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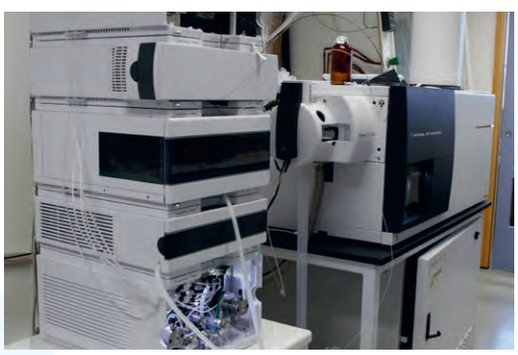
Annual report 2012

Greenhouse gas levels - no sign of improvement
Page 6

Ash detection no longer in the clouds
Page 18

Contents



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Front page: Clouds over Tenerife. The picture has been taken during installation of equipment measuring content of African desert sand in the air. Photo: Adam Durant, NILU.

Small pictures:
NILU's observatory on Zeppelin Mountain close to Ny-Ålesund, Svalbard. Photo: Ove Hermansen, NILU.
AVOID ash detector mounted at the AIRBUS 340-300 test plane. Photo: Fred Prata, NILU.

Internationalising research

The importance of international collaboration in research is increasingly recognised nationally, and is fundamental to the development of our society. International collaboration takes time to establish. It requires that the parties have something substantial to contribute with and networking is essential. The individual researchers' contribution to the networks is not only of a professional nature, it is also based on individual characteristics. Hence, insight and a long term strategy are the essence.

Over many years, NILU has gained experience in coordinating international research projects. Internationalisation is in itself reinforcing; the likelihood of funding increases with the quality of research and network building. NILU's international projects, funded in international currencies, contribute to more than 30% of our annual budget. In addition most of our national projects have an international link which gives an added value nationally.

So, is the way to international success plain sailing? Not quite: In Norway, costs are a challenge and the financial situation in Europe is likely to exacerbate this. The consequence may be fewer opportunities to coordinate projects and lesser possibilities for Norwegian scientists to participate in EU research.

International research departments

A new concept for NILU is the development of international research departments. The first NILU research department outside Norway is established in Abu Dhabi, housed at Abu Dhabi University. Read more about it in this annual report.

Benefit for the society

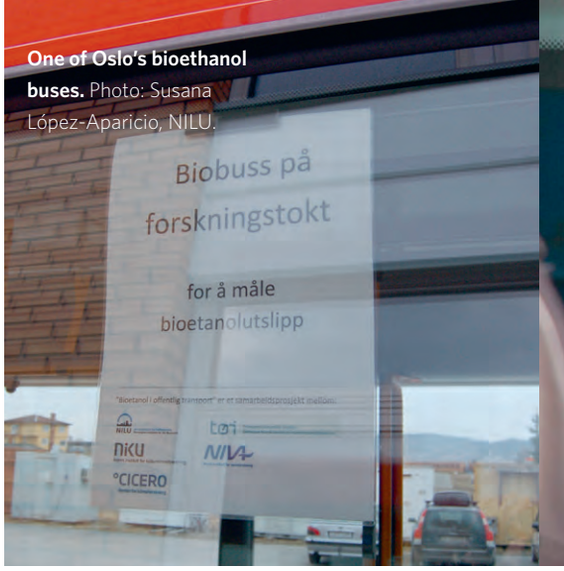
Is there a key to international success? In addition to high professional standards and recruiting expertise internationally, it is necessary to demonstrate that the research is useful to the society. Co-financed with the Climate and Pollution Agency and the Ministry of the Environment, NILU has generated long time series from its surveillance programmes for air quality and climate. The results are reported as a part of Norway's international commitment. Through decades NILU has developed databases, adding value by making these time series accessible for research and international collaboration. One example of the significance of long time series in climate research is the incorporation of Norwegian time series into the international time series from our observatories, the so called super sites in Ny-Ålesund and at Birkenes.

For many years, NILU has been an important contributor to conventions and environmental agreements, by providing data and knowledge generated through research and surveillance. In this annual report, you can read that research works: The depletion of the ozone layer is slowing down and a binding agreement to reduce the use and emissions of mercury has been agreed by the UN countries.

Photo: Ingar Næss

Kari Nygaard,
Managing Director

Measuring acetaldehyde in Oslo. Photo: Susana López-Aparicio, NILU.



One of Oslo's bioethanol buses. Photo: Susana López-Aparicio, NILU.

Bioethanol –

Bioethanol has become increasingly popular as a sustainable fuel alternative to reduce greenhouse gas emissions. But how clean is bioethanol? Will it reduce air pollution or only make it worse? NILU has taken a closer look.

Susana López-Aparicio
Senior Scientist

American novelist Jennifer Egan wrote "Vinegar; that's what fear smells like". We cannot rely on odour to define potential hazardous exposure, but it was the smell of vinegar which triggered this project. Everything started in some Oslo streets, where a strong pungent smell of acetic acid was noticed at regular intervals. It became apparent that the smell was associated with buses, in particular, with the exhaust from the bioethanol buses.

Bioethanol is a liquid biofuel produced by fermenting plants containing starch, sugar or cellulose. When used as engine fuel, bioethanol is commonly blended with petrol in different proportions (e.g. E95; 95% ethanol and 5% petrol). Bioethanol has become popular as it is thought to be a sustainable source of energy which can help to reduce our emissions of greenhouse gases.

- solution or dead end?

Susana López-Aparicio. Photo: Ingunn Trones, NILU.

Bioethanol and air quality

Combustion of bioethanol may have consequences for air quality. One of the main issues associated with alcohol fuels is that they oxidize to aldehydes, and thereby the ethanol molecules oxidize to acetaldehyde. The exhaust from bioethanol fuelled vehicles is expected to contain unburned ethanol, acetaldehyde and acetic acid as oxidation products. Some studies even report a 500% increase of acetaldehyde emissions for fuel blends with more than 70% ethanol, when compared with pure petrol.

Acetaldehyde is suspected of harming human health as it might be carcinogenic, a respiratory toxin and an irritant. In addition, acetaldehyde contributes to the formation of peroxyacetyl nitrate (PAN), a secondary pollutant present in photochemical smog, an oxidant and a mutagen considered hazardous. Acetic acid, on the other hand, is a source of odour complaints and thus affects human comfort. Moreover, acetic acid is known to be corrosive to different types of metals and carbonaceous materials, speeding up degradation and increasing maintenance cost.

En route to science

In order to shed light on and contribute to the understanding of emissions from bioethanol combustion, an innovative study was designed in order to look at individual compounds associated with the emissions from bioethanol buses. The plan was to determine differences in ambient concentration between locations exposed and not exposed to the circulation of bioethanol buses. From a methodological point of view, it was challenging and sometimes even impossible to determine the subtle differences. Ambient acetaldehyde measurements were taken at locations both exposed to and not exposed to bioethanol buses. The lowest concentrations were observed at the locations that were not exposed to bioethanol buses. To compensate for the rather low number of sampling locations – there were six in all – we performed additional measurements of the exhaust under on-road driving conditions.

Exceptionally high concentrations of acetaldehyde

The online monitoring of Volatile Organic Compounds (VOC's) with a PTR-TOF showed that ethanol, acetaldehyde and acetic acid are the compounds with the highest concentrations in the exhaust of bioethanol buses, especially during idling conditions and when the catalyst cools down. The acetaldehyde concentration measured in the exhaust of the bioethanol buses is exceptionally high (100-250 ppm: idling conditions), indicating that acetaldehyde concentration may be a health concern. Acetic acid concentrations in the exhaust of the bioethanol buses were above irritating odour threshold values for all situations of on-road driving conditions.

Both acetaldehyde and acetic acid in the dispersion plume and at close distance from the bioethanol bus were estimated. The US Environmental Protection Agency established that when breathing air contains 5 $\mu g/m^3$ of acetaldehyde, there is an increased chance of developing cancer of one-in-a-hundred thousand. Acetaldehyde concentrations estimated in our study were above 50 $\mu g/m^3$, indicating an increased chance of developing cancer of one-in-ten thousand for an individual who continuously breathes the air around the bioethanol bus during his entire life. Acetic acid estimated in the dispersion plume is above odour threshold levels, explaining the odour noticed and associated with the passage of bioethanol buses.

