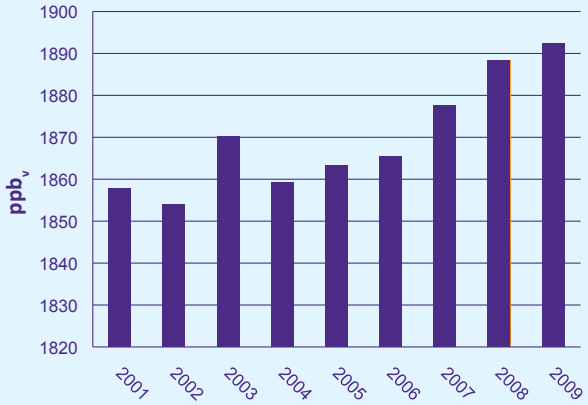
Methane levels have been observed to be on the increase, after a period of about 8 years without much change. Anthropogenic sources account for about 60% of emissions, while natural sources account for about 40% in the current atmosphere. The main anthropogenic sources are agriculture (ruminants), rice paddies, landfills, coal, oil, gas and fires. The most important natural sources are wetlands, termites, geological sources, ocean, wild animals and fires. There are also large natural reservoirs of methane stored in permafrost, both on land and under the sea. An increase in methane in the atmosphere may be due to either an increase in emissions from one or more sources, or a change in the destruction. Methane has a lifespan of about 10 years, and is degraded in the atmosphere by the OH radical. It is expected that many of the natural sources of methane are and will be strongly affected by climate change, such as temperature increases, particularly in the Arctic, and changes in precipitation. You can read more about this issue at: http://game.nilu.no

Termites and cattle are two of the sources for methane.

Methane at Zeppelin

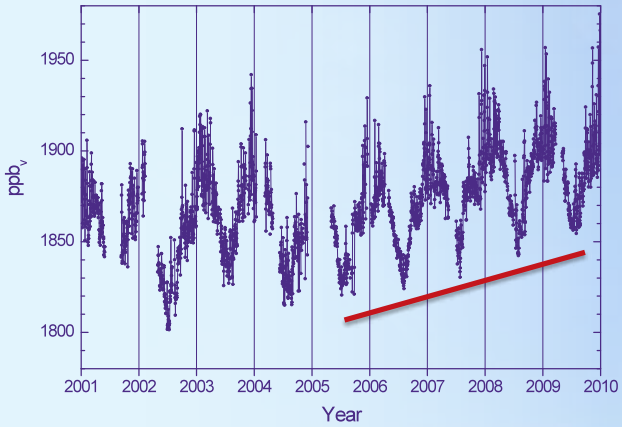
Background concentrations and long term changes

Annual mean 2001-2009



	Zeppelin	Global mean (WMO)
2006-2007	12 ppb	6 ppb
2007-2008	7 ppb	7 ppb
2008-2009	4 ppb	5 ppb

Long term changes and peak cource regions



Annual trend, 2001-2009; 4.5 ppb year

Annual trend, 2005-2009; 8.1 ppb year

Midnight sun on the Holtedahlfonna Plateau, Ny-Ålesund, Svalbard.

Arctic reflections affect global climate

Reflected sunlight, called albedo, from snow and ice in the Arctic is an important factor in global warming, but nobody knows exactly how important it is. "Albedo is influenced by a lot of factors. A better understanding of albedo will give us better climate models," says NILU research scientist John F. Burkhart.

By Bjarne Røsjø

Albedo is a measure of the reflection from a surface and is defined as the ratio between the incoming and outgoing radiation. Previous research has shown that freshly fallen snow has a maximum albedo of almost 90 per cent, but the albedo from windswept snow or snow polluted with soot or other light-absorbing aerosols is much lower. Albedo is also influenced by a number of other factors. John F. Burkhart leads the research project VAUUAV, which uses small autonomous aeroplanes (UAV – Unmanned Aerial Vehicle) to measure the variability of albedo over glaciers, sea ice, and ice sheets in the Arctic.

A significant open question concerning the albedo of the Arctic is the influence of soot, also called black carbon, and other short-lived pollutants on the regional climate system, and thequantitative role in the albedo feedback process for climate change, says John Burkhart, senior scientist at NILU.

Highly variable albedo

It is clear that the albedo of Arctic regions is an important factor in influencing global climate, but current global climate models tend to use static values for Arctic albedo in both summer and winter. "The models assume that there is no change in albedo over a day, and that there is very little change over a season. But this is not a good approximation, because albedo is in fact highly variable. Even slight changes in albedo can have significant impacts on the radiative forcing in the atmosphere," Burkhart says.

A significant open question concerning the albedo of the Arctic is the influence of soot, also called black carbon, and other short-lived pollutants on the regional climate system, and the quantitative role in the albedo feedback process for climate change. "The big problem is that all measurements of black carbon in the Arctic have been ground based. The concentrations of black carbon on the snow and in the lower layers of the atmosphere have been decreasing for several years, but there ▶▶

Excavation of the Cryowing UAV following an unplanned landing, high on the Holtedahlfonna Plateau.

is still a lot of black carbon in the upper atmosphere, mostly from agricultural burning in parts of Asia and forest fires in the northern hemisphere. With the amount of biomass burning that is still going on, it is likely that this has increased," Burkhart says.

Better global climate models

"The fundamental objective of the VAUUAV project is to provide a measure of the variability of the albedo in the Arctic. We are trying to figure out how the albedo varies over time, how it is affected by temperature changes and physical parameters in the snow pack, and how it is affected by variables such as solar zenith angle, incoming light and cloud cover. There are many different things that can affect albedo, so we really need a better sense of the variability in order to develop better global climate models," says Burkhart.

The first UAV flights took place over Svalbard in 2009, with extensive testing of the equipment and the development of flight systems and protocols. "We also had a successful field season on the summit of the Greenland ice sheet in 2010, and we are going to have another major campaign in 2011," Burkhart explains.

It wasn't going to be easy

Burkhart knew from the start that it wasn't going to be easy to gather more information about Arctic albedo. "Albedo is not really a property of the surface you are looking at, it is instead a property of the system. You can have two identical surfaces in different light conditions, and they will have different albedos. If there is absolutely no sun, as in the polar regions in the middle of winter, albedo is not an important factor. But as soon as you get any sun early in spring, albedo becomes important. But the sun angles have a big impact on albedo all through spring and summer. The albedo associated with low sun angles in spring is very different from the albedo in summer, when the sun is much higher in the sky."

Affected by your point of view

As if that wasn't enough, the albedo is also affected by the observer's point of view and the physical properties of the snow. "Snow reflects light in what we scientists call a highly anisotropic manner. If you are looking at a snow surface with the sun in front of you, it will seem brighter than if the sun is behind you. This is a well-known property of snow and a fundamental factor in all kinds of remote sensing, but the problem is different for snow packs that are highly

FACTS ABOUT VAUUAV

The VAUUAV research project (Variability of Albedo Using an Unmanned Aerial Vehicle) is supported by the Research Council of Norway's large research programme NORKLIMA. VAUUAV is led by NILU, with the Norwegian Polar Institute and the research institution Norut IT as partners.

www.vauuav.nilu.no

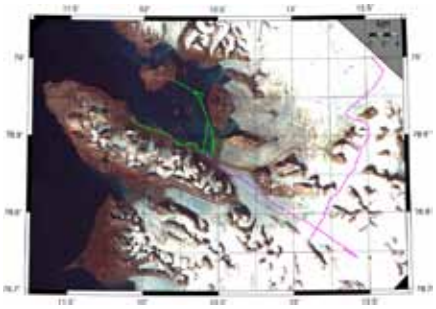
Torborg Heid making measurements near the airport on a warm day in April.

structured. The VAUUAV project has already shown that the structure of the snow has an impact on the reflection, which has not been incorporated very well into previous observations from satellites," Burkhart explains.

The VAUUAV project has in fact documented that the albedo is strongly influenced by the sharp irregular grooves or ridges called *sastrugi* (also spelled sustrugi or zastrugi after a Russian word), which can be formed on the snow surface by wind erosion and deposition. When the sun shines, these structures create a mixture of bright spots and shadows that make it very hard to calculate an average albedo. "You could say that this has become a project with many more wrinkles than I had originally anticipated. That's research!" Burkhart says.

UAVs for peaceful purposes

UAVs were originally developed for military purposes, but Burkhart is proud to be using them for peaceful purposes and for the benefit of research. This has not been very easy, however. From a technical standpoint, UAVs are considered to be a reliable and robust platform, but using them is another matter altogether. There is currently no strong national or international law governing their use in airspaces over populated areas, so they can only be used in very remote areas.



Ground tracks from experiments around Ny Ålesund, overlaid on optical satellite imagery. Figure from R. Ian Crocker.

John F. Burkhart is also leader of the research project CICCI (Coordinated Investigation of Climate-Cryosphere Interactions), the Norwegian and US components of which are funded by the National Oceanic and Atmospheric Administration (NOAA), the Research Council of Norway, and the Arctic Monitoring and Assessment Programme. The central goal is to improve the understanding of processes controlling the distribution of black carbon in the Arctic atmosphere and its deposition on snow and ice surfaces, and the resulting climate impacts.

Combining all our efforts

"The aim of these projects is to collect and share data and other scientific information. VAUUAV generates a lot of snow sample data but we lack atmospheric data, although through CICCI we'll add atmospheric data to our data on the physical structure of the snow pack and other factors on the ground. By combining all our efforts, we should be able to collect a really robust set of measurements," Burkhart explains.

Polen has one of the largest coal power plants in the world, here represented by the Belchatow power plant.
Photo: Marek Zaborowski, Bellona Polska.

Yellow granules help save the climate

NILU and the Technical University of Czestochowa have developed a new approach to saving the global climate: a yellowish powder that can remove up to 90 per cent of the CO_2 in exhaust gas from coal-fired power plants. The granules could transform coal-fired power plants in Poland from climate offenders to a cleaner form of energy.

By Bjarne Røsjø

The Polish power sector is almost entirely dependent on coal-fired thermal power plants, and Poland has some of the largest coal reserves in the world. The bad news is that the combustion of coal in power plants releases large amounts of the greenhouse gas CO_2 (carbon dioxide). The good news is that the powder or granules developed by NILU and the Technical University of Czestochowa (CUT) can absorb large amounts of CO_2 in much the same way that a sponge absorbs water. Afterward, the CO_2 -saturated granules can be stored permanently in places such as abandoned mines, so that the gas no longer escapes to the atmosphere.

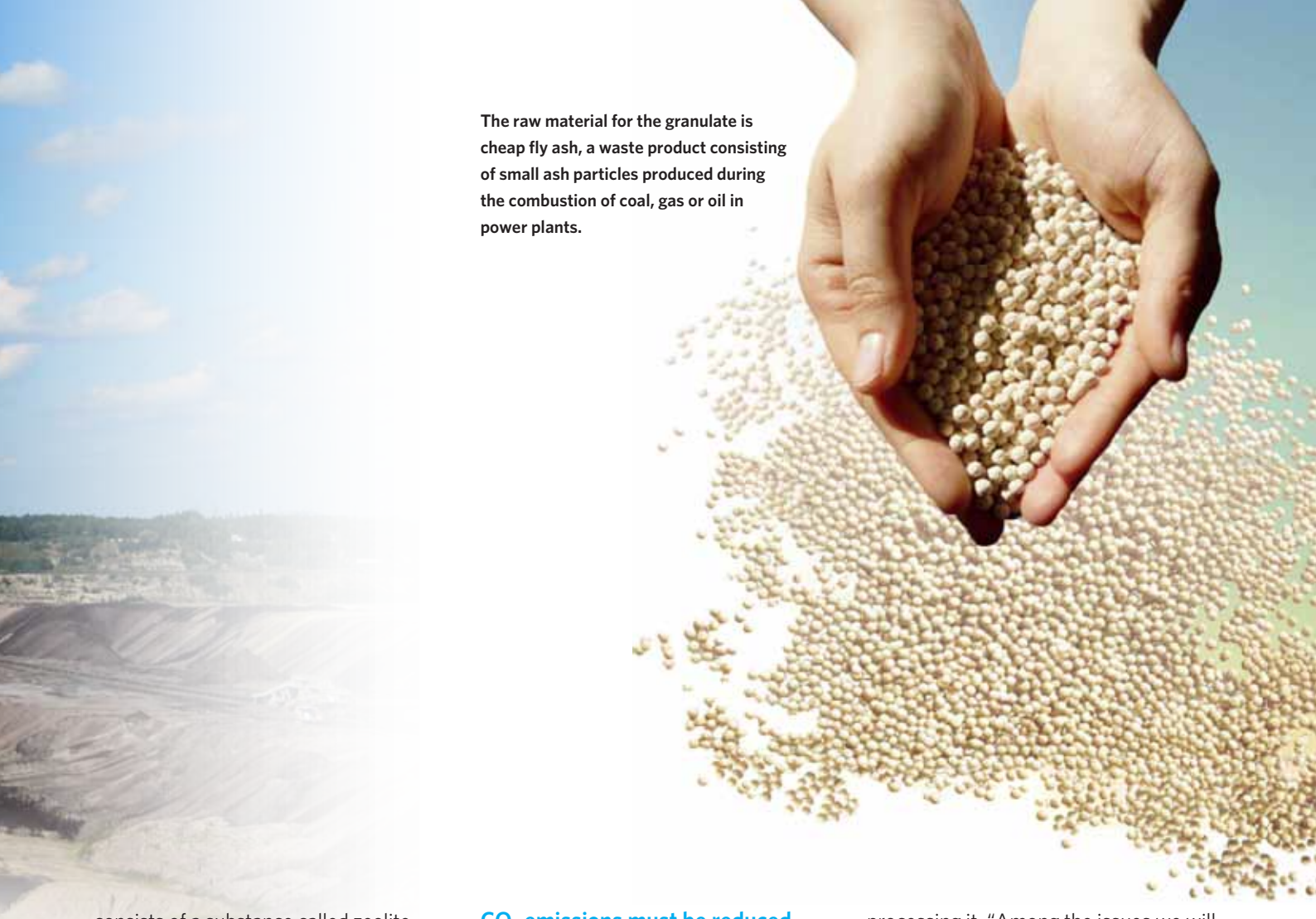
"We have a goal to reduce CO_2 emissions from coal power plants by 90 per cent using the new granules, which can also be used for gas- and oil-fired power plants," says Professor Jozef Pacyna, Director of the Centre for Ecology and Economics (CEE) at NILU.

From waste to climate saviour

At the heart of the Norwegian-Polish SORBENT project is a granular substance that can suck up or adsorb large amounts of CO_2. The raw material for the granulate is cheap fly ash, a waste product consisting of small ash particles produced during the combustion of coal, gas or oil in power plants. The fly ash is currently used partly as an additive in cement, special bricks and road surfaces, but there is still plenty left. "We are thus using a waste product to make a substance that can be used to reduce greenhouse gas emissions," says Pacyna. The project coordinator at CUT is Professor Wojciech Nowak.