Co-benefit analyses needed when combating GHG emissions

This study is an example of how climate change policies, like shifting from fossil fuels to biofuels, need to be carefully assessed. There may be unintended disadvantages, as in this case, where the change was shown to have a negative impact on local air quality. Our results support previous studies which show higher emissions of acetaldehyde associated with bioethanol fuelled vehicles. The results were obtained from on-road driving conditions of a specific bioethanol bus and from a few ambient measurements in Oslo, where only one bus line running on bioethanol is in operation; therefore the results may be especially relevant in cities with a bigger fleet of bioethanol vehicles, e.g. in USA, Brazil or Sweden.

Greenhouse gas levels – no sign of

CO_2-levels at Svalbard reached 400 ppm for the first time in March 2012. A new report by NILU into the levels of other greenhouse gases gives little ground for optimism.

Hilde Syversen
Journalist

"Concentrations of all the main climate gasses are increasing", says Senior Scientist Cathrine Lund Myhre at NILU. She is responsible for measuring greenhouse gases at the Zeppelin station at Svalbard, and has analysed material from this research station and the NILU observatory at Birkenes on the south coast of Norway. The work was carried out on behalf of the Norwegian Climate and Pollution Agency, Klif, and published in the report "Monitoring of greenhouse gases and aerosols at Svalbard and Birkenes: Annual report 2011", which was published in spring 2013.

Most significant greenhouse gas

The most significant greenhouse gas is CO_2. It has the highest emission rates and a very long life span. It is also the greenhouse gas which has had the largest impact on the global temperature change, and highest so called radiative forcing since pre industrial times. According to the UN Meteorological Organization, WMO, CO_2 levels in the atmosphere have increased from 280 ppm in the pre industrialised era to 390 ppm in 2011.

The Kyoto agreement to reduce CO_2 emissions is divided into two periods. The first period, 2008 to 2012, stipulates a stabilisation and reduction in CO_2 emissions by the end of that period. Despite this, NILU's figures show an increase of 2.2 ppm (parts per million) from 2010-2011. This is an increase of roughly the same magnitude as for previous years. The Zeppelin average for the last ten years is an annual increase of 2.2 ppm.

"The CO_2 level is increasing, and the rate of increase does not seem to be falling either. We have not finished analysing the figures from 2012 yet, but the measurements are clearly up on the previous year", says Lund Myhre. She is not surprised that the Zeppelin reading for March 2012 was yet another all-time high. Still, this record is particularly significant.

Crossed the 400 ppm threshold

"It was the first time we had registered an annual monthly reading of over 400

NILU's observatory on Zeppelin Mountain is continuously measuring 23 climate gases in the air. Photo: Ove Hermansen, NILU.

f improvement

ppm. Also, this was happening at other research stations in North America and northern Canada. An global annual average of 400 ppm is also the international target limit set for the two degree target", Lund Myhre points out.

The so-called two degree target is the aim to keep the world average temperature from raising more than two degrees compared to the average temperature before industrialisation started in the 18th century. These are average values, and for some parts of the earth the temperature increase is greater, for example in the Arctic.

According to Lund Myhre, the preliminary figures for 2012 look set to stay below 400 ppm, with an annual average of 392.5 ppm for Zeppelin and 390.9 ppm globally.

"If emissions carry on at the same rate, without significant changes in CO_2 uptake, for instance by sea or vegetation, the 400 ppm annual limit will be reached sometime around year 2016. CO_2 levels in the northern hemisphere are highest in spring, because the environment does not absorb CO_2 in the winter to the same degree as it does in the summer", says Lund Myhre.

Calls for sharper focus

She continues: "We had hoped that this threshold would not be reached, but as it has been reached, it is important to draw attention to this. Perhaps this could prompt a new debate about climate change, not least so that we can put into place effective measures to curb emissions. As it stands now, new oil and gas finds are getting a lot of attention. This is a paradox that can be hard to understand."

In March 2012, the CO_2 level at NILU's observatory by Ny-Ålesund at Svalbard was measured at over 400 ppm for the first time. "It is significant that such a high level has been measured in the Arctic, far from the main sources of CO_2 emissions", says Senior Scientist Cathrine Lund Myhre. Photo: Ingar Næss.

Methane on the rise again

2011 was a year of record high global methane concentrations, and the trend is also upwards. Nobody knows why.

Hilde Syversen
Journalist

Methane levels stabilised in the first decade of this century, after a dismal record in 2003, but again seem to be increasing. Methane has a life span of around ten years in the atmosphere, and, after CO_2, is the gas with the highest raditative forcing since 1750. According to the UN World Meteorological Organization, the concentration of methane has increased by 170% since the mid 18th century, from 770 ppb (parts per billion) to 1813 ppb in 2011.

"Our data from the Norwegian observatories show a small insignificant decrease for 2011, but when we look at the trend for the ten year period from 2001 to 2011, there is a clear upward trend", says Senior Scientist Cathrine Lund Myhre at NILU. She is the author of the report "Monitoring of greenhouse gases and aerosols at Svalbard and Birkenes: Annual Report 2011", published by the Norwegian Climate and Pollution Agency, Klif, in spring 2013.

Lund Myhre is unable to give one definitive explanation for the rise in methane levels; the possibilities are many. Methane is emitted both as a result of human activity – e.g. agriculture, rice fields, landfills and combustion – but is also released naturally from fires, wetlands, the ocean floor and from animals. The 2003 peak was explained by high rainfalls in the tropics, which increased the natural emissions from wetlands. The current increase is more difficult to explain, and the picture is complex.

"To find out why methane levels are increasing, we have to dig deeper", says Lund Myhre. And that is exactly what she intends to do. In collaboration with three other research institutions in Norway, NILU has been allocated funds by the Research Council of Norway to start a large project studying methane emissions from Arctic sources.

Bubbling up

"We will measure methane emissions at ground level, in the air using aircraft, and at the sea bed", explains Lund Myhre. "For example, we know methane is bubbling up to the surface of the sea, but we don't know whether this methane reaches the atmosphere. Also, we know that the water in the Arctic has become warmer, but we don't know if this affects the amount of methane released from the sea bed.

NILUs partners in this project is the University of Tromsø and the Center for International Climate and Environmental Research in Oslo. Lund Myhre will head the research team.

Methane is emitted both by human activities - agriculture, rice fields, landfills and combustion - and also released naturally from fires, wetlands, the ocean floor and animals. The picture is taken at Ny-Ålesund, Svalbard. Photo: Kjetil Tørseth, NILU.

THE ONLY GOOD NEWS

The only greenhouse gases showing signs of stabilising and even falling are the halocarbons.

The only encouraging reading in a new report about the level of greenhouse gases in Norway, is the reported reductions in halocarbon levels. This is a group of gases which, when looked at together, is almost as significant as methane. These gases are found in, for example, solvents, refrigerators, air conditioning and insecticides. Amongst the halocarbons, the largest contributors to global warming is the chlorofluorcarbons (known as CFCs). The other halocarbons are the halofluorcarbons (HCFCs and HFCs).

CFCs and HCFCs deplete the ozone layer, and have been regulated by the Montreal Protocol since 1997. The report "Monitoring of greenhouse gases and aerosols at Svalbard and Birkenes: Annual Report 2011", published by the Norwegian Climate and Pollution Agency, Klif, in Spring 2013, shows that these are the only greenhouse gases showing signs of stabilising and even falling. Other greenhouse gases are increasing, especially the new substitute gases, the HFCs.

"We can see that the Montreal Protocol is working. Even so, it is important to continue to monitor these substances to make sure the agreement is adhered to in all countries", says Cathrine Lund Myhre, Senior Scientist at NILU, who has written the report for Klif.

"At the moment, the concentration of these gases is slowly falling, and we are set to reach pre 1980 levels by 2050".

Ozone anniversary

On 16 September 2012 it was 25 years since the Montreal Protocol was signed, an international treaty designed to protect the ozone layer. There is good reason to celebrate. The ozone layer seems to recover and the agreement has saved the atmosphere from many billions of tonnes of greenhouse gases.

Anne Nyeggen
Director of Communications

"Our monitoring data show that the depletion of the ozone layer has stopped. This means that international environmental collaboration works", says Senior Scientist Tove Svendby at NILU. She is responsible for a national ozone and UV monitoring programme, financed by the Norwegian Climate and Pollution Agency.

Through the Montreal Protocol, signed 25 years ago, 197 countries have agreed to reduce the use of ozone depleting substances (halogenated hydrocarbons).

Results from the national programme for monitoring of greenhouse gases show that the concentrations of the most significant ozone depleting substances in the atmosphere above Svalbard and Norway are declining.