We have a goal to reduce CO_2 emissions from coal power plants by 90 per cent using the new granules, says Professor Jozef Pacyna, Director of the Centre for Ecology and Economics (CEE) at NILU.

The simplicity of the granulate about to be tested in a series of industrial pilot projects belies the years of joint effort behind its development. The granulate



The raw material for the granulate is cheap fly ash, a waste product consisting of small ash particles produced during the combustion of coal, gas or oil in power plants.

consists of a substance called zeolite, which is in grains about 5 mm in diameter. Zeolite has large pores and channels that provide a very large surface relative to volume. When zeolite comes in contact with CO_2, the gas molecules stick to the surface, where they will essentially remain forever.

An added benefit – mercury

An important additional aspect of the granulate is that it can also adsorb mercury, which also poses a great threat to the global environment. Today, large amounts of mercury are emitted to the atmosphere as a byproduct of coal combustion, cement production and other industrial processes. In 2007, the United Nations Environmental Programme (UNEP) awarded NILU and Jozef Pacyna a central role in efforts to develop a global agreement on reducing mercury emissions. This process has progressed to the point that an agreement will likely be adopted in 2013.

"We believe that the granulate can be very useful also for fire departments in many countries. If there is a petrol or oil leakage due a traffic accident, the granules absorb and remove the liquid so that it is no longer flammable," adds Pacyna.

CO_2 emissions must be reduced

The combustion of coal, oil and gas leads to global annual emissions of about 28 billion tonnes of CO_2, 15 per cent of which comes from the EU countries. The IPCC and EU leaders, along with a number of industrialized countries including Norway, have agreed that man-made CO_2 emissions must be reduced dramatically if we want to avoid problematic climate change. "If we use fossil fuels in the future, it is absolutely necessary to do something about CO_2 emissions. Then we're talking aboutn two important measures to address this problem. One is to make combustion more efficient, because today only about 32–34 per cent of the energy in coal, oil and gas is converted to electricity, while the rest goes to waste. The second is to start with carbon capture and storage or CCS (Carbon Capture and Storage) on a large scale," Pacyna says.

Secure storage

The SORBENT project has already shown that fly ash can be used as feedstock for the development of a granulate that can adsorb large amounts of CO_2 and mercury. The next step will be to develop the best approach to processing it. "Among the issues we will examine is whether or not the granules can be stored in abandoned coal mines, which today are often filled with sand or fly ash. We absolutely believe that this kind of storage will be possible, but we must first find a way to ensure that mercury will not leak into the groundwater," concludes Pacyna.

The project is financed with EEA funds, which represent Norway, Iceland and Liechtenstein's contribution to building social and economic cohesion in Europe and to strengthening cooperation with EU and EEA member countries in Central and Southern Europe. The name "EEA funds" is a term for both EEA Grants and Norway Grants.

Zeolite: A three-dimensional chemical structure that includes aluminium and silicon. Zeolites are widely used as catalysts and can be found in detergents, for example. All gasoline that is produced is typically passed through a zeolite.

Adsorption: A process that occurs when a gas or liquid binds to the surface of a solid or liquid. The process is different from absorption, where the drug diffuses into another substance.

CO_2 capture:
NILU at the forefront of research on nitramines

NILU's laboratories are developing specialized analytical methods for a key substance that can be used in CO_2 capture technology, while the institute's scientists are studying the substance's broad range of toxic properties.

By Christian Dye, Lise Fjellsbø og Elise Rundén Pran, scientists

The use of amines for CO_2 capture is considered the most promising technology to control emissions of this important greenhouse gas. Amines are involved in the process of extracting CO_2 from flue exhaust gases. Once the CO_2 has been safely stored, the amines can also be recycled. Some amines will inevitably escape into the atmosphere, however, which makes it important to learn more about the nitramines that escape, and what if any environmental effects they may have.

NILU's research on nitramines was initiated by Statoil, the Norwegian petroleum company, and Gassnova, a publicly funded Norwegian company created to spearhead the country's development of carbon capture and storage technologies. In particular, the Norwegian effort in the full-scale development of CO_2 capture and storage (CCM) at the Technology Centre Mongstad (TCM) demands on new knowledge and new methods of handling CO_2. The NILU project will help with current gaps in the technological knowledge by building expertise in a variety of areas, including emission measurements, before the final choice of technology is made. Amines will be one of several possible solvents that will be used in the Mongstad full-scale project.

Researcher Zuzana Magdonelova prepares tests for toxicology testing in the health effect laboratory at NILU.

Tests are ready for analysis in the GC-TEA.

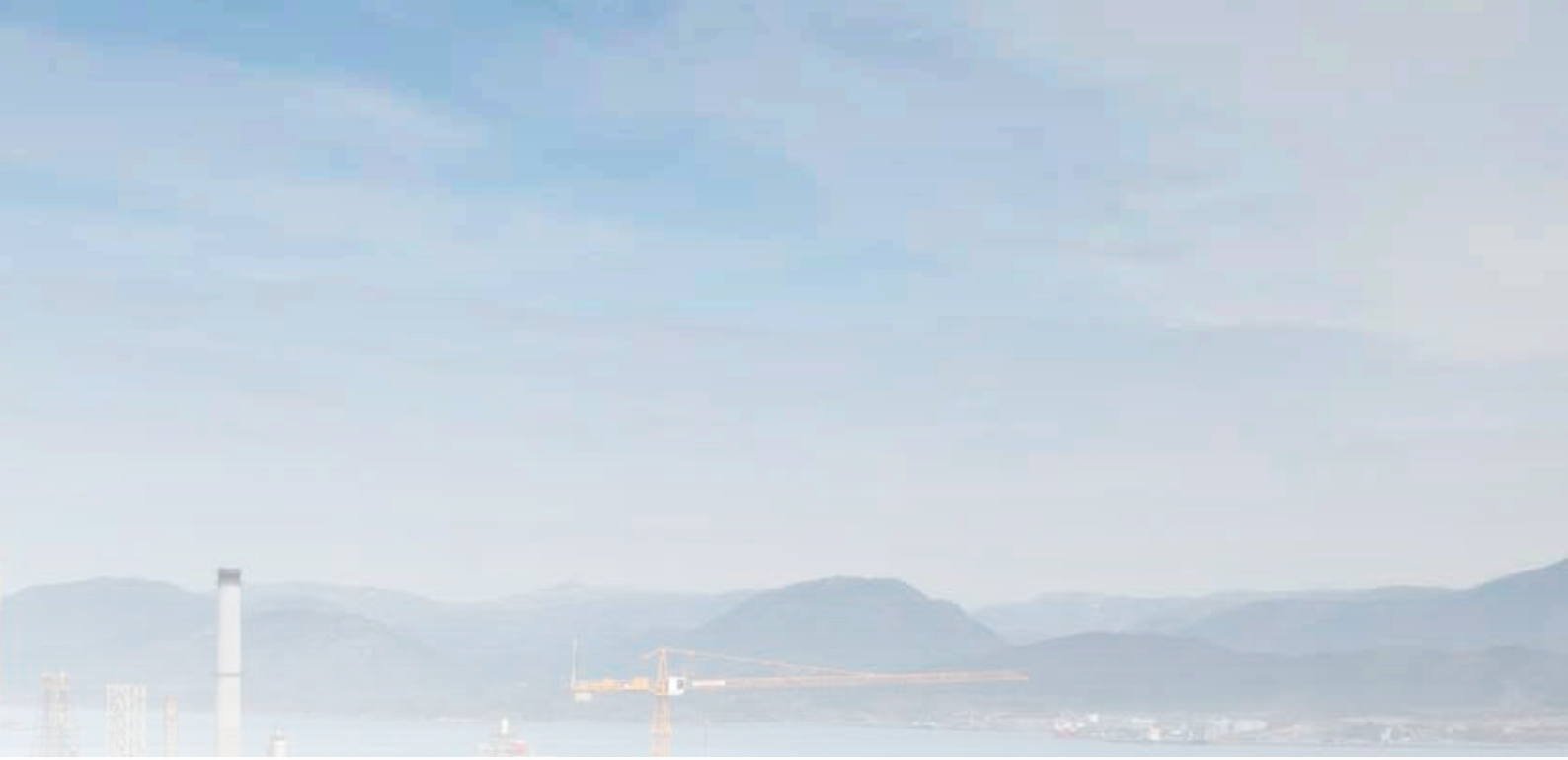
Research clarifies the risk of amine-based capture technology

The chemical analysis of nitramines is very demanding, and NILU has developed advanced methods for measuring amounts in both the wastewater from the capture process as well as emissions from exhaust stacks. Accurate measurements are important to clarify the risks associated with amine-based capture technology.

Researchers at the institute have studied the effects of five nitramines on health and the environment. Amines have been tested for acute toxicity (toxicity), toxicity in cell cultures, skin irritation, skin and eye irritation, allergy (sensitization), and the potential to damage genetic material (genotoxicity and mutagenicity). In addition, a modelling tool called QSAR has been used to evaluate potential environmental effects.

Carcinogenic and mutagenic

NILU's results showed that nitramines were not acutely toxic. Some types of nitramines did result in eye irritation. The most worrying finding, however, was



Amine technology

By Tore Flatlandsmo Berglen, scientist

Amine technology is widely used to purify CO_2 from natural gas and capture CO_2 from flue gases. Amines are chemical compounds derived from ammonia (NH_3) where one or more hydrogen atoms are replaced by an organic group, as in methylamine CH_3NH_2 (CH_3: methyl group, NH_2: amine group).

CO_2 capture with the use of amines is one of the options being considered for the full-scale CO_2 capture project (CCM) at the Technology Centre Mongstad.

The chemical breakdown of amines during the CO_2 capture process and in the atmosphere creates substances called degradation products, some of which are potentially dangerous. There has been a special focus on nitrosamines and nitramines.

Nitrosamines are generally very reactive and are quickly broken down by photolysis in the atmosphere, while nitramines are more resistant.

The Norwegian Institute of Public Health has recommended that the concentration of nitrosamines and nitramines combined should not exceed 0.3 ng/m3 in air (ng = nanograms, 10-9 grams, or billionths of grams). NILU has conducted research on issues related to amines for several years, including the development of analytical methods, toxicity, chemical degradation, dispersion and the transport of emissions, among others.

NILU also has a monitoring programme to determine the concentration of amines and amine degradation products in the environment.

These related projects are being partly funded by Statoil, Gassnova, and the two Mongstad-based efforts – CCM and TCM.

that one of the nitramines, called ethanol nitramine, proved to be genotoxic and mutagenic in three different tests, and therefore is potentially carcinogenic. The other nitramines need further testing before conclusions can be reached regarding their genotoxic potential. There were also indications that both methyl nitramine and dimethyl nitramine can be mutagenic.

Not so toxic for the environment

SINTEF, the Trondheim-based independent research institute, has been responsible for ecotoxicological testing, including the degradability of nitramines in the environment, and vice versa – or the ability of nitramines to be absorbed and stored in plants and animals (called biodegradation and bioaccumulation, respectively). Five nitramines were tested for biodegradability in water. Their acute toxicity was tested using an algae and a crustacean. SINTEF found that all nitramines tested had low to moderate acute ecotoxicity. None of nitramines was readily biodegradable.

Little known internationally

NILU was first to test the possible adverse effects of CO_2 treatment with amines. There is currently very little knowledge about their toxicity, and researchers at the institute are working diligently to identify additional issues. The results presented here are a part of this research.

NITRAMINES **are chemical compounds that arise when nitrogen dioxide, or NOX, reacts with amines under certain conditions. This component class has been poorly researched in relation to its toxicology and chemical / physical properties. The best-known industrial application of nitramines is as explosives. Nitramines are highly water-soluble and the substance absorbs light. Primary nitramines are acidic (low pKa), secondary nitramines are neutral.**

GENOTOXIC AND MUTAGENIC: **a genotoxic substance is one that causes damage to genetic material. DNA damage that is not repaired by the body manifests itself as a mutation that may be carcinogenic, depending upon the gene in which the mutation occurs.**

Like many other animals that are high on the food chain, polar bears are particularly vulnerable to contaminants. Unfortunately the contaminants cumulate in the favorite fatty part of the prey animals. Photo: Magnus Andersen, Norsk Polarinstitutt

Contaminants on the agenda in the

High levels of contaminants have been found in the Arctic, in the bodies of polar bears, arctic foxes and glaucous gulls, among others. "If we find dead animals or animals that behave abnormally, we often find a correlation with the amount of toxins in the animal," says NILU research director Eldbjørg Heimstad.

By Bjarne Røsjø

When Prime Minister Jens Stoltenberg came to inaugurate the Fram Centre in Tromsø on September 29, 2010, Heimstad and many other scientists had already spent more than a year preparing for the big day. The Fram Centre will provide a boost to Norway's already high level of northern-oriented climate research, and Heimstad was also gratified that the Fram Centre will put research on pollution and environmental toxins higher the national agenda.

New research flagship

"There has been a tendency for contaminants and toxins in some regions to be overshadowed by other research priorities. That makes it very encouraging that the Ministry has given such a high priority to pollutants and toxins that the Fram Centre has been given its own scientific flagship that will focus on the issue," Heimstad said. She is NILU's research director at the Fram Centre and head of *Environmental Pollutants – Effects on Ecosystems and Health*, one of the research flagships established at the Centre.

The flagship will expand our understanding of the effects that pollutants in the Arctic have on ecosystems and humans, and how pollutants interact with other stressors such as climate change, changes in living conditions and disease. "This knowledge is not only important in assessing the health of wildlife in the Arctic, but is also critical for the people living in northern areas and has potential social impacts. We are also concerned with the socio-economic impacts on the business sector, such as the need for industry to certify and demonstrate that fish and other products from the ocean are free of contaminants," says Heimstad.

north

Old and new pollutants

There are few local sources of pollution in the Arctic, and the substances that NILU finds are primarily due to long-range transport by air and sea currents from Europe and Eurasia. "We can still find old and well-known pollutants such as PCBs and DDT and their breakdown products in the Arctic, but new contaminants continue to pop up that we have to learn to detect and study. These include brominated flame retardants and fluorinated surface substances used to prevent fires and for impregnation of textiles to make them water resistant," Heimstad says.

"Analyses of dead and sick animals have shown that they often contain a lot of contaminants. However, there is almost no evidence that the hazardous substances were the cause of death. But when we connect these findings with the results of the tests we have done on biological effects in animals, the picture is clear: There is a high probability that contaminants in the Arctic are a threat to the environment and have a harmful effect on some species that live there. The damage is greatest in those species that are high on the food chain, such as polar bears, glaucous gulls and arctic foxes," Heimstad says.