Beneficial to the climate

The ozone layer in the stratosphere protects all life on earth against damaging ultraviolet radiation from the sun. In the 1980s it became clear that the extensive use of ozone depleting substances – especially CFC's from e.g. aerosol cans and refrigerants - was a threat to the ozone layer.

As well as damaging to the ozone layer, most of these substances are also powerful greenhouse gases. Hence, the phasing out of ozone depleting substances between 1990 and 2000 has had a beneficial effect on the climate.

Time consuming

Despite the success in phasing out the ozone depleting substances, their long life span in the atmosphere means that it will still take several decades before the ozone layer is restored to its pre 1980 level. This is expected to happen between 2050 and 2075. Many factors influence the speed at which the ozone layer is recovering. One uncertainty factor is the effect the emission of greenhouse gases has on the climate and the temperature in the stratosphere, and hence, indirectly on the restoration of the ozone layer.

"Our monitoring data show that the depletion of the ozone layer has stopped. This means that international environmental collaboration works", says senior researcher Tove Svendby at NILU. She is responsible for NILU's ozone and UV monitoring programme, financed by the Norwegian Climate and Pollution Agency. Photo: Ingunn Trones, NILU.

Substantial annual variations

From 1979 to the mid 1990s there was a marked reduction of the ozone layer above Norway, nearly six percent per decade. Since the middle of the 1990s a further ozone decrease is not observed over Norway, but there are substantial variations from one year to another.

Ozone measurements from 2011 show that the ozone layer over Norway and Svalbard was the thinnest registered this century. The ozone layer depleted substantially in the winter of 2010/2011 and remained low throughout the rest of the year.

From December 2010 to April 2011 the temperatures in the Arctic stratosphere were very low. Combined with reduced transport of ozone from lower latitudes it is likely that the low temperatures were one of the reasons for the thin ozone layer that winter.

THIS IS THE OZONE LAYER

The ozone layer is a region in the stratosphere containing relatively high levels of ozone, located from about 15 to 35 km above the ground. About 90 percent of all ozone in the atmosphere is found there.

Ozone is formed and broken down in a continuous natural process. Emissions of ozone depleting substances have disturbed this balance.

When the ozone layer becomes thinner, more ultraviolet radiation (UV-B) reaches the surface of the earth.

Why is the ozone layer important?
Increased UV radiation can damage plants and animals, which in turn leads to lower crop yields and food production. The ecosystem in the oceans may also be affected by increased UV. The reduction of sea ice in the Polar region increases the exposure of marine organisms to UV radiation, making the ozone layer even more important in the Arctic.

Increased UV radiation can weaken the immune system and increase the risk of skin cancer and infections. There is also a higher risk of damage to the eyes, especially of developing cataract.

Materials break down more quickly when exposed to UV radiation.

Agreement on UN mercury protocol – NILU plays a key role

In January 2013, UN member states finally agreed on a protocol for reducing the use and emissions of mercury. Research at NILU played a pivotal role in securing that agreement.

Hilde Syversen
Journalist

MUCH QUOTED TEAM: NILU-scientist Elisabeth Pacyna was the main author of the article Global emission of mercury to the atmosphere from anthropogenic sources in 2005 and projections to 2020, which was one of the 50 most quoted articles in 2010-11 in the renowned publication Athmospheric Environment. Elisabeth Pacyna wrote the article with her head of department, Jozef Pacyna and her NILU colleague Kyrre Sundseth, as well as five other researchers from Norway, Sweden, The Netherlands and Belgium. The article is based on research commissioned by the UN Environment Programme and several EU projects. It also formed the basis for Elisabeth Pacyna's PhD in 2010. Photo: Ingunn Trones, NILU.

"I never thought that an agreement would be reached so quickly", says Professor Jozef Pacyna. He is the head of NILU's Department for Environmental Impact and Economics (IMPEC), and has carried out research on sources, emissions and the effects of mercury in the environment for three decades. "When I stood in front of the UN Environment Programme Governing Council's meeting on mercury in 2008, as the only scientist, the response was underwhelming. I remember thinking that this would take decades."

The year before, NILU had been asked by the UN to co-ordinate the research needed as a scientific justification for an international agreement, and it was this research Pacyna presented to the Council.

NILU had been assessing and mapping mercury emissions since the 1980s. The first overview of global emissions to air, water and soil of 16 polluting substances, including mercury, was published in the renowned Nature in 1988. The authors were Pacyna and his colleague at the then National Institute for Water Research in Canada, Professor Jerome Nriagu. In years to come, this publication was quoted in more than 2000 published research papers, which is a record for Norwegian environmental scientific publishing. This pioneering work was formally acknowledged by ICHMET – The International Conference on Heavy Metals in the Environment – in 2012, when they awarded Pacyna and Nriagu the ICHMET Lifetime Achievement Award.

Even if research advances had been made since the 1988 study, further research was needed if the UN were successfully to negotiate an agreement on mercury.

"We knew mercury was poisonous, but we needed to know more about how much is released into the environment, where this happens, how this substance behaves in the environment and where it eventually ends up. For example, we now know that mercury changes in the atmosphere and becomes water soluble. In this form, it returns with precipitation to the soil and the sea. We also know now that mercury breaks down very slowly and can be transported around the whole world, so that, for example, at least 30% of mercury deposited in the United States originates in China."

Minamata

It was only in the mid 1950s that it was discovered that mercury can find its way into the human food chain. People living in the Japanese city of Minamata became affected; many died. Eventually, the cause was found: mercury emissions from a local plant had poisoned the sea, and thereby also the people who ate local fish and shellfish.

Depending on how mercury is absorbed by the body, it can do severe and very different damage, including damage to the central nervous system. Children are particularly exposed to mercury poisoning. In Europe, every third child is born with mercury levels above the limit set by WHO. "High levels of mercury can

lead to mental problems, lower IQ and learning disabilities", explains Pacyna.

Recently, a link was established between mercury levels in humans and cardiovascular diseases.

Economically viable

Part of NILU's UN brief was to look into how much mercury emissions cost the global society.

"We carried out cost-benefit analyses, and it is easy to show that reducing mercury emissions also makes sense from an economic point of view. Currently, we humans let out about 2000 tons of mercury every year. In addition, about the same amount again is emitted from other non-anthropogenic sources. If we in the next eight years reduce the anthropogenic emissions by 50-60%, we estimate that the annual saving by 2020 will be between 1.8 and 2.2 billion US dollars." (Expressed in 2005 dollars).

Since problems arising from mercury emissions are more easily quantifiable than those from CO_2 emissions, Pacyna believes the Minamata agreement will be easier to implement than the Kyoto protocol: "Measures to reduce mercury emissions are less costly, and the economic benefits are obvious." He also draws a comparison with the successful work on lead reductions, the only other metal which the world has made a systematic effort to eliminate.

Another reason for Pacyna's optimism is that he thinks the agreement will be easier to monitor than the Kyoto agreement. "We can relatively easily gather reliable data from the whole world. We have sampling stations not only on land, in the Arctic and the Antarctic, but also on aircraft – there is a collaboration with airlines – and on cruise ships".

Reduce use, not just emissions

The agreement does not only concern the reduction in emissions, but also stipulates a reduction in the use of mercury. A list of products to be phased out has been drawn up. Mercury is currently used in the manufacture of screens, like those for mobile phones and computers. Many of the new energy saving light bulbs also contain mercury. The challenge now is to find alternatives to mercury, just like it once became possible to produce lead-free petrol.

New sources

Around half of today's anthropogenic emissions are from coal combustion, particularly from burning of coal in China and India. Other sources are cement production, smelting and cremation. There is, however, one recent source of mercury emissions which is increasing rapidly; artisanal gold mining. When a mining company no longer deems a mine economically viable, poor adventurers move in.

These miners buy mercury on the black market and use it as a magnet for the gold to attach itself to. Back home from the mine, they heat up the mercury until it evaporates and the gold remains, if they are lucky.

"We believe about 10 million people are involved in this operation, and have estimated the emissions at 400-500 tons a year, in other words nearly a quarter of the emissions made by us humans", says Pacyna.

In the Minamata agreement, a cost of local and international measures has been drawn up to reduce artisanal mining, and there are also provisions for technical and financial help, as well as education and research into finding alternatives to using mercury in this type of mining.

October signing

The agreement is due to be signed in Minamata in October 2013, and will come into force within three to five years, depending on how quickly it is ratified. Along with Japan and Switzerland, Norway has promised funds in the hope that other countries will follow.
NIILU's role in the Minamata agreement will carry on. The institute can deliver the data necessary to follow up and monitor the agreement.

"The basis for the agreement was information about emissions in 2005, and currently we are working to update this information with 2011 data", explains Pacyna. "I hope we will be involved in the implementation of the agreement. As I see it, EU's GMOS-project – Global Mercury Observation System – may be used as the foundation for the network which will be established to monitor air and water mercury concentrations in the future. Norway and NILU are amongst the main partners in this project."

Pacyna, E.G., Pacyna, J.M., Sundseth, K., Munthe, J., Kindborn, K., Wilson, S., Steenhuisen, F., Maxson, P. (2010) Global emission of mercury to the atmosphere from anthropogenic sources in 2005 and projections to 2020. *Atmos. Environ., 44*, 2487-2499. doi:10.1016/j.atmosenv.2009.06.009.

Prof. Jozef Pacyna, Research Director at NILU.
Photo: Ingar Næss.

Photo: iStockphoto

Non-target screening

The complete inventory

Non-target screening is a researcher's utopian dream come true. But, behind the tantalising prospect of the all-seeing analysis, new problems lurk: This is big, in all sorts of ways.

Hilde Syversen
Journalist

"This is the second of its kind in Norway. We got it just before Christmas", says Senior Scientist Martin Schlabach of the large, grey, box shaped machine in NILU's lab. It is the size of two household washing machines, with what looks like a chimney sticking up at the far end. The simple exterior hides an advanced tool for analysing samples; a mass spectrometer. Inside, ions are sent up into the chimney-like closed cylinder at the far end. The time it takes an ion to be sent up and fall down again, the so called ToF (Time of Flight), is measured for each and every ion of the sample. This is useful information, to those who know how to use it.

Finding the unlooked for

In the lab next door to the new mass spectrometer, we find the old technology: glass vials side by side, containing fish samples from the Grenland area, south west of Oslo. Each vial is used to look for a set number of substances.

"Crucially, this new way of testing, enables us to pick out substances that we previously didn't see at all, because we did not know that they existed or there was no reason to believe that they were present", explains Schlabach. Photo: Ingunn Trones.

Exactly what to look for has to be decided at the outset. The fish from Grenland is tested for dioxins and other known pollutants emitted from a now closed down magnesium factory in the area. By using the traditional testing method, samples are typically tested for 20 to 30 compounds, sometimes up to a hundred.

Often, the researchers have an idea of what a sample might contain, an inkling of what they are looking for. They might know that certain substances are present in the environment where the sample is collected, as in the case of the Grenland fish, or there may be other indicators of what to test for. But ultimately, the traditional testing method relies on coincidences and hunches rather than a systematic, scientific approach. That which isn't tested for, will not be found. Non-target screening is designed to deal with this problem.

Table of contents

The grey magic box can register all the substances in a sample. Instead of checking to see if it finds a number of predefined chemicals, it produces a complete overview.

"Crucially, this new way of testing enables us to pick out substances that we previously didn't see at all, because we did not know that they existed or there was no reason to believe that they were present", explains Schlabach.

Before the sample is fed in to the mass spectrometer it is passed through a chromatograph in order to separate out substances with differing polarity by pressing the liquid sample through a very thin column. As the substances come out of the chromatograph and into the mass spectrometer, they go for an airing in the cylinder to measure the time of flight, which again is a measurement of each substance's mass.

The researcher ends up with information about the polarity and mass of all the substances in the sample. A sample might contain over a thousand substances, sometimes up to 50,000, giving large data files of up to several gigabytes. The challenge is to identify which substances have been found. Sometimes, this can be achieved by comparing the results with information about different substances' polarity and mass held in international data bases. This will identify those substances that are already catalogued.

"But new substances are appearing all the time", explains Schlabach. "In the past, we knew more about which substances were used in manufacturing industries. Now, many manufacturers are more reticent. The rapidly growing manufacturing industries in India and China are difficult to keep track of, and many imported products don't have proper, detailed declarations of what they contain. All this means that for some substances which the mass spectrometer identifies, it takes pure detective work to find out what they actually are."

Schlabach explains that one way of doing this is to separate the samples by using different criteria, and then test them in other ways to be able to eliminate data that is of little interest. But this is a time consuming process.

Processing Power

Non-target screening is not new, but has been developed over the last ten

NILU's mass spectrometer is the second of its kind in Norway. Instead of searching for selected substances, one receives information about polarity and the masses of all substances in the sample. Photo: Ingunn Trones, NILU.

years. However, it is only recently that new software and more powerful data processors have made it possible for researchers to make better use of the information that comes out of the process. Now, researchers can go back to raw data files from old samples and look for things they didn't look for the first time around.

"A good example is when we were asked if we knew if a sweetener called sucralose was present in waste water. By looking at old raw data from samples of waste water, we could establish that sucralose was present, even if it had not been tested for at the time the samples were gathered", says Schlabach.

"These samples had originally been analysed to see to what degree pharmaceuticals were present in sewage before it was treated. At that time, no-one talked about sucralose, which is a new artificial sweetener."

By storing all the information from non-target screening, databases can be built for future retrospective analysis. This is more cost-effective than storing physical samples, and also, the information is more accessible.

But despite the obvious advantages of storing data files instead of physical samples, there is still a need to store physical samples for future analysis.

Physical samples not passé

A national bank of environmental samples was opened in November 2012 under the auspices of CIENS – Oslo Centre for Interdisciplinary Environmental and Social Research. Together with the Norwegian institutes for nature and water research (NINA and NIVA) and the University of Oslo, NILU is responsible for the day-to-day running of the sample bank. In a controlled environment, the bank will store samples from Norway and the Arctic, submitted by research institutes from all over the country. In the future, these samples might provide information that may not be available in the data files of non-target screening.

"In order to analyse the samples, we first have to make an extract of the sample. This is the same both for the traditional way of testing and the new non-targeted testing", says Schlabach. »

The big picture

Pawel Rostkowski came to NILU from Poland, via Japan and Britain. The appeal was NILU's research into mass spectrometry.

"By using mass spectrometry, we can find things we wouldn't think to look for", explains the research chemist who joined NILU in August 2012. "We are just finishing a mass spectrometry project for the Norwegian Climate and Pollution Agency (Klif) with the University in Umeå. The project has looked at the possibilities for using non-target screening to identify new toxins in the environment."

Pawel Rostkowski. Photo: Ingunn Trones, NILU.

The Klif project looked at many different samples collected from all over Norway; air, water, sludge, waste water from sewage treatment plants, fish and birds' eggs.

"In many samples, we found benzothiazoles and benzotriazoles, which are not a subject of the regular monitoring in Norway at present, although they have been found in some earlier studies. Benzothiazole is used in, amongst other things, car tires and textiles. Benzotriazole is used for dishwasher detergents and in de-icing fluids for aeroplanes. We do not know for certain where they originate. In order to find the source, we will have to make further investigations", explains Rostkowski.

He also found benzothiazole derivatives in prawns and birds' eggs.

"We do not know much about the toxicity of benzotriazole, but there are some indications that it is carcinogenic. Neither know we much how about the fate of this substance in the environment; whether it changes or to where it eventually makes it way. In the samples, we found benzotriazole not only in the influent (water going into the waste treatment plants) but also in the effluent (water after treatment). In other words, it is not removed in the treatment process. Our finding is in agreement with recently published studies reporting that not all wastewater treatment processes are able to remove benzotriazole efficiently", says Rostkowski.

"The Klif project has shown that non-target screening is a useful tool. Both for detecting new, unknown substances and for finding chemicals we know, but hadn't thought to look for. Another exciting aspect of this method is the opportunity to make retrospective analysis. By looking at old data files, we can check to see if the chemicals we are looking for were present in the past".

Using the fish from Grenland as an example, Schlabach explains how it is first pulped and then treated in order to make a liquid extract. This is how the sample is prepared, regardless of whether it is due to be analysed in the traditional way or be sent through the mass spectrometer. It is possible that something is lost or changed through the extraction process, and in all likelihood, there will be further progress in testing methods. By storing physical samples, we can make sure that future researchers can perform retrospective analysis on physical samples, and not rely solely on raw data from non-target screening.