International watchdogs

The NILU-led research flagship at the Fram Centre can have international significance because pollution in the Arctic is dominated by the long-range transport of substances, says Heimstad. "The Norwegian areas in the Arctic can be considered to be a global reference laboratory for chemicals with undesirable characteristics. The global Stockholm Convention of 2001, designed to protect health and the environment from persistent organic pollutants, turns a spotlight on precisely the environmental pollutants we are finding in the North. These chemicals must in fact be persistent to be transported over long distances. If we find these chemicals in animals and humans, as well as in the water and air, it indicates that they may have potential harmful effects."

In May 2009, the Norwegian Parliament decided that Norway should join the European Union's REACH program, which includes a new system for the control and registration of chemicals. "It is gratifying that industry in the EU must take more responsibility for the content of the chemicals in their products. Our part of the job in relation to national and international management and REACH is to use different methods to provide scientifically based assessments of the risk potential of these chemicals, and also act as watchdogs and whistleblowers when they appear in the North," adds Heimstad.

There is a high probability that contaminants in the Arctic are a threat to the environment and have a harmful effect on some species that live there. The damage is greatest in those species that are high on the food chain, such as polar bears, glaucous gulls and arctic foxes, says Eldbjørg Heimstad, NILU's research director at the Fram Centre and head of *Environmental Pollutants – Effects on Ecosystems and Health*.
Photo: Helge M. Markusson, Framsenteret.

FACTS ABOUT THE FRAM CENTRE

FRAM – The High North Research Centre for Climate and the Environment is located in Tromsø, and is an expansion of the Norwegian Polar Environmental Centre. The Fram Centre is a collaboration between 19 research institutions whose specialties include the natural and physical sciences, technology and the social sciences.

The centre had about 300 employees from ten institutions at the turn of 2010/2011. An extension of the building is planned to be completed around the end of 2013/2014, when there will be a total of about 500 employees in a building of over 23,000 square metres.

The centre is one of the key initiatives of the Norwegian Government's High North strategy. In addition to Prime Minister Stoltenberg, the Fram Centre opening was also attended by Education Minister Kristin Halvorsen, Local Government and Regional Development Minister Liv-Signe Navarsete and Fisheries and Coastal Affairs Minister Lisbeth Berg-Hansen.

The Fram Centre's member institutions conduct their own research and also collaborate on five so-called research flagships. The Research Flagship *Pollutants - effects on ecosystems and health* **is managed by NILU, with Akvaplan-niva as the deputy leader. The flagship's key partners are the Norwegian Polar Institute, the Norwegian Institute for Nature Research, the Norwegian Radiation Protection Authority, University of Tromsø, NORUT -- the Northern Research Institute, the Geological Survey of Norway, the Norwegian School of Veterinary Science, National Veterinary Institute and Institute of Marine Research.**

The other four flagships are: *Effects of climate change on sea and coastal ecology in the north; Ocean acidification and ecosystem effects in Northern waters; Sea ice in the Arctic Ocean, technology and agreements; and Effects of climate change on terrestrial ecosystems, landscapes, society and indigenous peoples.*

www.framsenteret.no

Skin care chemicals

Many skin care products contain a variety of chemical substances with partially unknown and possibly harmful effects, and these chemicals not only affect your skin. They end up in your blood – and in the environment as far north as the Arctic.

By Bjarne Røsjø

"Most people don't think about the fact that the creams and emollients that we smooth on our skin don't just stay on our skin. Our investigations have shown that substances including parabens, which are common additives in skin creams and other cosmetic products, can be detected in blood samples shortly after you have used them. If these substances are found in your blood, that means they are also in your liver and other places in your body," says Torkjel Sandanger, a senior researcher at NILU.

Parabens in the rich and famous

Norwegians spend more money on creams, deodorants and shampoos than ever before, and many of these products contain chemical substances that are potential pollutants. D2, a weekend magazine published by Dagens Næringsliv, a Norwegian financial newspaper, invited the Norwegian comedian and TV personality Sigrid Bonde Tusvik, along with yoga instructor and program manager Vibeke Klemetsen to participate in a comparison of blood samples, in cooperation with NILU. Tusvik uses quite a few cosmetics and dabs them on, while Klemetsen carefully reads product labels and tries to select cosmetics that don't contain the questionable chemicals.

"We found methyl- and propylparabens in the blood of both candidates, but the highest levels by far were in Bonde Tusvik," Sandanger told D2 after the blood samples were analysed. NILU also tested an anonymous third party who does not use cosmetics, and there were no measurable amounts of parabens in that individual's blood.

Green living is a good idea

"We humans are exposed to thousands of chemicals every day, and the basic idea should be that we do not need more chemicals in our bodies. Today, researchers must prove that a substance is likely to be dangerous before the authorities can ban it, but it would be better to use the precautionary principle. We know so little about how each substance affects the body and the environment, but we know even less about how many different substances interact with each other," said Sandanger.

Sandanger is very careful with his own use of skin care products and usually studies the label before he buys a new product. "Every Day Green, a Norwegian environmental organization, has investigated many products and has made a list of what these products contain," he says, suggesting that consumers use the list as a resource.

A big step forward

It has been difficult to determine whether parabens can cause cancer or hormonal disorders in humans, but in 2010 NILU scientists took a big step forward when they analysed blood samples from the "Wo-

end up in your blood - and in the Arctic

men and Cancer" study, led by Professor Eiliv Lund at the University of Tromsø.

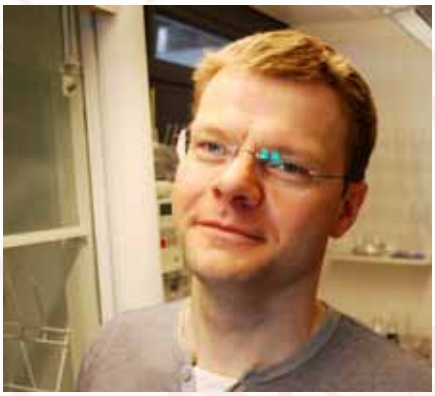
Professor Lund has collected data and questionnaires from more than 70 000 Norwegian women. In 2010, NILU scientists analysed blood samples from 350 of these women and compared their findings with the women's own reports on their use of skin cream and other skin care products. "We found a clear correlation between self-reported use and the levels of parabens in the blood. The full results of this survey will be published in 2011," Sandanger says.

Methylsiloxanes in Svalbard

NILU scientists are also concerned about methylsiloxanes, which postdoc Nicholas Warner found in the fjord outside of Longyearbyen in the arctic archipelago of Svalbard in 2010. "We also found siloxanes in Kongsfjorden outside of Ny-Ålesund, and low levels in the remote Liefdefjorden on the northwest coast of Svalbard," Warner says. These results were published in the journal Environmental Science & Technology.

"Communities in Longyearbyen and Ny-Ålesund seem to be point sources, while it is difficult to say where the siloxanes in Liefdefjorden are coming from. It may be that fish have swum there from more contaminated areas, or that there have been discharges from cruise ships in the area," said Warner.

Manufacturers have already phased out what are called D4 siloxanes, after studies suggested they had a toxic effect on marine life. "Producers have shifted more to D5 and D6 siloxanes, which so far do not have any documented toxic effect. The main focus now is to investigate whether these substances accumulate in the environment. If we can show that they accumulate, we can go back to the toxicologists and check to see if they have any toxic effect. There seems to be a low risk of accumulation of methylsiloxanes in mammals, but there is reason for concern when it comes to fish and other aquatic organisms," Warner says.



We humans are exposed to thousands of chemicals every day, and the basic idea should be that we do not need more chemicals in our bodies, says senior scientist Torkjel Sandanger at NILU in the Fram Centre.

PARABENS AND SILOXANES

Parabens are preservatives used in a wide range of cosmetic products and are suspected of having endocrine disrupting and possibly carcinogenic effects. Siloxanes are softening chemicals used in cosmetics and many other products, such as detergents and protective coatings, and are suspected of having toxic effects.

Cleaning products and paints increase the risk of asthma and allergies in children

A study by researchers from the Harvard School of Public Health (USA), Karlstad University in Sweden and NILU suggests that offgassing from a group of chemicals - PGE - can result in a variety of allergic symptoms in children, such as asthma, eczema and hay fever.

By Anne Nyeggen

"We have for the first time seen a correlation between the concentration of PGE in bedroom air, and an increased risk of allergies in children," says Norbert Schmidbauer, senior scientist at NILU. He has been central in a study that has received considerable international media attention, including in Scientific American in the United States. Schmidbauer believes it is important that these findings be examined more closely, and that there be a serious discussion about what our chemical society does to people's health.

PGE - Propylene glycol and propylene glycol ethers - are additives in ordinary detergents, paint and polishes, cosmetics and a host of other "western lifestyle" products.

Doubled risk of asthma - tripled for hay fever

Even relatively modest amounts of PGE in indoor air show a clear statistical correlation with the incidence of asthma and allergy. The study has been ongoing for nearly ten years, and is based on a survey of 400 children and their homes in Värmland in Sweden.

The study showed that children living in houses with the highest PGE concentrations (in the top 25% of the 400 houses surveyed) have a doubled chance of having asthma, are 150% more likely to have eczema and have a 320% higher likelihood of having hay fever. Among children with several symptoms, PGE exposure doubled the likelihood of developing hypersensitivity to other allergens.

We have for the first time seen a correlation between the concentration of PGE in bedroom air, and an increased risk of allergies in children, says Norbert Schmidbauer, senior scientist at NILU.

Sensational

"This is the first time that there has been such a clear link between chemicals in indoor air and the occurrence of asthma and allergies," says Schmidbauer. "But what is perhaps most startling is that this group of chemicals is present in relatively small concentrations - several hundred times lower than those that are reported as being harmful in workers such as professional painters."

There is much to suggest that the statistical relationship the researchers found is not due to chance. The increase in symptoms was found for any increase in exposure level.

"This is the finding that confirms what we have feared, namely that the increased amount of chemicals in indoor air not only makes our groups suffer more, but that individuals can actually develop these diseases," said Geir Endregard, Secretary General of the Norwegian Asthma and Allergy Association.

"This is such a disturbing finding that the government must immediately arrange for further investigation, while at the same time it must determine which products contain these substances, so that the process can begin to remove them," says Endregard.

The development of asthma and allergy in children in Norway is steadily increasing, and 20% of children have or have had asthma by the time they are ten. More than 30% react positively to prick tests for one or more allergens at the same age.

The study itself offers no explanation for the biological and medical causes of the findings, nor how such relatively low concentrations can result in such chronic effects. The answers to these questions must be determined in further investigations. "The statistical study should be followed up by clinical studies, so we can find a medical explanation," says Schmidbauer.

Our "chemical society"

"Nevertheless, we as a society should begin a serious discussion of our 'chemical society' - what this does to people's health, and what we need to know to protect the population. We must also discuss whether our risk assessments of chemicals are good enough to protect foetuses and infants," says the researcher.

While this study was underway, two of the 17 chemicals in the PGE group, DEGBE and DEGME, were listed as harmful in the EU / EEA. They are now subject to much stricter limitations on the maximum amount permitted in products, and are partially banned in products that are sold to private individuals.

A little boy in the kinder garden takes his asthma medicine. Photo: Ståle Andersen / NAAF

Nearly 10 years of data

The study has been on-going for nearly ten years, and is based on a survey of 400 children and their homes in Värmland in Sweden. One hundred and ninety-eight preschool children with asthma or allergies and 202 healthy children were examined by doctors in the winter of 2001/2002. A comprehensive survey was also undertaken, and the children's homes were thoroughly investigated with respect to moisture, ventilation, mould and dust.

Air samples from each of the children's bedrooms were also analysed at NILU. In each of these 400 air samples, the 50 chemicals with the highest concentrations were identified – in total around 20 000 individual results. The NILU researchers then grouped the hundreds of different chemicals that were found into eight different categories based on their chemical properties or source.

The survey was conducted in a completely anonymous manner so that none of the researchers who either took or analysed the samples had any knowledge of the children belonging to the control group or the group of children with symptoms.

The statistical analysis of the data was then performed at Karlstad University and at Harvard University. Of the eight different categories of chemicals in indoor air, only the PGE group showed an increased risk of disease in children.

Scientists are from Mars, policymakers are from Venus

By Bjarne Røsjø

Researchers and policymakers have difficulty understanding each other, almost as if they come from different planets. NILU has led the development of a network and an Internet portal that will make health and environmental research results more accessible, so that high-quality information can form the basis for better policy decisions.

"The goal of the HENVINET project (Health and Environment Network) is to make researchers better at presenting their findings and recommendations to politicians and other decision makers – so that research can be used as a basis for better policy decisions. We still have a long way to go before we have reached our goal, but we've come pretty far," says senior scientist Alena Bartonova, at the NILU Centre for Ecology and Economics. Bartonova has been the leader of the HENVINET project, which includes about 30 research institutions in and outside the EU system. The network now has about 400 individual members worldwide.

A network and a portal

HENVINET is both a research network and an Internet portal that will collect and present research-based information about the relationships between the environment, climate and public health. The research network will identify knowledge gaps and areas where experts disagree, among other efforts, and will present existing knowledge in new and more easily understood ways. The Internet portal may be used by decision makers and others, who will be able to use it to find the best available expertise in different disciplines.

"So far the project has been most valuable to scientists, because we have had the opportunity to examine how best to rephrase our research so that it can be used to make decisions. We have also developed good tools, which have at their core the use of visualization and the web. The portal also presents discussions of research results, how scientists have come up with these results, and the areas where scientists still disagree. My background at NILU has been a great advantage for me, because we are accustomed to translating research results into practical measures," Bartonova says.

We researchers should be better at presenting our findings and recommendations to politicians and other decision makers, says Alena Bartonova at NILU CEE.

Good research can be better

HENVINET has been used by an association of private practice physicians in different EU countries. The doctors wanted research-based advice on what climate change will mean for patients with respiratory diseases. The network has also selected six cancers and identified chemical substances in the environment that might be contributing factors. "The usual approach is for researchers to study environmental pollutants and determine whether or not they can cause cancer. We are among the first to have gone the other way in examining how this health condition can be affected by pollution. There is much good research in Europe, but we can do a better job putting it to use," says Bartonova.
HENVINET: http://www.henvinet.eu/

Climate Frames protect European art

In the museum world, it has become increasingly common to use what are known as microclimate frames to protect valuable works of art. But how much protection do the frames actually provide? NILU has recently completed a project funded by the EU to investigate the fate of famous paintings in European museums.

By Anne Nyeggen

The PROPAINT project is the first ever to examine the microclimate in and around paintings that have been enclosed in microclimate frames. A number of museums were involved, including the Tate in London and the Uffizi in Florence, in addition to the National Museum of Art, Architecture and Design in Oslo.

"The question is whether the microclimate created by these frames protects

A microclimate frame is being tested in the National Art Museum in Copenhagen.