Looking back - moving forward

All this is in the future. At present, Schlabach and his colleagues have their hands full dealing with the huge amounts of data gathered through non-target screening. He is particularly interested in exploring the opportunities for retrospective analysis.

"We have research stations both in the Antarctic, at Troll, and in the Arctic, at Ny-Ålesund at Svalbard. By looking at samples from these stations, we can detect substances transported over long distances in the atmosphere, substances we had never even guessed could be found so far from where they are emitted", explains Schlabach. This kind of documentation is necessary in order to establish the existence of long-lived organic pollutants, with a view to submitting these substances for consideration under the Stockholm Convention.

The Stockholm Convention

The Stockholm Convention is an international agreement to reduce and eliminate the use of so-called persistent organic pollutants, often abbreviated to POPs. For a substance to be defined as a POP, it must be shown that it is slow to break down and disappear.

"Being able to document such long distance transport of substances is a crucial input to the international collaboration on environmental problems", Schlabach points out.

Photo: Colourbox

FACTS:

Siloxanes have previously been found in fish in Mjøsa, the largest lake in Norway, where The Norwegian Institute for Water Research (NIVA) determined that the concentrations increased higher up in the food chain (http://www.forskning.no/artikler/2012/mai/321036).

Siloxanes are chemicals that consist of a skeleton (rings or chains) of oxygen and silicon, with organic side groups attached. The most controversial siloxanes are D4 (octamethylcyclotetrasiloxane), D5 (decamethylcyclopentasiloxane), and D6 (dodecamethylcyclohexasiloxane).

Siloxanes are used in the production of silicone polymers, in personal care products, and in various technical products. In the European Union the consumption of D4, D5, and D6 has been estimated to be about 9500, 19,000, and 2000 tons per year respectively (numbers for 2004 include personal care products and polymer production only). Siloxanes have many uses in the manufacture of personal care products, amongst others to give a soft, silky feeling to the products and as fragrance carriers.

The content of siloxanes in cosmetics is usually only a few per cent, but certain products can contain more than 50 per cent siloxanes, and in extreme cases close to 100 per cent. The uptake of siloxanes through the skin is minimal, and most of it volatilizes or is washed off. In the list of ingredients on personal care products, siloxane substances have names that end with –siloxane or –methicone.

D4 has been classified as harmful to reproduction and to aquatic organisms, but there is still uncertainty as to whether or not D5 and D6 have any harmful effects. The reason for concern about siloxanes is primarily their harmful environmental effects, especially on aquatic organisms, and not their effects on human health.

Reference to the scientific paper:
Krogseth, I.S., Kierkegaard, A., Mclachlan, M.S., Breivik, K., Hansen, K.M., Schlabach, M. (2013) Occurrence and seasonality of cyclic volatile methyl siloxanes in Arctic air. Environ. Sci. Technol., 47, 502-509. doi:10.1021/es3040208.

Additional information:

http://gronnhverdag.no/nor/Bakgrunn/Helse-og-miljoebelastende-stoffer-i-hudpleie-og-kosmetikk/Fakta-om-siloksaner/(language)/nor-NO

http://www.miljostatus.no/no/Tema/Kjemikalier/Noen-farlige-kjemikalier/Siloksaner/

Chemicals from your deodorant fly to the Arctic

Do you ever think about what actually happens to all of the deodorants, skin lotions and makeup you put on every day? Do they just disappear? Or perhaps not? New research has for the first time found siloxanes in air samples from the Arctic. These siloxanes come from areas much further south, which gives reason for concern.

Ingjerd Sunde Krogseth
PhD candidate, NILU

Lately, there is increased focus on substances found in personal care products and how these may be harmful to human health and the environment. Siloxanes are chemicals that are used in large volumes in personal care products, such as in deodorants, skin lotions and shampoos. They are emitted to the environment mainly through volatilization to the atmosphere and through the wastewater.

Higher levels than PCB

In cooperation with Stockholm University and Aarhus University, NILU has carried out an extensive study that confirms the presence of siloxanes in Arctic air. A previous study had detected the same substances in a few single samples, but not with enough certainty to say with confidence that they are present, or at which levels. The new results show that the siloxanes D5 and D6 are present in the Arctic atmosphere. The concentrations might seem low - about 1 nanogram per cubic meter of air (1 nanogram = 0.000 000 001 gram) - but this is still about 100 to 1000 times higher than typical concentrations of the classical pollutants PCBs at the same site.

There are currently no regulations on the uses of siloxanes, but two siloxanes – D4 and D5 – are on the Norwegian government's list of chemicals that should be phased out by 2020, due to their threat to human health and the environment. The knowledge about any potential effects of these chemicals on human health and the environment is still very limited. They are very volatile, and hence it is not expected that they can be deposited from the Arctic atmosphere to the terrestrial and aquatic environment as effectively as other pollutants. However, this new study by NILU proves that they have the ability to be transported over great distances in the atmosphere, which is in itself a reason for concern.

Long-range transport likely

With support from computer models, we can conclude with a high degree of certainty that the measured siloxanes have been transported with atmospheric currents from regions further south, like Scandinavia and Europe. The measurements have been performed at the Zeppelin observatory, which is located on a 400 meter high mountain next to the settlement of Ny-Ålesund at Svalbard. The settlement is so small that it is not expected to have had any influence on the measurements. The ability to be transported over long distances is one of the criteria which need to be fulfilled in order to classify a chemical as a persistent organic pollutant.

The concentrations of siloxanes in Arctic air are higher in winter than in the summer. In summer, the siloxanes are degraded by atmospheric radicals produced in the presence of sunlight. In the Arctic winter, when the sun is completely gone for several months, the siloxanes are not degraded to the same extent, and the concentration in the atmosphere increases.

Ingjerd Sunde Krogseth. Photo: Ingunn Trones, NILU.

Difficult to measure

Siloxanes in air are very challenging to measure. Firstly, the chemicals are very volatile, which means that the traditional air sampling methods are not necessarily suitable. Secondly, siloxanes are ubiquitous in our surroundings, both in laboratory equipment, indoor air, and also on the researchers themselves (e.g. hand creams). Hence, extreme caution is necessary to avoid any contamination of the samples. The new observations were carried out from August until December 2011, using a new method that was developed at Stockholm University over the last couple of years. The study was financed by Miljø2015 (The Research Council of Norway), and the results from the study were recently published in the renowned journal Environmental Science & Technology.

Into the small unknown

Nanomedicine has great potential, but is still in its infancy. The NanoTEST project evaluated and improved test methods used to establish how safe this new technology is.

Sonja Grossberndt, Scientist
Lise Marie Fjellsbø, Scientist

From cancer treatments to diagnostics, the use of engineered nanomaterials (ENM) – like minute particles of gold, iron oxide or silica – is showing great potential. But it remains unclear how exactly these nanoparticles interact with the human body. Concerns raised by scientists, politicians and the public about potential health hazards associated with the use of ENM in medical therapies, need to be answered.

The NanoTEST project, coordinated by NILU, sought to answer some of these questions. It was set up as a collaborative research project funded under the EU Seventh Framework Programme in 2008, bringing together a team of leading European scientists. The overall aim of the project was to develop alternative strategies and more effective test methods to test nanoparticles for toxicity. In turn, this would improve the risk assessment of nanoparticles used in medical diagnostics, paving the way for safe use of medical ENM.

The NanoTEST findings are also an important contribution to setting new guidelines and recommendations for future risk assessment of ENM used in clinical practice.

Testing the tests

Initially, cell cultures from different organs were exposed to six different engineered nanomaterials to establish their toxicological properties and effects on the human body. The researchers wanted to see if nanoparticles were absorbed by the cells, if they could cross biological barriers, if they induced oxidative stress or if they damaged the cell nucleus. The researchers also looked for inflammations and damage to the immune system.

NanoTEST wanted to use alternative testing methods, with a view to developing a testing strategy less reliant on using animals in research. However, in order to validate the results from the *in vitro* test methods, they inevitably needed to be compared to the results from animal studies. The findings showed that the project's testing strategies were reliable in finding the toxic effects of ENM on the immune system.

After four years as the administrative manager of the NanoTEST project, Lise Marie Fjellsbø is pleased that they have found several methods that are suitable for testing nanoparticles without using animals. She emphasises that there is still a long way to go before the use of animals in research can be completely replaced. Photo: Finn Bjørklid, NILU.

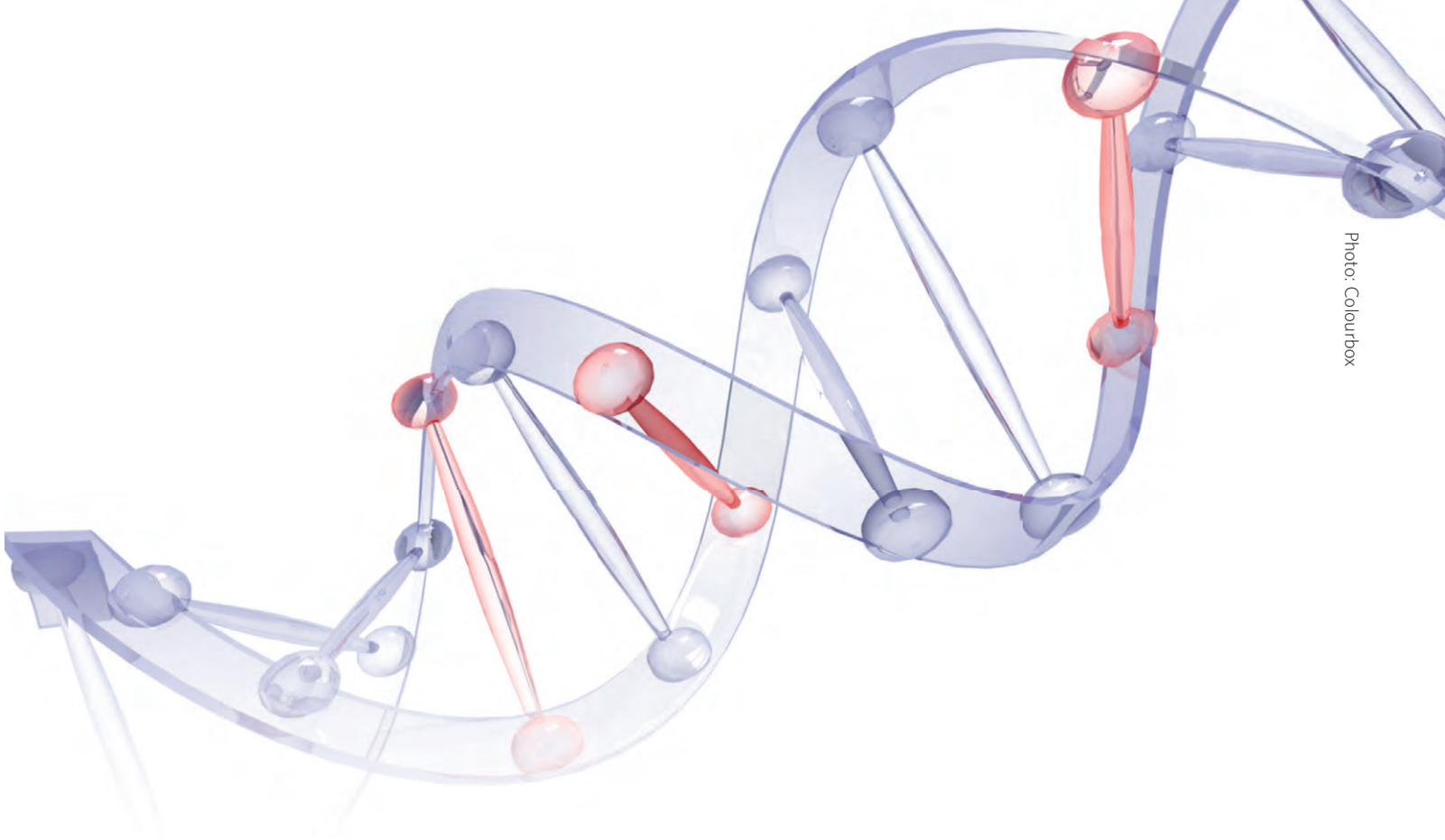


Photo: Colourbox

The NanoTEST project revealed that the toxicity of each nanoparticle group is dependent on their chemical and physical properties, as well as the test and cell type that had been used. Test methods which needed modification, or were not suitable at all, were also identified.

The results show that with proper refinement of computational models and methodologies, the testing strategies used in NanoTEST may serve as an alternative testing strategy, replacing experiments that are expensive and time consuming.

Testing for DNA damage

Health Effects Laboratory (HEL) at NILU participated in the NanoTEST project, and compiled toxicological profiles of the six ENMs used in medical diagnostics. Their work involved investigating the potential toxic effects on cells and DNA in human and mammalian blood and kidney cells.

An important part of the project was looking at ways to optimise and standardise the methods used to assess how potentially damaging these ENMs were to the cells and the DNA. For these analyses the HEL group used the so called comet assay testing method. This method detects damage in DNA by visualizing them using a fluorescent microscope. Thus, the extent of DNA breaks can be measured at a single cell level.

The comet assay testing method was found to be suitable for testing nanoparticles' potential to damage DNA, and could be used in further *in vitro* testing activities. The results also show that toxicity of ENM depends on their dispersion in different media, size, coating and surface properties. NILU is recommending the comet assay method for further validation, with a view to using it for regulatory purposes.

The NanoTEST project was finished in March 2012, and has given rise to more than 20 peer reviewed articles so far. Later in 2013, the scientific journal Nanotoxicology is bringing out a special issue on the NanoTEST project, including 16 articles summarising all the main outcomes and the most important results.

FOOTNOTE:

In vitro means literally "in the glass", and is used to describe a situation where experiments and tests take place outside the organism, for example on a bit of tissue removed from a body. The most well known use of this term is probably IVF – *in vitro* fertilisation.

NANOPARTICLES

Nanoparticles are ultrafine particles measuring between 1-100 nanometres. A human hair is about 60,000 nanometres thick, while a DNA molecule is between two and twelve nanometres wide. Nanoparticles can be used in a range of products, from cosmetics to TV, in batteries or even to give antibacterial properties to clothes and detergents. They can also be used to develop new very light and strong materials for the auto and aviation industries.

The term nanomedicine describes the medical application of nanotechnology. This includes the application of nanomaterials in diagnostic and therapeutic drugs as well as use of nanoelectronic biosensors. Examples of such materials are carbon nanotubes, gold, silver, quantum dots (QD), silicon dioxide (also known as silica), metal oxides and nanopolymers.

The NanoTEST project used the following nanoparticles: titanium dioxide (as a reference), iron oxide (with and without coating), two different sizes of fluorescent silica and PLGA-PEO.

AVOID ash detector mounted on the AIRBUS 340-300 test plane.
Photo: Fred Prata, NILU.

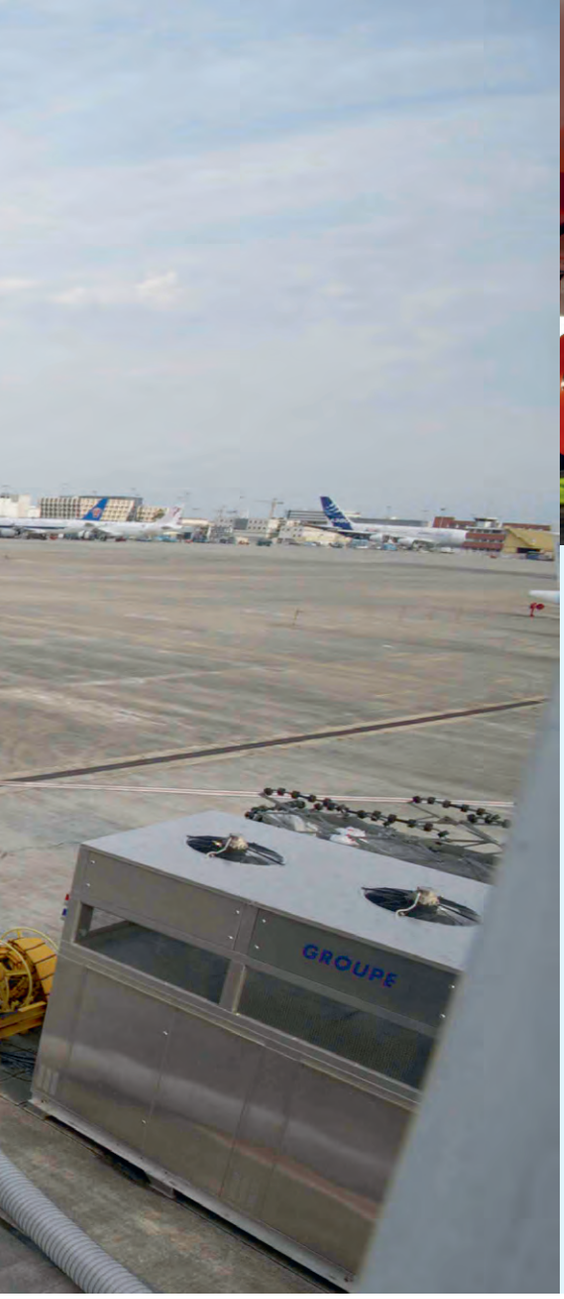
Ash detection no longer in the clouds

This summer, the ash detection system AVOID will be put to new tests. In the meantime, AVOID inventor Fred Prata has been named Aviator of the Year, together with his partner from easyJet, Ian Davies.