FACTS:

A microclimate frame is a nearly airtight frame for pictures (usually) composed of glass, backing and a seal. The frame protects the picture from external influences and stabilizes the climate. Microclimate frames can also contain additional systems for controlling and monitoring the climate and pollution levels inside the frame.

The EWO dosimeter developed by NILU is now available on the market. It can be used to assess the condition of organic materials found in museums and collections.

Reserarcher Susana López-aparicio from NILU demonstrates the EWO dosimeter at the closing seminar for the PROPAINT project in Krakow, Poland.

Our results so far prove that the microclimate frames do a good job of protecting artwork from the impacts of external environment, says project manager Elin Dahlin, senior scientist at NILU.

the paintings, or if the air between the painting and the glass/frame can accelerate the degradation of the painting's surface," says Elin Dahlin, senior scientist at NILU and the project's coordinator.

The study shows that microclimate frames do a good job of protecting artwork from the ravages of the external environment. The National Museum found these results encouraging, and reports that it will continue to use the microclimate frames.

"Self-Pollution"

A team of scientists from seven European countries measured the air in and around a series of microclimate frames that enclosed paintings in 12 museums in Europe and Mexico City. Three years of research showed that pollutants such as ozone, nitrogen dioxide and sulphur dioxide from the outdoor environment were able to penetrate the protective framework, but only to a very limited extent.

"However, we found that the frame itself, along with the glue, varnish and paint can give off a number of aggressive organic compounds that are then trapped in the microclimate frame," Dahlin says. "This means that the frame meets our expectations when it comes to protection from external pollution, but there are still unanswered questions as to how harmful the organic gases trapped in the frames are," she says.

Munch is fine - given the circumstances

In Oslo, measurements were carried out at the National Museum of Art, Architecture and Design on a painting by Edvard Munch.

"In fact, we measured higher levels of pollutants inside the National Museum in Oslo than were measured inside the National Museum in Krakow," says senior scientist Terje Grøntoft, also from NILU.

"But we also saw that the microclimate frames protected paintings such as the Munch from contaminants. Only low values of the pollutants were measured inside the frames. In Krakow, however, we measured relatively high levels inside the frame where Leonardo da Vinci's painting, 'Lady with an Ermine' was kept. This frame was less tight than the frame that was used to protect the Munch painting," says Grøntoft.

National Museum satisfied

Officials from the National Museum in Oslo say they are pleased with the results of the survey. "We will continue to use microclimate frames for selected, highly moisture-sensitive paintings. This applies particularly to those painted on wood panels," says Trond E. Aslaksby, museum curator. "We hope that there will continue to be studies of the gases inside these frames, but we think - for now - that the benefits outweigh any disadvantages."

A small, smart sensor

The pollution was measured with small passive samplers, in addition to three different types of specially developed sensors, "dosimeters", which measure the total pollution load over a certain time. The EWO dosimeter, which was developed by NILU, can provide a warning to museums that the conditions inside the frame are not optimal for preserving the painting, and that action must be taken to purify the air.

Variable varnish

There were also extensive studies of various types of varnishes to examine the extent to which the painting's surface breaks down when enclosed in microclimate frames. This effort was led by NILU researcher Susana López-Aparicio. It was clear that some types of varnish degraded faster than others. However, the researchers concluded that more investigation was needed to understand what happens with the degradation of the paint layers themselves.

European Standard

PROPAINT also evaluated different types of microclimate frames used to protect valuable paintings. This work has led to specific guidelines for the design and use of microclimate frames, and has contributed to the development of a European standard for display cases for use in museums and collections. In addition to the Norwegian researchers, the PROPAINT project included participants from England, Germany, Poland, Denmark, Italy and Spain.

Climate-friendly solution

An important feature of the microclimate frames is that they stabilize the climate around pictures without the need to air-condition large indoor spaces. This can reduce energy costs.

NILU on the international front:

Air pollution dominates

Air pollution is a major health problem in many countries, and NILU is involved in several projects that address this concern. Central to this effort has been the development of analytical and modelling tools to improve air quality. The projects are based on the results of basic research at NILU.

By Bjarne Sivertsen, Associate Research Director

Air quality and climate in Abu Dhabi

NILU is a strategic partner for all issues related to air pollution and greenhouse gases for the environmental authorities (EAD) in Abu Dhabi, United Arab Emirates. NILU conducts measurements and manages of air quality on behalf of EAD, and has the responsibility for reporting on the state of the environment in the Emirate. NILU operates ten stations, a central calibration laboratory, and currently has a staff of 15 people at its Abu Dhabi office. One of the main problems facing the region is particulate matter, and sand storms sometimes result in very high levels of dust in the air.

New centre for air quality in Dakar, Senegal

LE SOLEIL - JEUDI 18 MARS 2010

CTU

CENTRE DE GESTION DE LA QUALITE DE L'AIR

Un instrument de veille sur la pollution atmosphérique

Le Premier ministre, Souleymane Ndéné Ndiaye, a procédé, hier, à Dakar, à l'inauguration du Centre de gestion de la qualité de l'air (Cgqa) qui, grâce à la coopération entre le Sénégal et le Fonds nordique de développement, dispose dorénavant d'équipements ultra-modernes et uniques en Afrique de l'Ouest, pour assurer la veille sur la pollution atmosphérique, une meilleure gestion de l'environnement et plus spécifiquement à celle de la qualité de l'air.

Le Premier ministre inaugurant le centre. (Photo : Sarakh Diop).

The Centre for Air Quality was opened by the Prime Minister of Senegal, Souleymane Ndéné Ndiaye, documented by an impressive number of journalists.

With support from the Nordic Development Fund, NILU has developed a programme for monitoring and managing air quality in Senegal. This includes the development of planning tools for efforts to combat pollution. Local experts have undergone training based on a planning tool called AirQUIS, which was developed by NILU. A five-year development programme ended in 2010 with the official opening of the new centre in Dakar.

Dhaka, Bangladesh

Dhaka, Bangladesh is one of the world's most polluted cities. Concentrations of particulate matter regularly exceed both national and international limits, especially in the dry winter months. Larger cities such as Dhaka and Chittagong are polluted by thousands of small and large industrial sources such as steel mills, cement factories and brick factories. Traffic problems can also be significant.

In cooperation with the Ministry of Bangladesh, NILU received funding from NORAD in 2010 to conduct a three-year project to study and attempt to resolve some of these problems.

The «Bangladesh Air Pollution Project Management» (BAPMAN) started in August 2010. The first measurements in Dhaka already show that pollution levels are considerably higher than what we are used to in Europe.

Mongolia

NILU has worked in Ulaanbaatar to study problems related to particulate matter. This effort consisted of basic measurements, analysis and reporting. NILU has also used modelling studies to improve the understanding of the area's air pollution problem.

China

NILU has worked on several projects and project proposals in China during 2010, including follow-up to a previous project in Shanxi. A proposal for the study of haze and small particles in the air (less than 2.5 micrometres) was discussed with the authorities of Hubei Province. Plans for the coordinated studies of local air quality problems and greenhouse gas emissions (co-control studies) and multi-component studies in various parts of China were also presented and discussed with NILU's Chinese colleagues.

Marketing and innovation – NILU style:

Two subsidiaries miles apart

The Marketing and Innovation Group has one simple goal, to create additional value from the research and ideas found within the walls of NILU. 2010 made for a very interesting year. We started two new subsidiaries which are miles apart in terms of both technology and markets.

Nicarnica Aviation AS was created to provide IR solutions to detect airborne hazards for the aviation industry (see the article Troublesome ash clouds in this magazine).

We always knew that the aviation market could be interesting for our solutions but the timing had to be perfect. Well after the volcanic eruption in mid-April of 2010 when the aviation industry was searching for answers and technologies which would allow them some level of operation during the next ash event, Nicarnica Aviation AS was born. Development of the airborne ash detection system, AVOID, has been a primary focus and initial system testing will take place in the summer 2011 with major aviation partners.

Comet BioTech AS saw NILU working together with the University of Oslo to create a new company providing the latest, state-of-the-art, high throughput assays targeted at the chemical industry, cosmetic and pharmaceutical companies, regulatory bodies, the REACH Directive, basic genome research and bio-monitoring projects.

We start 2011 with more opportunities than we had in the beginning of 2010. New markets are opening and new products are in development within both NILU Innovation AS and the daughter companies. We look forward to the busy times ahead.

NILU wins certification

As one of the first environmental institutes in Norway, NILU has now received its ISO 14001:2004 environmental certification. "Now we're not only giving advice to others about how to act in environmentally friendly manner, but we also know that we ourselves are behaving in this way too," says Paal Berg, Deputy Managing Director of NILU.

"This has taken months of preparation, topped by a three-day exam," Berg says. He believes that the certification will strengthen NILU's credibility by showing that the institute practices what it preaches.

The certification has consequences for everything that NILU does – from handling waste to energy use and travel. Among other things, NILU will provide annual statistics on CO_2 emissions from flights taken by the institute's staff. This focus will increase the use of video conferencing to reduce travel. NILU's headquarters at Kjeller will also switch to the use of district heating and cooling.

"But NILU's research matters, too, because our very existence is based on promoting environmentally sustainable development," Berg says.

NILU – making a difference for the environment

NILU is an independent, non-profit institution established in 1969. The institute holds strong national and international positions in its core research areas.

NILU's 182 researchers, technicians and other experts are primarily commissioned by the Research Council of Norway and by Norwegian and international industry and government agencies. The institute takes an active part in the EU's research programs.

NILU topics

- Atmospheric composition
- GHG and climate-forcing agents
- Ozone-layer depletion and UV radiation
- Long-range transport of air pollution
- Urban and industrial pollution
- Aerosol and particulate matter
- Chemicals and their environmental effects
- Health-effect studies
- Ecology and economics

From Pole to Pole

NILU monitors climate change, global air quality and air pollution transport pathways via observatories in Norway (Birkenes and ALOMAR – Andøya), in the Arctic (Svalbard, Zeppelin) and in Antarctica (Troll). NILU's observatories supply researchers all over the world with important data on a wide spectrum of pollutants, climate gases and climate forcing agents.

Services

NILU offers a wide range of services and products to customers both on a national and international level, including air quality monitoring and chemical analysis services:

Air quality consulting services

NILU has 40 years of experience in studying and analysing air pollution issues. By combining highly qualified scientific researchers and in-house software developers, NILU has developed a complete range of air quality consulting services to meet any requirement.

Chemical analysis

NILU's laboratories can perform advanced analysis on a broad range of organic and inorganic pollutants on all kinds of samples.

Laboratories

NILU's chemical laboratories are among the most advanced in Europe. The laboratories are equipped with state-of-the art analytical equipment, including a series of high-resolution mass spectrometers that can measure a wide range of organic and inorganic pollutants.

Health effects laboratory

The health effects laboratory investigates the direct health impacts of pollution, climate change and new materials on humans and animals. Its establishment completes the "circle" of monitoring, modelling, analysing, evaluation and effects conducted by NILU.

International activities

NILU has extensive experience in coordinating international research projects and is involved in a long list of international assignments. The institute is strategic partner for the environmental authorities in Abu Dhabi in the United Arab Emirates. NILU is also actively involved in EU's framework programmes for research. It also co-ordinates the Programme for Monitoring and Evaluation of the Long-Range Transmission of Air Pollutants in Europe (EMEP). Finally, NILU plays a leading international role in collecting and storing measurement data from atmospheric research and monitoring programmes.

Some major NILU clients:

- European Commission
- UN ECE, Europe
- European Environmental Agency
- World Bank
- Asian Development Bank
- World Meteorological Organization
- World Health Organization (WHO)
- UN Environmental Programme (UNEP)
- Ministries and Governments
- Local authorities and industries

Key figures

Extracts from the Annual accounts, All figures in MNOK

INCOME STATEMENT	2010	2009
Project revenue	165,1	164,4
Basic grant	20,7	18,6
Other operating income	0,7	1,4
Operating revenue	**186,5**	**184,4**
Personell expenses	-120,1	-117,3
Direct project expenses	-29,1	-31,8
Other expenses	-34,0	-29,0
Operating profit	**3,3**	**6,3**
Net financial items	-0,6	-1,8
Tax	-1,8	-0,4
Net operating profit	**0,9**	**4,1**

BALANCE	2010	2009
Total current assets	78,1	66,6
Total fixed assets	94,6	49,2
Total assets	**172,7**	**115,8**
Equity	108,5	58,2
Liabilities	64,2	57,6
Total equity and liabilities	**172,7**	**115,8**

	2010	2009
NUMBER OF MAN-YEARS	**182**	**177**
- whereof research man-years	97	95
- whereof man-years of other personnel	85	82
Turnover per research man-year	**1 923**	**1 941**

NUMBER OF EMPLOYEES	194	192
- whereof women	86	83
- whereof men	108	109
Number of employees holding a doctorate	**55**	**51**
National projects	54 %	52 %
International projects	35 %	38 %
Basic grant	11 %	10 %
Total	**100 %**	**100 %**

INTERNATIONAL PROJECTS - NUMBERS	2010	2009
European Commission	34	34
Nordic Council of Ministers	4	3
United Nations	1	1
World Bank	2	1
Other projects	21	9
Total	**62**	**48**

PROJECT PORTFOLIO - NUMBERS	2010	2009
0 - 100 000	108	89
101 000 - 500 000	134	84
501 000 - 2 000 000	68	89
2 001 000 and over	16	66
Total	**326**	**328**

NILU PUBLICATIONS	2010	2009
Scientific papers	109	124
Scientific reports	92	57
Technical reports	15	2
EMEP/CCC reports	4	6
Lectures	111	131
Posters	31	32
NILU scientists also contributed to the publishing of:		
External reports	21	15
Papers in books/reports	56	70

Scientific Papers

Andelova, L., Smolik, J., Ondrackova, L., Ondracek, J., Lopez-Aparicio, S. Grøntoft, T., Stankiewicz, J. Characterization of airborne particles in the Baroque Hall of the National Library in Prague. *e-Preserv. Sci., 7, 141-146.*

Arshinov, M., Paris, J.-D., Stohl, A., Belan, B., Ciais, P., Nédélec, P. Measurements of ultra-fine and fine aerosol particles over Siberia: Large-scale airborne campaigns. *Geophys. Res. Abstr., 12, EGU2010-6417.*

Baklanov, A., Lawrence, M., Pandis, S., Mahura, A., Finardi, S., Moussiopoulos, N., Beekmann, M., Laj, P., Gomes, L., Jaffrezo, J.-L., Borbon, A., Coll, I., Gros, V., Sciare, J., Kukkonen, J., Galmarini, S., Giorgi, F., Grimmond, S., Esau, I., Stohl, A., Denby, B., Wagner, T., Butler, T., Baltensperger, U., Builtjes, P., van den Hout, D., van der Gon, H. D., Collins, B., Schluenzen, H., Kulmala, M., Zilitinkevich, S., Sokhi, R., Friedrich, R., Theloke, J., Kummer, U., Jalkinen, L., Halenka, T., Wiedensholer, A., Pyle, J., Rossow, W.B. MEGAPOLI: concept of multi-scale modelling of megacity impact on air quality and climate. *Adv. Sci. Res, 4, 115-120.*