Anne Nyeggen, Director of Communications
Hilde Syversen, Journalist

Successful test flights in Europe in July 2012 gave the go-ahead for phase two of the collaboration between the NILU company Nicarnica Aviation, the British airline easyJet and the European aircraft manufacturer Airbus. In phase two, AVOID (Airborne Volcanic Object Imaging Detector) will be tested on volcanic ash clouds at commercial aeroplanes' regular cruising altitude. Test flights with the Airbus test aircraft A340-300 in July 2012 proved that at these altitudes, the system can detect different types of clouds and objects, like ice crystals. The system has previously been tested on ash clouds at lower altitudes.

"It is crucial to test the equipment at the regular cruising altitudes of commercial jet aircrafts. This may be as high as 38,000 feet, where it is very cold, and temperatures falling below -55 degrees Celsius. We have also successfully tested the equipment at high speed",



Aviator of the Year: Fred Prata from NILU and Nicarnica Aviation and easyJet's head of engineering Ian Davies, were awarded the prestigious Aviator of the Year prize by Flightglobal, an international information and news provider to the aviation industry. Amongst previous winners is Chesley Sullenberger, the pilot who successfully landed his failing plane on the Hudson River outside Manhattan in January 2009. Photo: Bård Amundsen

THIS IS AVOID

The patented detection system AVOID consists of two or more small, infrared cameras built into the body of the aircraft, feeding information to highly specialised software in the cockpit. It is designed to detect and warn of ash clouds at 100 kilometres, day or night. The infrared technology is calibrated to make the particles in the ash cloud visible to the camera, even at low concentrations. These silicate particles can be very damaging to the aeroplane. They are pulled into the warm engine, where they melt into a sticky mass, causing damage to the engine, and in some cases complete failure. Hence, to avoid damage, it is essential for the pilots to know in advance if ash clouds from erupting volcanos are in their flight path. AVOID is able to process the information from the infrared cameras and give the pilot information about the location and amount of particles in the air. With this information, the pilot is able to assess whether it is possible to fly through the cloud, or if it is necessary to change course. A distance of 100 kilometres gives the pilot between seven and ten minutes to act.

On the ground, the information from AVOID will be used to build accurate models showing where the ash clouds are at any one time. During an eruption, this would make it possible to open large parts of the air space which would otherwise be closed to traffic.

says Fred Prata. It is 20 years since he came up with the idea for AVOID. Six years ago, he brought it to NILU to continue to develop it. When the 2010 volcanic eruption of Eyjafjallajökull in Iceland closed European airspace for over a week, the head of engineering at easyJet, Ian Davies, contacted Prata. A partnership was formed, and was subsequently joined by Airbus. At last, AVOID was ready to leave the lab.

From research to commerce

"We are very pleased to have joined forces with both easyJet and Airbus. We need partners like this in order to test the system. This is also key when it comes to turning AVOID into a commercially viable product", says Ove Bratsberg, head of Nicarnica Aviation. Nicarnica Aviation was established by NILU to commercialise the detection system. The company has its own premises at Kjeller, Norway, close to NILU.

"The chances of a small Norwegian technology company supplying the international aviation industry are as good as non-existent. We depend on collaboration with the large players in this field. Airbus and easyJet are helping us through the tests and the certification processes, which are both time consuming and costly. Normally, this process takes years, but there are plans to fast-track AVOID", says Bratsberg. He points out that their business partners can also be of great help when it comes to developing a commercial product and bringing it to the market, when that time comes.

100 kilometre warning

At the test flights over Toulouse in France in summer 2012, it was shown that AVOID was able to detect the clouds at 100 kilometres distance.

"For the first time, we were able to demonstrate that the passive, infrared camera can give warning far enough ahead for the planes to change their course", says Fred Prata.

Real ash clouds

AVOID has passed all its tests with flying colours. In the third quarter of 2013, it will be put to its final test. The research plane will be flown close to an erupting volcano. It is assumed that there will be an eruption in Indonesia, Alaska, Japan, or indeed Iceland. AVOID has previously been tested over Etna and Stromboli on a test plane from easyJet (Flight Design CT) at lower altitudes, up to 12,000 feet.

After the test period, AVOID will have to go through the certification process of the European Aviation Safety Agency, EASA, before it can be put into production.

Managing Director Kari Nygaard (NILU) and Chancellor Nabil Ibrahim (Abu Dhabi University) during the solemn opening ceremony of NILU's office at the university campus. Norway's ambassador to Abu Dhabi, Åse Elin Bjerke and H.E. Razan al Mubarak, secretary general at the Environmental Agency - Abu Dhabi (EAD) participated together with guests from more than 40 institutions and companies within the field of environmental management, industry and research. Photo: Abu Dhabi University.

Forging stronger links with Abu Dhabi University

NILU and Abu Dhabi University have signed a Memorandum of Understanding for increased strategic collaboration. NILU UAE now resides at the Abu Dhabi University campus.

Anne Nyeggen, Director of Communications
Hilde Syversen, Journalist

"We have already moved in to our new offices at the Abu Dhabi University, and are very pleased to be here", says the new head of NILU's UAE department, Alena Bartonova. When she took the helm in January 2013, the department had 16 employees as well as two undergraduates from ADU on work placements. The placements are part of the collaboration with the University, whilst a committee is making plans for future strategic research collaboration.