Begoin, M., Richter, A., Weber, M., Kaleschke, L., Tian-Kunze, X., Stohl, A., Theys, N., Burrows, J.P. Satellite observations of long-range transport of a large BrO plume in the Arctic. *Atmos. Chem. Phys., 10, 6515-6526, doi:10.5194/acp-10-6515-2010.*

Berger, J., Walker, S.-E., Denby, B., Berkowicz, R., Løfstrøm, P., Ketzel, M., Härkönen, J., Nikmo, J., Karppinen, A. Evaluation and inter-comparison of open road line source models currently in use in the Nordic countries. *Boreal. Env. Res., 15, 319-334.*

Birmili, W., Göbel, T., Sonntag, A., Ries, L., Sohmer, R., Gilge, S., Levin, I., Stohl, A. A case of transatlantic aerosol transport detected at the Schneefernerhaus Observatory (2650 m) on the northern edge of the Alps. *Meteorol. Zeitschrift, 19, 591-600.*

Bitar, L., Duck, T.J., Kristiansen, N.I., Stohl, A., Beauchamp, S. Lidar observations of Kasatochi volcano aerosols in the troposphere and stratosphere. *J. Geophys. Res., 115, D00L13, doi:10.1029/2009JD013650.*

Brambilla, G., Dellatte, E., di Domenico, A., Heinemeyer, G., D'Hollander, W., Herzke, D., van Leeuwen, S., De Voogt, W.P. Retrospective and prospective intake assessment of perfluorinated chemicals within the European Union: the PERFOOD project. *Organohalogen Compd., 72, 1644-1647*

Breivik, K., Czub, G., McLachlan, M.S., Wania, F. Towards an understanding of the link between environmental emissions and human body burdens of PCBs using CoZMoMAN. *Environ. Int., 36, 85-91.*

Brioude, J., Portmann, R.W., Daniel, J.S., Cooper, O.R., Frost, G.J., Rosenlof, K.H., Granier, C., Ravishankara, A.R., Montzka, S.A., Stohl, A. Variations in ozone depletion potentials of very short-lived substances with season and emission region. *Geophys. Res. lett., 37, L19804, doi:10.129/2010GL044856.*

Bustnes, J.O., Lie, E., Herzke, D., Dempster, T., Bjørn, P.A., Nygård, T., Uglem, I. Salmon farms as a source of organohalogenated contaminants in wild fish. *Environ. Sci. Technol., 44, 8736-8743.*

Bustnes, J.O., Moe, B., Herzke, D., Hanssen, S.A., Nordstad, T., Sagerup, K., Gabrielsen, G.W., Borgå, K. Strongly increasing blood concentrations of lipid-soluble organochlorines in high arctic common eiders during incubation fast. *Chemosphere, 79, 320-325.*

Cairo, F., Pommereau, J. P., Law, K. S., Schlager, H., Garnier, A., Fierli, F., Ern, M., Streibel, M., Arabas, S., Borrmann, S., Berthelier, J. J., Blom, C., Christensen, T., D'Amato, F., Di Donfrancesco, G., Deshler, T., Diedhiou, A., Durry, G., Engelsen, O., Goutail, F., Harris, N. R. P., Kerstel, E. R. T., Khaykin, S., Konopka, P., Kylling, A., et al. An introduction to the SCOUT-AMMA stratospheric aircraft, balloons and sondes campaign in West Africa, August 2006: rationale and roadmap. *Atmos. Chem. Phys., 10, 2237-2256.*

Carn, S.A., Prata, F.J. Satellite-based constraints on explosive SO_2 release from Soufrière Hills Volcano, Montserrat. *Geophys. Res. Lett.,37, L00E22, doi:10.1029/2010GL044971.*

Cassiani, M., Vinuesa, J.F., Galmarini, S., Denby, B. Stochastic fields method for sub-grid scale emission heterogeneity in mesoscale atmospheric dispersion models. *Atmos. Chem. Phys., 10, 267-277.*

Cavalli, F., Viana, M., Yttri, K.E., Genberg, J., Putaud, J.-P. Toward a standardised thermal-optical protocol for measuring atmospheric organic and elemental carbon: the EUSAAR protocol. *Atmos. Meas. Tech., 3, 79-89.*

Chaemfa, C., Barber, J.L., Huber, S., Breivik, K., Jones, K.C. Screening for PFOS and PFOA in European air using passive samplers. *J. Environ. Monit., 12, 1100-1109.*

Choi, H., Schmidbauer, N., Spengler, J., Bornehag, C.-G. Sources of propylene glycol and glycol ethers in air at home. *Int. J. Environ. Res. Public Health, 7, 4213-4237.*

Choi, H., Schmidbauer, N., Sundell, J., Hasselgren, M., Spengler, J., Bornehag, C.-G. Common household chemicals and the allergy risks in pre-school age children. *PLoS ONE, 5, 10, e13423.*

Clarisse, L., Hurtmans, D., Prata, A.J., Karagulian, F., Clerbaux, C., De Maziere, M., Coheur, P.F. Retrieving radius, concentration, optical depth, and mass of different types of aerosols from high-resolution infrared nadir spectra. *Applied Optics, 49, 3713-3722.*

Clarisse, L., Hurtmans, D., Prata, F., Karagulian, F., Clerbaux, C., De Mazière, M., Coheur, P.F. Sounding of aerosols with IASI - observations, retrievals and open questions. *Geophys. Res. Abstr., 12, EGU2010-11383.*

Clarisse, L., Prata, F., Hurtsmans, D., Coheur, P., Clerbaux, C. Remote sensing of volcanic ash with the IASI iinterferometer on board the METOP satellite. *Geophys. Res. Abstr., 12, EGU2010-15734.*

Clarisse, L., Prata, F., Lacour, J.-L., Hurtmans, D., Clerbaux, C., Cohe, P.-F. A correlation method for volcanic ash detection using hyperspectral infrared measurements. *Geophys. Res. Lett., 37, L19806, doi:10.1029/2010GL044828.*

Cooper, O.R., Parrish, D.D., Stohl, A., Trainer, M., Nédeléc, P., Thouret, V., Cammas, J.P., Oltmans, S.J., Johnson, B.J., Tarasick, D., Leblanc, T., McDermid, I.S., Jaffe, D., Gao, R., Stith, J., Ryerson, T., Aikin, K., Campos, T., Weinheimer, A., Avery, M.A. Increasing springtime ozone mixing ratios in the free troposphere over western North America. *Nature, 463, 344-348.*

Corradini, S., Merucci, L., Prata, F., Piscini, A. Volcanic ash and SO2 in the 2008 Kasatochi eruption: Retrievals comparison from different IR satellite sensors. *J. Geophys. Res., 115, D00L21.*

de Wit, C.A., Herzke, D., Vorkamp, K. Brominated flame retardants in the Arctic - Spatial and temporal trends and new candidates. *Organohalogen Compd., 72, 378-381.*

de Wit, C.A., Herzke, D., Vorkamp, K. Brominated flame retardants in the Arctic environment - trends and new candidates. *Sci. Total Environ., 408, 2885-2918.*

Denby, B., Karl, M., Laupsa, H., Johansson, C., Pohjola, M., Karppinen, A., Kukkonen, J., Ketzel, M., Wåhlin, P. Estimating domestic wood burning emissions of particulate matter in two Nordic cities by combining ambient air observations with receptor and dispersion models. *Chem. Ind. Chem. Eng. Quart., 16, 237-241.*

Denby, B., Sundvor, I., Cassiani, M., de Smet, P., de Leeuw, F., Horálek, J. Spatial mapping of ozone and SO2 trends in Europe. *Sci. Total Environ., 408, 4795-4806.*

Dobrzynska, M., Gajowik, A., Radzikowska, J., Gromadzka-Ostrowska, J., Oczkowski, M., Krawczynska, A., Brunborg, G., Dusinska, M., Lankoff, A., Kruszewski, M. The effects of silver nanoparticles on male rats sperm quantity and quality. *Toxicol. Lett, 196, suppl. 1, S285-S286.*

Durant, A., Voss, P., Watson, M., Roberts, T., Thomas, H., Prata, F., Sutton, J., Mather, T., Witt, M., Patrick, M. Real-time in situ measurements of volcanic plume physico-chemical properties using Controlled METeorological balloons. *Geophys. Res. Abstr., 12, EGU2010-4937.*

Elguindi, N., Clark, H., Ordóñez, C., Thouret, V., Flemming, J., Stein, O., Huijnen, V., Moinat, P., Inness, A., Peuch, V.-H., Stohl, A., Turquety, S., Athier, G., Cammas, J.-P., Schultz, M. Current status of the ability of the GEMS/MACC models to reproduce the tropospheric CO vertical distribution as measured by MOZAIC. *Geosci. Model Dev., 3, 501-518.*

Engelsen, O. The relationship between ultraviolet radiation exposure and vitamin D status. *Nutrients, 2, 482-495.*

Forsius, M., Posch, M., Aherne, J., Reinds, G.J., Christensen, J., Hole, L. Assessing the impacts of long-range sulfur and nitrogen deposition on Arctic and Sub-Arctic ecosystems. *Ambio, 39, 136-147.*

Gangale, G., Prata, A.J., Clarisse, L. The infrared spectral signature of volcanic ash determined from high-spectral resolution satellite measurements. *Rem. Sens. Environ., 114, 414-425.*

Gasic, B., MacLeod, M., Klanova, J., Scheringer, M., Ilic, P., Lammel, G., Pajovic, A., Breivik, K., Holoubek, I., Hungerbühler, K. Quantification of sources of PCBs to the atmosphere in urban areas: A comparison of cities in North America, Western Europe and former Yugoslavia. *Environ. Pollut., 158, 3230-3235.*

Gilman, J.B., Burkhart, J.F., Lerner, B.M., Williams, E.J., Kuster, W.C., Goldan, P.D., Murphy, P.C., Warneke, C., Fowler, C., Montzka, S.A., Miller, B.R., Miller, L., Oltmans, S.J., Ryerson, T.B., Cooper, O.R., Stohl, A., de Gouw, J.A. Ozone variability and halogen oxidation within the Arctic and sub-Arctic springtime boundary layer. *Atmos. Chem. Phys., 10, 10223-10236.*

Gimeno, L., Drumond, A. Nieto, R., Trigo, R.M., Stohl, A. On the origin of continental precipitation. *Geophys. Res. Lett., 37, L13804, doi:10.1029/2010GL043712.*

Glodek, A., Panasiuk, D., Pacyna, J.M. Mercury emission from anthropogenic sources in Poland and their scenarios to the year 2020. *Water Air Soil Pollut., 213, 227-236.*

Godsey, S.E., Aas, W., Clair, T.A., de Wit, H.A., Fernandez, I.J., Kahl, J.S., Malcolm, I.A., Neal, C., Neal, M., Nelson, S.J., Norton, S.A., Palucis, M.C., Skjelkvåle, B.L., Soulsby, C., Tetzlaff, D., Kirchner, J.W. Generality of fractal 1/f scaling in catchment tracer time series, and its implications for catchment travel time distributions. *Hydrol. Process., 24, 1660-1671.*

Gröbner, J., Hülsen, G., Wuttke, S., Schrems, O., De Simone, S., Gallo, V., Rafanelli, C., Petkov, B., Vitale, V., Edvardsen, K., Stebel, K. Quality assurance of solar UV irradiance in the Arctic. *Photochem. Photobiol. Sci., 9, 384-391.*

Grøntoft, T. Derivation of a model for the calculation of impact loads of air pollutants to paintings in microclimate frames. *e-Preserv. Sci., 7, 132-140.*

Grøntoft, T., Odlyha, M., Mottner, P., Dahlin, E., Lopez-Aparicio, S., Jakiela, S., Scharff, M., Andrade, G., Obarzanowski, M., Ryhl-Svendsen, M., Thickett, D., Hackney, S., Wadum, J. Pollution monitoring by dosimetry and passive diffusion sampling for evaluation of environmental conditions for paintings in microclimate frames. *J. Cult. Herit., 11, 411-419.*

Hansen, M.C., Børresen, M.H., Schlabach, M., Cornelissen, G. Sorption of perfluorinated compounds from contaminated water to activated carbon. *J. Soils Sediments, 10, 179-185.*

Hansen, S., Nieboer, E., Odland, J.Ø., Wilsgaard, T., Veyhe, A.S., Sandanger, T.M. Levels of organochlorines and lipids across pregnancy, delivery and postpartum periods in women from Northern Norway. *J. Environ. Monit., 12, 2128-2137.*

Hanssen, L., Röllin, H., Odland, J.Ø., Moe, M.K., Sandanger, T.M. Perfluorinated compounds in maternal serum and cord blood from selected areas of South Africa: results of a pilot study. *J. Environ. Monit., 12, 1355-1361.*

Harrad, S., de Wit, C.A., Abdallah, M.A.E., Bergh, C., Bjorklund, J.A., Covaci, A., Darnerud, P.O., de Boer, J., Diamond, M., Huber, S., Leonards, P., Mandalakis, M., Oestman, C., Haug, L.S., Thomsen, C., Webster, T.F. Indoor contamination with hexabromocyclododecanes, polybrominated diphenyl ethers, and perfluoroalkyl compounds: An important exposure pathway for people? *Environ. Sci. Technol., 44, 3221-3231.*

Haukås, M., Hylland, Nygård, T., Berge, J.A., Mariussen, E. Diastereomer-specific bioaccumulation of hexabromocyclododecane (HBCD) in a coastal food web, Western Norway. *Sci. Total. Environ., 408, 5910-5916.*

Haukås, M., Ruus, A., Hylland, K., Berge, J. A., Mariussen, E. Bioavailability of hexabromocyclododecane to the polychaete Hediste diversicolor: Exposure through sediment and food from a contaminated fjord. *Environ. Toxicol. Chem., 29, 1709-1715.*

Helgason, L.B., Arukwe, A., Gabrielsen, G.W., Harju, M., Hegseth, M.N., Heimstad, E.S., Jørgensen, E.H., Mortensen, A.S., Wolkers, J. Biotransformation of PCBs in Arctic seabirds: Characterization of phase I and II pathways at transcriptional, translational and activity levels. *Comp. Biochem. Physiol. C: Toxicol. Pharmacol., 152, 34-41.*

Henne, S., Brunner, D., Folini, D., Solberg, S., Klausen, J., Buchmann, B. Assessment of parameters describing representativeness of air quality in-situ measurement sites. *Atmos. Chem. Phys.,*

10, 3561-3581.

Hirdman, D., Burkhart, J. F., Sodemann, H., Eckhardt, S., Jefferson, A., Quinn, P. K., Sharma, S., Ström, J., Stohl, A. Long-term trends of black carbon and sulphate aerosol in the Arctic: changes in atmospheric transport and source region emissions. *Atmos. Chem. Phys., 10, 9351-9368.*

Hirdman, D., Sodemann, H., Eckhardt, S., Burkhart, J.F., Jefferson, A., Mefford, T., Quinn, P.K., Sharma, S., Ström, J., Stohl, A. Source identification of short-lived air pollutants in the Arctic using statistical analysis of measurement data and particle dispersion model output. *Atmos. Chem. Phys., 10, 669-693.*

Hoffmann, A., Ritter, C., Stock, M., Maturilli, M., Eckhardt, S., Herber, A., Neuber, R. Lidar measurements of the Kasatochi aerosol plume in August and September 2008 in Ny-Ålesund, Spitsbergen. *J. Geophys. Res., 115, D00L12.*

Hudecova, A., Hasplova, K., Miadokova, E., Magdolenova, Z., Rinna, A., Galova, E., Sevcovicova, A., Vaculcikova, D., Gregan, F., Dusinska, M. Cytotoxic and genotoxic effect of methanolic flower extract from Gentiana asclepiadea on COS 1 cells. *Neuro. Endocrinol. Lett, 31, Suppl. 2, 21-25.*

Hung, H., Kallenborn, R., Breivik, K., Su, Y., Brorström-Lundén, E., Olafsdottir, K., Thorlacius, J.M., Leppänen, S., Bossi, R., Skov, H., Manø, S., Patton, G.W., Stern, G., Sverko, E., Fellin, P. Atmospheric monitoring of organic pollutants in the Arctic under the Arctic Monitoring and Assessment Programme (AMAP): 1993-2006. *Sci. Total Environ., 408, 2854-2873.*

Jenssen, B.M., Aarnes, J.B., Murvoll, K.-M., Herzke, D., Nygård, T. Fluctuating wing asymmetry and hepatic concentrations of persistent organic pollutants are associated in European shag (Phalacrocorax aristotelis) chicks. *Sci. Total Environ., 408, 578-585.*

Joksic, J., Radenkovic, M., Cvetkovic, A., Matic-Besarabic, S., Jovasevic-Stojanovic, M., Bartonova, A., Yttri, K.E. Variations of PM10 mass concentrations and correlations with other pollutants in Belgrade urban area. *Chem. Ind. Chem. Eng. Quart., 16, 251-258.*

Jonson, J.E., Stohl, A., Fiore, A.M., Hess, P., Szopa, S., Wild, O., Zeng, G., Dentener, F.J., Lupu, A., Schultz, M.G., Duncan, B.N., Sudo, K., Wind, P., Schulz, M., Marmer, E., Cuvelier, C., Keating, T., Zuber, A., Valdebenito, A., Dorokhov, V., De Backer, H., Davies, J., Chen, G.H., Johnson, B., Tarasick, D.W., Stübi, R., Newchurch, M.J., von der Gathen, P., Steinbrecht, W., Claude, H. A multi-model analysis of vertical ozone profiles. *Atmos. Chem. Phys., 10, 5759-5783.*

Jovasevic-Stojanovic, M., Bartonova, A. Current state of particulate matter research and management in Serbia. *Chem. Ind. Chem. Eng. Quart., 16, 207-212.*

Kahnert, M. Numerical methods in electromagnetic scattering theory. *J. Quant. Spectro. Radiat. Transfer, 111, 1791-1840. (Reprinted from vol 79, pg 775-824, 2003).*

Karagulian, F., Clarisse, L., Clerbaux, C., Prata, A.J., Hurtmans, D., Coheur, P.F. Detection of volcanic SO_2, ash, and H_2SO_4 using the Infrared Atmospheric Sounding Interferometer (IASI). *J. Geophys. Res., 115, D00L02, doi:10.1029/2009JD012786.*

Karl, M., D'Anna, B., George, C., King, S., Wisthaler, A., Dye, C., Nielsen, C.J. Particle formation in photo-oxidation experiments with 2-aminoethanol (MEA). *Geophys. Res. Abstr., 12, EGU2010-8196.*

Karl, M., Gross, A., Pirjola, L., Leck, C. New particle formation in the high Arctic: observations and model simulations. *Geophys. Res. Abstr., 12, EGU2010-8393.*

Kaurola, J., Lindfors, A., Lakkala, K., Hansen, G., Josefsson, W., Vuilleumier, L., Feister, U., Slaper, H. On the usability of the ERA-40 reanalysis in the estimation of past surface UV radiation over Europe. *J. Geophys. Res., 115, D24107.*

Kim, J., Li, S., Kim,K.-R., Stohl, A., Mühle, J., Kim, S.-K., Park, M.-K., Kang, D.-J., Lee, G., Harth, C.M., Salameh, P.K., Weiss, R.F. Regional atmospheric emissions determined from measurements at Jeju Island, Korea: Halogenated compounds from China. *Geophys. Res. Lett., 37, L12801.*

Kristiansen, N., Stohl, A., Prata, F., Rischter, A., Eckhard, S., Seibert, P., Hoffmann, A., Ritter, C., Bitar, L., Duck, T.J., Stebel, K. Remote sensing and inverse transport modeling of the Kasatochi eruption sulfur dioxide cloud. *J. Geophys. Res., 115, D00L16, doi:10.1029/2009JD013286.*

Kruszewski, M., Dusinska, M., Dobrzynska, M., Gromadzka-Ostrowska, J., Brunborg, G., Lankoff, A., Wojewodzka, M., Sommer, S., Brzoska, K., Meczynska-Wielgosz , S., Rumianek , K., Wojciuk, G., Stepkowski, T., Gradzka, I., Buraczewska, T., Schwarze, P.E., Refsnes, M., Sandberg, W., Asare, N., Instanes, C., Dziendzikowska, K., Oczkowski, M., Krawczynska, A., Gajowik, A., Radzikowska, J., Fjellsbø, L.M., Magdolenova, Z., Rinna, A., Rundén-Pran, E., Hudecova, A., Hasplova, K. Impact of nanomaterials on human health: lessons from in vitro and animal models. *The Parliament Magazine's RESEARCH European Research and Innovation Review, 12, 43.*

Kylin, H., Haglund, K. Screening for antifouling biocides around a pleasure boat marina in the Baltic Sea after legal restrictions. *Bull. Environ. Contam. Toxicol., 85, 402-406.*

Kylin, H., Louette, M., Herroelent, P., Bouwman, H. Nominate Lesser Black-backed Gulls (Larus fuscus fuscus) winter in the Congo basin. *Ornis Fennica, 87, 106-113.*

López-Aparicio, S., Grøntoft, T., Dahlin, E. Air quality assessment in cultural heritage institutions using EWO dosimeters. *e-Preserv. Sci., 7, 96-101.*

Lopez-Aparicio, S., Grøntoft, T., Odlyha, M., Dahlin, E., Mottner, P., Thickett, D., Ryhl-Svendsen, M., Schmidbauer, N., Scharff, M. Measurement of organic and inorganic pollutants in microclimate frames for paintings. *e-Preserv. Sci., 7, 59-70.*

Lundqvist, C., Rugland, E., Clench-Aas, J., Bartonova, A., Hofoss, D. Children are reliable reporters of common symptoms: results from a self-reported symptom diary for primary school children. *Acta Pædiatrica, 99, 1054-1059.*

Madsen, C., Gehring, U., Walker, S.E., Brunekreef, B., Stigum, H., Næss, Ø., Nafstad, P. Ambient air pollution exposure, residential mobility and term birth weight in Oslo, Norway. *Environ. Res., 110, 363-371.*

Mariussen, E., Haukås, M., Arp, H.P.H., Goss, K.U., Borgen, A., Sandanger, T.M. Relevance of 1,2,5,6,9,10-hexabromocyclododecane diastereomer structure on partitioning properties, column-retention and clean-up procedures. *J. Chromatogr. A, 1217, 1441-1446.*

Misik, M., Hoelzl, C., Wagner, K.-H., Cavin, C., Moser, B., Kundi, M., Simic, T., Elbling, L., Kager, N., Ferk, F., Ehrlich, V., Nersesyan, A., Dusinska, M., Schilter, B., Knasmüller, S. Impact of paper filtered coffee on oxidative DNA-damage: results of a clinical trial. *Mutat. Res. Fund. Mol. Mech. Mutagen., 692, 42-48.*

Mwevura, H., Amir, O.A., Kishimba, M., Berggren, P., Kylin, H. Organohalogen compounds in blubber of Indo-Pacific bottlenose dolphin (Tursiops aduncus) and spinner dolphin (Stenella longirostris) from Zanzibar, Tanzania. *Environ. Pollut., 158, 2200-2207.*

Newton, A., Oliveira, P.S., Icely, J.D., Foster, P.A. Monitoring of oxygen condition in the Ria Formosa coastal lagoon, Portugal. *J. Environ. Monit., 12, 355-360.*

Nicolae, D., Vasilescu, J., Carstea, E., Stebel, K., Prata, F. Romanian atmospheric research 3D observatory: synergy of instruments. *Rom. Rep. Phys., 62, 838-853.*

Nishii, K., Nakamura, H., Orsolini, Y. Influence of the Western Pacific pattern on the wintertime Arctic stratosphere. *Geophys. Res. Abstr., 12, EGU2010-3344.*

Nishii, K., Nakamura, H., Orsolini, Y.J. Cooling of the wintertime Arctic stratosphere induced by the western Pacific teleconnection pattern. *Geophys. Res. Lett., 37, L13805, doi:10.1029/2010GL043551.*

Orsolini, Y. J., Urban, J., Murtagh, D., Lossow, S. , Limpasuvan, V. Descent from the polar mesosphere and anomalously high stratopause observed in 8 years of water vapor and temperature satellite observations by the Odin Sub-Millimetre Radiometer. *J. Geophys. Res., 115, D12305, doi:10.1029/2009JD013501.*

Pacyna, E.G., Pacyna, J.M., Sundseth, K., Munthe, J., Kindborn, K., Wilson, S., Steenhuisen, F., Maxson, P. Global emission of mercury to the atmosphere from anthropogenic sources in 2005 and projections to 2020. *Atmos. Environ., 44, 2487-2499.*

Pacyna, J.M., Pacyna, E.G., Sundseth, K., Munthe, J., Wilson, S., Leaner, J. Global emissions of mercury to the atmosphere in 2005 and their 2020 scenarios. *Geophys. Res. Abstr., 12, EGU2010-2761.*

Pacyna, J.M., Sundseth, K., Pacyna, E.G., Jozewicz, W., Munthe, J., Belhaj, M., Astrom, S. An assessment of costs and benefits associated with mercury emission reductions from major anthropogenic sources. *J. Air Waste Manage. Assoc., 60, 302-315.*

Paris, J.-D., Ciais, P., Nédélec, P., Stohl, A., Belan, B.D., Arshinov, M. Yu., Carouge, C., Golitsyn, G., Granberg, I.G. New insights on the chemical composition of the Seberian air shed from the YAK-AEROSIB aircraft campaign. *Bull. Amer. Met. Soc., 91, 625-641.*

Paris, J.-D., Stohl, A., Ciais, P., Nédélec, P., Belan, B.D., Arshinov, M.Y., Ramonet, M. Source-receptor relationships for airborne measurements of CO_2, CO and O_3 above Siberia: a cluster-based approach. *Atmos. Chem. Phys., 10, 1671-1687.*

Paris, J.-D., Stohl, A., Ciais, P., Ramonet, M., Nedelec, P. Relations source-récepteur transcontinentales identifiées avec un modèle Lagrangien de dispersion et une analyse en clusters. *Pollution atmosphérique. Special issue September 2010, 143-148.*

Pikridas, M., Bougiatioti, A., Hildebrandt, L., Engelhart, G.J., Kostenidou, E., Mohr, C., Prévôt, A.S.H., Kouvarakis, G., Zarmpas, P., Burkhart, J.F., Lee, B.-H., Psichoudaki, M., Mihalopoulos, N., Pilinis, C., Stohl, A., Baltensperger, U., Kulmala, M., Pandis, S.N. The Finokalia Aerosol Measurement Experiment - 2008 (FAME-08): an overview. *Atmos. Chem. Phys., 10, 6793-6806.*

Plósz, B.G., Leknes, H., Liltved, H., Thomas, K.V. Diurnal variations in the occurrence and the fate of hormones and antibiotics in activated sludge wastewater treatment in Oslo, Norway. *Sci. Total Environ., 408, 1915-1924.*

Plosz, B.G., Leknes, H., Thomas, K.V. Impacts of competitive inhibition, parent compound formation and partitioning behavior on the removal of antibiotics in municipal wastewater treatment. *Environ. Sci. Technol., 44, 734-742.*

Prata, A.J., Gangale, G., Clarisse, L., Karagulian, F. Ash and sulfur dioxide in the 2008 eruptions of Okmok and Kasatochi: Insights from high spectral resolution satellite measurements. *J. Geophys. Res., 115, D00L18, doi:10.1029/2009JD013556.*

Prata, F., Stohl, A., Tørseth, K., Clarisse, L., Carn, S., Pavalonis, M., Corradini, S., Merucci, L., Piscini, A. Satellite detection of volcanic ash from Eyjafjallajökull and the threat to aviation. *Geophys. Res. Abstr., 12, EGU2010-15732.*

Rylander, C., Sandanger, T.M., Froyland, L., Lund, E. Dietary patterns and plasma concentrations of perfluorinated compounds in 315 Norwegian women: The NOWAC postgenome study. *Environ. Sci. Technol., 44, 5225-5232.*

Saito, S., Yokouchi, Y., Stohl, A., Taguchi, S., Mukai, H. Large emissions of perfluorocarbons in East Asia deduced from continuous atmospheric measurements. *Environ. Sci. Technol., 44, 4089-4095.*

Schuster, J.K., Gioia, R., Breivik, K., Steinnes, E., MacLeod, M., Scheringer, M., Jones, K.C. Trends in European background air reflect reductions in primary emissions of PCBs and PBDEs. *Environ. Sci. Technol., 44, 6760-6766.*

Seibert, P., Eckhardt, S., Kristiansen, N., Prata, F., Richter, A., Stohl, A. Uncertaintines in the inverse modelling of sulphur dioxide eruption profiles. *Geophys. Res. Abstr., 12, EGU2010-12406.*

Sivertsen, B., Bartonova, A. Co-benefit and co-control studies in Norway. *Chem. Ind. Chem. Eng. Quart., 16, 281-286.*

Smolders, R., Bartonova, A., Boogaard, P.J., Dusinska, M., Koppen, G., Merlo, F., Sram, R.J., Vineis, P., Schoeters, G. The use of biomarkers for risk assessment: Reporting from the INTARESE/ ENVIRISK Workshop in Prague. *Int. J. Hyg. Environ. Health., 213, 395-400.*

Sodemann, H., Zubler, E. Seasonal and inter-annual variability of the moisture sources for Alpine precipitation during 1995-2002. *Int. J. Clim., 30, 947-961.*

Solazzo, E., Di Sabatino, S., Aquilina, N., Dudek, A., Britter, R. Coupling mesoscale modelling with a simple urban model: The Lisbon case study. *Boundary-Layer Meteorol., 137, 441-457.*

Som, C., Berges, M., Chaudhry, Q., Dusinska, M., Fernandes, T.F., Olsen, S.I., Nowack, B. The importance of life cycle concepts for the development of safe nanoproducts. *Toxicology, 269, 160-169.*

Sonne, C., Bustnes, J.O., Herzke, D., Jaspers, V.L.B., Covavi, A., Halley, D.J., Moum, T., Eulaers, I., Eens, M., Ims, R.A., Hanssen, S.A., Erikstad, K.E., Johnsen, T., Schnug, L., Riget, F.R., Jensen, A.L. Relationships between organohalogen contaminants and blood plasma clinical-chemical parameters in chicks of three raptor species from Northern Norway. *Ecotoxicol. Environ. Saf., 73, 7-17.*

Stjern, C.W., Stohl, A., Kristjánsson, J.E. Have aerosols affected precipitation variations in Europe? *Geophys. Res. Abstr., 12, EGU2010-8626.*

Stohl, A. Cat out of the bag. Ice-breaking study that could reduce the melt.

Meteorol. Technol. Int., November 2010.

Stohl, A., Kim, J., Li, S., O'Doherty, S., Mühle, J., Salameh, P.K., Saito, T., Vollmer, M.K., Wan, D., Weiss, R.F., Yao, B., Yokouchi, Y., Zhou, L.X. Hydrochlorofluorocarbon and hydrofluorocarbon emissions in East Asia determined by inverse modeling. *Atmos. Chem. Phys., 10, 3545-3560.*

Stohl, A., Kim, J., Li, S., O'Doherty, S., Zhou, L.X., Saito, T., Vollmer, M.K., Wan, D., Yao, B., Yokouchi, Y. Hydrochlorofluorocarbon and hydrofluorocarbon emissions in East Asia determined by inverse modeling. *Geophys. Res. Abstr., 12, EGU2010-1547.*

Stohl, A., Kristiansen, N.I., Eckhardt, S., Burkhart, J.F., Baltensperger, U., Pavolonis, M., Prata, F., Thorsteinsson, T., Tørseth, K. Modeling and forecasting the distribution of volcanic ash from the Eyjafjallajökull eruption. *Geophys. Res. Abstr., 12, EGU2010-15766.*

Stohl, A., Sodemann, H. Characteristics of atmospheric transport into the Antarctic troposphere. *J. Geophys. Res., 115, D02305, doi:10.1029/2009JD012536.*

Stone, V., Nowack, B., Baun, A., van den Brink, N., von der Kammer, F., Dusinska, M., Handy, R., Hankin, S., Hassellöv, M., Joner, E., Fernandes, T.F. Nanomaterials for environmental studies: Classification, reference material issues, and strategies for physico-chemical characterisation. *Sci. Total Environ., 408, 1745-1754.*

Sundseth, K., Pacyna, J.M., Pacyna, E.G., Munthe, J., Belhaj, M., Aström, S. Economic benefits from decreased mercury emissions: Projections for 2020. *J. Clean. Prod., 18, 386-394.*

Svensen, H., Planke, S., Fristad, K., Polozov, A., Schmidbauer, N. Pipe formation and degassing from the Tunguska Basin in East Siberia and the consequences for the end-Permian environment. *Geophys. Res. Abstr., 12, EGU2010-13916.*

Terushkin, V., Bender, A., Psaty, E.L., Engelsen, O., Wang, S.Q., Halpern, A.C. Estimated equivalency of vitamin D production from natural sun exposure versus oral vitamin D supplementation across seasons at 2 U.S. latitudes. *J. Am. Acad. Dermatol., 62, 929.e1-929.e9.*

Theloke, J., Breivik, K., van der Gon, H.D., Kugler, U., Li, Y-F., Pacyna, J., Panasiuk, D., Sundseth, K., Sweetman, A., Tao, S. POP emission inventories on different scales and their future trends. *Geophys. Res. Abstr., 12, EGU2010-12486.*

Trickl, T., Feldmann, H., Kanter, H.-J., Scheel, H.-E., Sprenger, M., Stohl, A., Wernli, H. Forecasted deep stratospheric intrusions over Central Europe: case studies and climatologies. *Atmos. Chem. Phys., 10, 499-524.*

Urban, J., Murtagh, D., Brohede, S., Lossow, S., Khosravi, M., Orsolini, Y. Observations of chemical and dynamical processes in the polar stratosphere by the Odin satellite: the 2009-2010 northern hemisphere winter compared to earlier years. *Geophys. Res. Abstr., 12, EGU2010-9874.*

Vaktskjold, A., Tri, D.V., Odland, J.Ø., Sandanger, T. Parity and birth weight in the Khanh Hoa province, Vietnam. *Open Wom. Health J., 4, 1-4.*

Vaktskjold, A., Tri, D.V., Phi, D.T., Sandanger, T. Stunted growth in a cohort of two-year olds in the Khanh Hoa province in Vietnam - a follow-up study. *J. Rural Trop. Publ. Health, 9, 77-81.*

Vaktskjold, A., Tri, D.V., Phi, D.T., Sandanger, T.M. Infant growth disparity in the Khanh Hoa province in Vietnam: a follow-up study. *BMC Pediatrics, 10, 62.*

van Gijsel, J.A.E., Swart, D.P.J., Baray, J.-L., Bencherif, H., Claude, H., Fehr, T., Godin-Beekmann, S., Hansen, G.H., Keckhut, P., Leblanc, T., McDermid, I.S., Meijer, Y.J., Nakane, H., Quel, E.J., Stebel, K., Steinbrecht, W., Strawbridge, K.B., Tatarov, B.I., Wolfram, E.A. GOMOS ozone profile validation using ground-based and balloon sonde measurements. *Atmos. Chem. Phys., 10, 10473-10488.*

Vieno, M., Dore, A.J., Stevenson, D.S., Doherty, R., Heal, M. R., Reis, S., Hallsworth, S., Tarrason, L., Wind, P., Fowler, D., Simpson, D., Sutton, M.A. Modelling surface ozone during the 2003 heat-wave in the UK. *Atmos. Chem. Phys., 10, 7963-7978.*

Viscardy, S., Lahoz, W., Errera, Q. The 2009 stratospheric major warming described from synergistic use of BASCOE water vapour analyses and EOS Aura MLS observations. *Geophys. Res. Abstr., 12, EGU2010-11668.*

Warneke, C., Froyd, K.D., Brioude, J., Bahreini, R., Brock, C.A., Cozic, J., de Gouw, J.A., Fahey, D.W., Ferrare, R., Holloway, J.S., Middlebrook, A.M., Miller, L., Montzka, S., Schwarz, J.P., Sodemann, H., Spackman, J.R., Stohl, A. An important contribution to springtime Arctic aerosol from biomass burning in Russia. *Geophys. Res. Lett., 37, L01801, doi:10.1029/2009GL041816.*

Warner, N., Evenset, A., Christensen, G., Gabrielsen, G.W., Borgå, K., Leknes, H. Volatile siloxanes in the European Arctic: assessment of sources and spatial distribution. *Environ. Sci. Technol., 44, 7705-7710.*

Xiao, X., Prinn, R.G., Fraser, P.J., Simmonds, P.G., Weiss, R.F., O'Doherty, S., Miller, B.R., Salameh, P.K., Harth, C.M., Krummel, P.B., Porter, L.W., Mühle, J., Greally, B.R., Cunnold, D., Wang, R., Montzka, S.A., Elkins, J.W., Dutton, G.S., Thompson, T.M., Butler, J.H., Hall, B. D., Reimann, S., Vollmer, M.K., Stordal, F., Lunder, C., Maione, M., Arduini, J., Yokouchi, Y. Optimal estimation of the surface fluxes of methyl chloride using a 3-D global chemical transport model. *Atmos. Chem. Phys., 10, 5515-5533.*

Zhang, D., Aunan, K., Seip, H.M., Larssen, S., Liu, J., Zhang, D. The assessment of health damage caused by air pollution and its implication for policy making in Taiyuan, Shanxi, China. *Energy Policy, 38, 491-502.*

Zhang, X., Brown, T.N., Wania, F., Heimstad, E.S. Goss, K-U. Assessment of chemical screening outcomes based on different partitioning property estimation methods. *Environ. Int., 36, 514-520.*

Zieger, P., Fierz-Schmidhauser, R., Gysel, M., Ström, J., Henne, S., Yttri, K.E., Baltensperger, U., Weingartner, E. Effects of relative humidity on aerosol light scattering in the Arctic. *Atmos. Chem. Phys., 10, 3875-3890.*

Zieger, P., Fierz-Schmidhauser, R., Gysel, M., Ström, J., Henne, S., Yttri, K.E., Baltensperger, U., Weingartner, E. Effects of relative humidity on aerosol light scattering in the Arctic. *Geophys. Res. Abstr., 12, EGU2010-4818.*

Zimanova, J., Batora, I, Dusinska, M., Burghardtova, K., Blazicek, P., Vojtech, I. The effect of repeated hyperbaric oxygen therapy on total antioxidant status of organism. *Rehabilitacia, 47, 2, 80-89.*

Scientific reports

OR - 2010 N = the report is in Norwegian

Slørdal, L.H., Sundvor, I. (2010) Calculated effects of abatement measures on the exposure levels of PM2,5/PM10 in Oslo and PM10 in Trondheim for 2020. Kjeller, NILU (NILU OR, 01/2010). N

Gjerstad, K.I., Liu, L. (2010) Calculation of dispersion and deposition, April 2008 - April 2009. Kjeller, NILU (NILU OR, 02/2010). N

Haugsbakk, I. (2010) Monitoring meteorological and air quality parameters in Sauda during the period of 01.04.-30.09.2009. Kjeller, NILU (NILU OR, 03/2010). N

Slørdal, L.H., Sundvor, I. (2010) Revision of the time variation of traffic emissions in AirQUIS. Kjeller, NILU (NILU OR, 04/2010). N

Sundvor, I. (2010) Status report. 1 July 2009 - 1 October 2009. Environmental surveillance of emissions to air from Snøhvit-Hammerfest LNG. Kjeller, NILU (NILU OR, 05/2010). N

Randall, S. (2010) Air quality in the classroom. 2009 Scandinavian student-based research campaign. Kjeller, NILU (NILU OR, 06/2010).

Tønnesen, D. (2010) Dust deposition at Lunckefjell. Kjeller, NILU (NILU OR, 07/2010). N

Nielsen, C.J., D'Anna, B., Dye, C., George, C., Graus, M., Hansel, A., Karl, M., King, S., Musabile, M., Muller, M., Schmidbauer, N., Stenstrøm, Y., Wisthaler, A. (2010) Atmospheric Degradation of Amines (ADA). Summary report: Gas phase photo-oxidation of 2-aminoethanol (MEA) CLIMIT project no. 193438. Kjeller, NILU (NILU OR, 08/2010).

Berglen, T.F., Tønnesen. D.A. (2010) Dispersion calculations from new Hot Oil Heater at Kollsnes Processing Plant. Kjeller, NILU (NILU OR, 09/2010). N

Haugsbakk, I., Tønnesen, D. (2010) Dispersion calculations from fragmentation facility at Eigersund. Kjeller, NILU (NILU OR, 10/2010). N

Tønnesen, D. (2010) Measurements of emissions and dispersion calculations for solvents at Weifa AS. Kjeller, NILU (NILU OR, 11/2010). N

Haugsbakk, I. (2010) Calculating air quality at Rødbøl and Bommestad schools in Larvik county. Kjeller, NILU (NILU OR, 12/2010). N

Randall, S. (2010 Air quality in the classroom. 2009 Scandinavian student-based research campaign. Kjeller, NILU (NILU OR, 13/2010). N

Haugsbakk, I. (2010) Monitoring air quality at Mosjøen. SO2 , PM10 and PAH. Kjeller, NILU (NILU OR, 14/2010). N

Randall, S. (2010) Summary Report: Air Quality in the Classroom. 2009 Scandinavian student-based research campaign. Kjeller, NILU (NILU OR, 15/2010).

Haugsbakk, I., Tønnesen, D. (2010) Tromsøsundtunnelen. Evaluating air quality around openings of tunnel and ventilation tower. Kjeller, NILU (NILU OR, 16/2010). N

Dauge, F.R., Marsteen, L., Guerreiro, C.B. (2010) Quality manual. Kjeller, NILU (NILU OR, 17/2010).

Sivertsen, B. (2010) Reporting air quality in Dakar, Senegal. Kjeller, NILU (NILU OR, 18/2010).

Sivertsen, B., Ndiaye, A., Diop, M. (2010) Air quality monitoring in Dakar. Monthly report no 01/2010. Kjeller, NILU (NILU OR, 19/2010).

Diokhane, A.M., Dam, V.T., Guerreiro, C. (2010) Air quality web portal in Dakar. Operational and editoral procedures. Kjeller, NILU (NILU OR, 20/2010).

Sivertsen, B. (2010) Luftkvalitetsovervåking, Abu Dhabi. Evaluering og utvidelse av programmet. Kjeller, NILU (NILU OR, 21/2010).

Barrett, K. (2010) Deposition of air pollutants around the North Sea and the North-East Atlantic in 2008. Kjeller, NILU (OSPAR monitoring and assessment, 511/2010) (NILU OR, 22/2010).

Marsteen, L. (2010) Supporting the Ethekwini air quality monitoring network in preparations for accreditation. Kjeller, NILU (NILU OR, 23/2010).

Myhre, C.L., Hermansen, O., Fjæraa, A.M., Lunder, C., Schmidbauer, N., Stebel, K., Prata, F. (2010) Greenhouse monitoring at the Zeppelin station - annual report 2008. Kjeller, NILU (Statlig program for forurensningsovervåking. Rapport 1071/2010. TA 2633/2010) (NILU OR, 24/2010).

Gjerstad, K.I. (2010) Status report. 1 October 2009 - 1 January 2010. Environmental surveillance of emissions to air from Snøhvit-Hammerfest LNG. Kjeller, NILU (NILU OR, 25/2010). N

Berglen, T.F., Arnesen, K. (2010) Esso Slagentangen - Monitoring report 2009. Kjeller, NILU (NILU OR, 26/2010). N

Hak, C. (2010) Planning ambient air pollution screening study in Burgas, Bulgaria. Winter 2009/2010. Kjeller, NILU (NILU OR, 27/2010).

Liu, H-Y., Bartonova, A., Dusinska, M. (2010) INTARESE Revised integrated monitoring. Kjeller, NILU (NILU OR, 28/2010).

Bartonova, A., Liu, H-Y. (2010) INTARESE Workshop report on integrated monitoring. Kjeller, NILU (NILU OR, 29/2010).

Costa, D., Haugen, A., Kopangen, M., Randall, S. (2010) Expert review of project description: Experimental studies investigating the risks of select amines (Part A: Human toxicity). Kjeller, NILU (NILU OR, 30/2010).

Haugsbakk, I. (2010) Dispersion calculations of NO2 emission and stack height calculations from a gas fueled incinerator at Vennesla. Kjeller, NILU (NILU OR, 31/2010). N

Tønnesen, D. (2010) Indoor air measurement. Invitrogen Dynal AS. Kjeller, NILU (NILU OR, 32/2010).

Aas, W., Solberg, S., Manø, S., Yttri, K.E. (2010) Monitoring of long-range transported air pollutants. Annual report for 2009. Kjeller, NILU (Statlig program for forurensningsovervåking. Rapport 1074/2010. TA-2664/2010) (NILU OR, 33/2010). N

Gjerstad, K.I. (2010) Status report. 1 January 2010 - 1 April 2010. Environmental surveillance of emissions to air from Snøhvit-Hammerfest LNG. Kjeller, NILU (NILU OR, 34/2010). N

Berglen, T.F., Andresen, E., Arnesen, K., Kalvenes, Ø., Ofstad, T., Rode, A., Tønnesen, D.A., Uggerud, H.T., Vadset, M. (2010) Air quality monitoring in the border areas of Norway and Russia - progress report April 2009 - March 2010. Kjeller, NILU ((Statlig program for forurensningsovervåking. Rapport 1082/2010) (TA-2730/2010)) (NILU OR, 35/2010). N

Negrente, E., Liu, H.-Y., Neofytou, P., Bartonova, A. (2010) HENVINET. Review of decision support tools, recommendations. Kjeller, NILU (NILU OR, 36/2010).

van den Hazel, P., Liu, H.-Y., Bartonova, A. (2010) HENVINET. Information materials for external users and dissemination plan. Kjeller, NILU (NILU OR, 37/2010).

Hak, C. (2010) Chemical speciation of trace metals in fine airborne particles in Abu Dhabi. Results from Hamdan, Khalifa

and Baniyas stations. Kjeller, NILU (NILU OR, 38/2010).

Hak, C., Sivertsen, B. (2010) Mission Report. Burgas, 1-12 March 2010 - Screening Study. Kjeller, NILU (NILU OR, 39/2010).

Hak, C., Sivertsen, B. (2010) Ambient air pollution screening study in Burgas March 2010. Kjeller, NILU (NILU OR, 40/2010).

Berglen, T.F., Tønnesen, D., Dye, C., Karl, M., Knudsen, S., Tarrasón, L. (2010) CO2 Technology Centre Mongstad - updated air dispersion calculations. Update of OR 12/2008. Kjeller, NILU (NILU OR, 41/2010).

Dahlin, E. (ed.). (2010) PROPAINT. Improved protection of paintings during exhibition, storage and transit. Final activity report. Kjeller, NILU (NILU OR, 42/2010).

Liu, H-Y., Bartonova, A. (2010) INTARESE. Integrated monitoring and its materials for toolbox. In press. Kjeller, NILU (NILU OR, 43/2010).

Hazel, P. van den, Liu, H.-Y., Bartonova, A., Grossberndt, S. (eds.). (2010) HENVINET. Report on raising public participation and awareness and report from final project meeting. Kjeller, NILU (NILU OR, 44/2010).

Haugsbakk,I., Guerreiro, C. (2010) Granfosslinjen. Evaluation of air pollution from tunnel outlets. Kjeller, NILU (NILU OR, 45/2010). N

Tønnesen, D., Haugsbakk, I. (2010) Emission of heavy metals from the aluminum industry in Norway. Kjeller, NILU (NILU OR, 46/2010). N

Randall, S. (2010) CO2nnect. CO2 on the way to school: Campaign data analysis. Kjeller, NILU (NILU OR, 47/2010).

Lopez-Aparicio, S. (2010) Indoor air quality in the Lithuanian Theatre, Music and Cinema Museum. Environmental monitoring and air quality assessment. Kjeller, NILU (NILU OR, 48/2010).

Sivertsen, B., Guerreiro, C., LY, I. (2010) Air quality standards for Senegal. Kjeller, NILU (NILU OR, 49/2010).

Guerreiro, C. (2010) Final project report. Kjeller, NILU (NILU OR, 50/2010).

Tønnesen, D. (2010) Urban air pollution 2000-2015. Results from monitoring and modeling in Oslo and Trondheim. Kjeller, NILU (NILU OR, 51/2010).

Guerreiro, C., Dam, V.T. (2010) Preliminary results from air quality modelling in Dakar. Kjeller, NILU (NILU OR, 52/2010).

Guerreiro, C., Dam, V.T. (2010) A bottom-up air pollution emission inventory for Dakar. Kjeller, NILU (NILU OR, 53/2010).

Legendre, B., Guerreiro, C. et Sivertsen, B. (2010) Recommendations pour assurer la durabilité du Centre de Gestion de la Qualité de l'Air. Kjeller, NILU (NILU OR, 54/2010).

Sundseth, K. (2010) HEIMTSA. A baseline scenario for a business-as-usual development of all relevant activities. In press. Kjeller, NILU (NILU OR, 55/2010).

Sundseth, K. (2010) HEIMTSA. First Draft of a list of policies which HEIMTSA will take into account, with special reference to case study pollutants. In press. Kjeller, NILU (NILU OR, 56/2010).

Haugsbakk, I. (2010) Dispersion calculations of NO2 emission and stack height calculations from a bio fueled incinerator at Sarpsborg. Kjeller, NILU (NILU OR, 57/2010). N

Karl, M., Lopez-Aparicio, S. (2010) Test of the NILU fog chamber as experiment reactor for droplet growth. Kjeller, NILU (NILU OR, 58/2010).

Haugsbakk, I. (2010) Dispersion calculations of SO2 emission and stack height calculations from a sulphur reduction facility at Fredrikstad. Kjeller, NILU (NILU OR, 59/2010). N

Karl, M. (2010) Atmospheric Degradation of Amines (ADA). Amines in aerosol - A review. CLIMIT project no. 201604. Kjeller, NILU (NILU OR, 60/2010).

Randall, S., Kobernus, M., Yang, A., Bartonova, A. (2010) HENVINET Networking Portal. Design specifications and extensions (Final report for Deliverable 2.6). Kjeller, NILU (NILU OR, 61/2010).

Sivertsen, B., Randall, S., Marsteen, L. (2010) Bangladesh Air Pollution Management (BAPMAN). Mission 1 Report. Dhaka, 27 July - 6 August 2010. Kjeller, NILU (NILU OR, 62/2010).

Randall, S. (2010) CO2nnect. CO2 on the way to school: Campaign data analysis summary report. Kjeller, NILU (NILU OR, 63/2010).

Haugsbakk, I. (2010) Monitoring meteorological and air quality parameters in Sauda during the period of 01.10.2009-31.03.2010. Kjeller, NILU (NILU OR, 64/2010). N

Gjerstad, K.I. (2010) Status report. 1 April 2010 - 1 July 2010. Environmental surveillance of emissions to air from Snøhvit-Hammerfest LNG. Kjeller, NILU (NILU OR, 65/2010). N

Tønnesen, D. (2010) Dust deposition at Lunckefjell. Kjeller, NILU (NILU OR, 66/2010). N

Hak, C., Sivertsen, B., Dye, C., Uggerud, H.T., Yttri, K.E. (2010) Chemical speciation of trace metals in fine airborne particles in Abu Dhabi. Results from six Abu Dhabi stations - Hamdan, Khalifa, Baniyas, Al Ain Street, Liwa and Bida Zayed. Kjeller, NILU (NILU OR, 67/2010).

Lopez-Aparicio, S., Grøntoft, T., Bernardi, A., Becherini, F., Bonazza, A. (2010) TeACH. Construction of a new compact soiling and dust dosimeter for indoor measurements. Deliverable D2.5. Kjeller, NILU (NILU OR, 68/2010).

Randall, S., Yang, A., Kobernus, M., Bartonova, A. (2010) HENVINET technical tools (Final report for Work Package 2). Kjeller, NILU (NILU OR, 69/2010).

El-Araby, T. (2010) Air Quality in Abu Dhabi. 2009 Annual Report. Kjeller, NILU (NILU OR, 70/2010).

Denby, B., Yttri, K.E., Larssen, S., Fiebig, M., Hak, C., Berger, J. Tørnkvist, K. (2010) Description of a measurement campaign for the development and validation of a non-exhaust PM traffic emisson model. In press. Kjeller, NILU (NILU OR, 71/2010).

Haugsbakk, I. (2010) Dispersion calculations of NO2 emission and stack height calculations from Kongsvinger Bioenergi AS, Kongsvinger. Kjeller, NILU (NILU OR, 72/2010). N

Grøntoft, T., López-Aparicio, S., Schmidbauer, N., Andresen, E., Hammerseth, G. (2010) Air quality measurements in the Sukiennice. Measurements in the Sukiennice, "Cloth Hall", in Krakow, Poland, after renovation, spring 2010. Kjeller, NILU (NILU OR, 73/2010).

Aparicio, S.L., Grøntoft, T. (2010) Environmental monitoring and evaluation of the indoor environment in the Baroque Library Hall of the National Library (Czech Republic). Indoor air quality assessment of the Baroque Library Hall. Kjeller, NILU (NILU OR, 74/2010).

Hak, C., Denby, B., Bartonova, A., Yttri, K.E. (2010) Description of a measurement campaign for the development and validation of a non-exhaust PM traffic emisson model. In press. Kjeller, NILU (NILU OR, 75/2010).

Dahlin, E., ed. (2010) MASTER. Preventive conservation strategies for protection of organic objects in museums, historic buildings and archives. Final report. Kjeller, NILU (NILU OR, 76/2010).

Liu, L., Tønnesen, D. (2010) Mission report. Air quality management feasibility study for Yerevan, Armenia. In press. Kjeller, NILU (NILU OR, 77/2010).

Haugsbakk, I., Tønnesen, D. (2010) Revised dispersion calculations of NO2 emissions from a boilers at Kallerud, Gjøvik. Kjeller, NILU (NILU OR, 78/2010). N

Berglen, T.F., Dauge, F., Andresen, E., Arnesen, K., Bäcklund, A., Bjerke, A., Hansen, T., Kalvenes, Ø., Manø, S., Schmidbauer, N., Tønnesen, D., Uggerud, H.T., Vadset, M. (2010) Kollsnes processing plant. Monitoring programme 2008-2009, air quality and precipitation. Kjeller, NILU (NILU OR, 79/2010). N

Grossberndt, S., Bartonova, A. (eds.). (2010) HENVINET Final Event. Approaching Complexities in Environment and Health, 14-15 April 2010, Brussels. Book of Abstracts. Kjeller, NILU (NILU OR, 80/2010).

Haugsbakk, I., Tønnesen, D. (2010) Revised dispersion calculations of dust emissions from a refinement process at Eramet Norway AS in Sauda. Kjeller, NILU (NILU OR, 81/2010). N

Hak, C., Gjerstad, K.I., Yttri, K.E. (2010) Measurement data. July 2009 - June 2010. Environmental monitoring of emissions to air from Snøhvit-Hammerfest LNG. Kjeller, NILU (NILU OR, 82/2010). N

Knudsen, S., Cassiani, M., Karl, M., Slørdal, L.H., Tarrasón, L. (2010) CO2 Capture Mongstad Project/H&ETQPAmine2. Modelling atmospheric dispersion for components from post combustion amine based CO2 capture. Kjeller, NILU (NILU OR, 83/2010).

Randall,S., Sivertsen, B., Dam, V.T., Gjerstad, K.I. (2010) Bangladesh Air Pollution Management (BAPMAN). Emission inventory training seminar. NILU, 25 - 29 October 2010. Kjeller, NILU (NILU OR, 84/2010).

Myhre, C.L., Edvardsen, K., Stebel, K., Svendby, T.M., Engelsen, O., Johnsrud, M., Dahlback, A. (2010) Monitoring of the atmospheric ozone layer and natural ultraviolet radiation. Annual report 2009. Kjeller, NILU (Statlig program for forurensningsovervåking. Rapport 1080/2010. TA-2725/2010) (NILU OR, 85/2010).

Haugsbakk, I. (2010) Monitoring particulate matter from stone crushing facility at O.C. Østraat at Sviland in Rogaland during period 25.02-06.09-2010. Kjeller, NILU (NILU OR, 86/2010). N

Haugsbakk, I., Tønnesen, D. (2010) Air quality at Geiranger. Summer 2010. Kjeller, NILU (NILU OR, 87/2010). N

Haugsbakk, I., Tønnesen, D. (2010) Dispersion calculations of NH3 to ambient air from a cooling unit at Leangen sport facility in Trondheim. Kjeller, NILU (NILU OR, 88/2010). N

Yang, A., Bartonova, A. (eds.). (2010) HENVINET. Second annual review of research and best practice. Kjeller, NILU (NILU OR, 89/2010).

Knudsen, S., Narayansamy, M. (2010) Storage and reporting of odd samples. Kjeller, NILU (NILU OR, 90/2010).

Knudsen, S., Ngema, P. (2010) Benzene in eThekwini. Concentrations in air. Kjeller, NILU (NILU OR, 91/2010).

Knudsen, S., Maharaj, S. (2010) Flaring from refineries. Environmental impacts and quality of life. Kjeller, NILU (NILU OR, 92/2010).

www.nilu.no

NILU – Norsk institutt for luftforskning
NILU main office
P.O.B 100
NO-2027 Kjeller
Norway
Visit adress: Instituttveien 18, Kjeller
Telephone 63 89 80 00
Fax number 63 89 80 50
E-mail nilu@nilu.no
www.nilu.no
NILU in the Fram Centre
Hjalmar Johansens gate 14
NO-9296 Tromsø
Norway
Telephone 77 75 03 75
Fax number 77 75 03 76
E-post nilu@nilu.no
www.nilu.no

NILU UAE
Zayed University Area - Street No. 10,
Postboks 34137
Abu Dhabi, UAE.
The United Arab Emirates
Telehone 971-2-445 00 88
Fax number +971-2-445 00 83
E-mail tnt@nilu.no
www.nilu.no

NILU Polska Sp. z o.o.
ul. Ceglana 4
40-514 Katowice
Poland
Telephone +48 32 257 08 58
Fax number +48 32 257 08 58
E-mail nilu@nilu.pl
www.nilu.pl

978-82-425-2413-3 (print)
978-82-425-2414-0 (electronic)