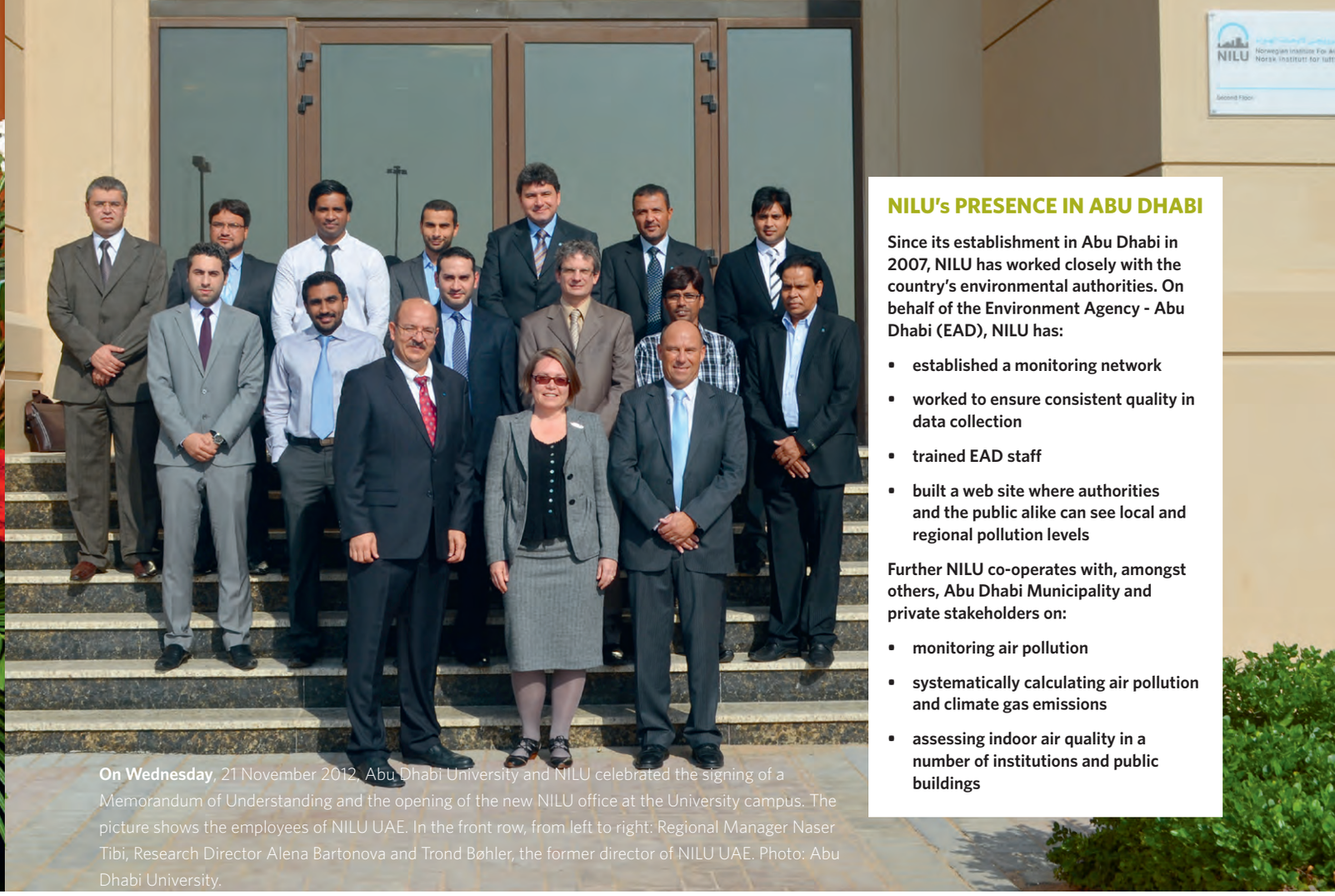
Full steam ahead

"We are gearing up our activities in Abu Dhabi", says Kari Nygaard, Managing Director of NILU. "From having mainly provided technical and advisory services to the authorities, we are now looking to develop larger research projects in The United Arab Emirates."

Alena Bartonova sees UAE's sizeable academic sector and industries as potential growth areas.

Research Director Alena Bartonova, NILU UAE. Photo: Ingar Næss.

"The UAE has developed its own universities and institutions for higher education. In addition, many foreign universities have a presence here, including several larger universities, like Sorbonne and MIT. There are also the oil and the construction industries. Almost all new buildings here have air conditioning. These systems require monitoring for air quality, both with regard to moulds



On Wednesday, 21 November 2012, Abu Dhabi University and NILU celebrated the signing of a Memorandum of Understanding and the opening of the new NILU office at the University campus. The picture shows the employees of NILU UAE. In the front row, from left to right: Regional Manager Naser Tibi, Research Director Alena Bartonova and Trond Bøhler, the former director of NILU UAE. Photo: Abu Dhabi University.

NILU's PRESENCE IN ABU DHABI

Since its establishment in Abu Dhabi in 2007, NILU has worked closely with the country's environmental authorities. On behalf of the Environment Agency - Abu Dhabi (EAD), NILU has:

- **established a monitoring network**
- **worked to ensure consistent quality in data collection**
- **trained EAD staff**
- **built a web site where authorities and the public alike can see local and regional pollution levels**

Further NILU co-operates with, amongst others, Abu Dhabi Municipality and private stakeholders on:

- **monitoring air pollution**
- **systematically calculating air pollution and climate gas emissions**
- **assessing indoor air quality in a number of institutions and public buildings**

and spores, as well as pollution from the activities within the building", Bartonova continues.

Important partner

Nygaard believes the new agreement with the University is an important step in NILU's work to develop its research and education activities. In particular, she feels NILU has a part to play in higher education and PhDs tied in to research projects.

"Our experience of combining surveillance with modelling and skills development is what particularly interested the University. An example is the Flexpart modelling used for tracking and identifying pollution incidents and emissions of climate gases. This model is developed by NILU and is used by many international research groups. It can also be used to forecast desert storms, which are a big air quality issue in Abu Dhabi", says Kari Nygaard.

Well established

NILU's Abu Dhabi department was established in 2007. In the last five years, the Institute has been a strategic partner to the UAE authorities, through their Environment Agency - Abu Dhabi (EAD), and contributed to a well functioning network for air quality monitoring.

"We now have 20 fixed monitoring stations in the UAE. These stations measure different components in real time, and also measure particles in two different sizes, which is quite unusual for a surveillance network", says Bartonova. "This is coming in Europe, but is not fully implemented there yet."

Local ambitions

NILU has established a well functioning surveillance system in Abu Dhabi, on behalf of the authorities. The next question will be how to reduce emissions and safeguard people's health.

"Air pollution levels in Abu Dhabi are above those deemed acceptable by the authorities here, as set out in the legislation", says Alena Bartonova, head of the NILU department in Abu Dhabi. Initiatives to curb pollution are just starting up, but local environment authorities are ambitious, and Bartonova is optimistic.

"In Europe, there is often one authority which monitors air quality whilst another handles the question of climate change. When there is this division, one depends on structures for co-operation between the different bodies in order to get people to talk to each other, and that can be rather cumbersome. Here, both these responsibilities are allocated to one government agency. This means that the problems are looked at in an integrated way, and the work seems to be well under way."

The CIENS building at Oslo Science Park. Photo: Bjørn Faafeng, NIVA (Norwegian Institute for Water Research).

Innovation and research – like hand in glove

The research collaboration CIENS has established its own research forum, the CIENS Innovation Forum. "Together, we have a great, as yet unutilised potential for innovation", says the newly elected leader of the forum, The Nguyen Thanh from NILU.

Anne Nyeggen
Director of Communications

The Research Council and the EU both emphasise that the knowledge triangle – education, research and innovation – must be closer knit together in order to meet challenges in society and business. This spans from the traditional form of technological innovation to applied research; from development of commercially viable products and services to new knowledge about how society, the civil service and the corporate sector can be organised in order to meet the complex challenges of the future, drawing on both natural and social sciences .

"All together, the CIENS institutes have a great, as yet unutilised, potential for research-based innovation, both through the opportunities the individual institutes have of learning from each other through exchange of knowledge, and particularly in developing new ideas through better and deeper collaboration. We are talking about both new commercial products and services, and about gaining new knowledge and solutions which are of use to society", says Thanh.

The CIENS Innovation Forum has established an internal project in three phases. "Firstly, it is important that we have a common understanding of what innovation is", says Thanh. "The next step is to make this known and embedded within the institutes. Last, but not least, we have to build on that common understanding in order to find out more about how innovation works in practice. In particular, we want to look at the potential benefits from collaboration between the institutes. We also have to consider the user context and communication through the whole research process", says Thanh, announcing a workshop in the CIENS centre for the autumn of 2013, where there will be a broad discussion of this issue.

CIENS, Centre for Interdisciplinary Environmental and Social Research, is a research collaboration between the University of Oslo, Norwegian Institute for Urban and Regional Research (NIBR), Institute of Transport Economics (TØI), Norwegian Institute for Water Research (NIVA), NILU – Norwegian Institute for Air Research, Norwegian Institute for Nature Research (NINA), CICERO Centre for International Climate and Environmental Research, Norwegian Meteorological Institute and Norwegian Water Resources and Energy Directorate (NVE).

Senior Adviser The Nguyen Thanh, NILU. Photo: Ingar Næss.

Heading north for POPs

Senior Scientist Athanasios Katsogiannis has followed the route of the POPs he studies. He has moved slowly northwards.

Hilde Syversen, journalist

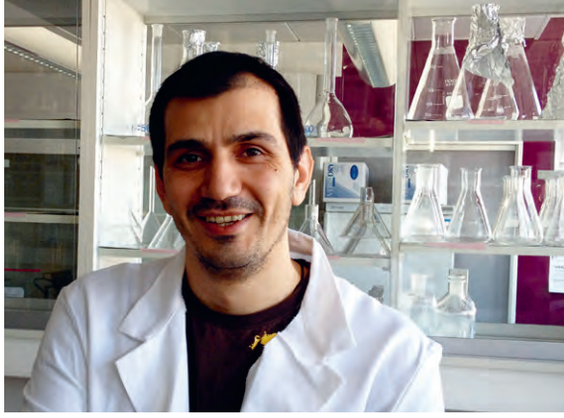
Athanasios Katsogiannis came from Greece to the arctic city of Tromsø, via Italy and Great Britain. When he applied for the job as a senior researcher at NILU's Environmental Chemistry Department, he had never been to Norway.

"I knew NILU, though. You're always bumping into papers from NILU, and when I worked in Lancaster, some colleagues of mine were collaborating with the Institute. NILU owns EBAS which is the largest "air pollutants concentrations database". "It was the right place to come to continue the kind of studies I am interested in", says Katsogiannis when asked why he wanted to move to Tromsø. He makes it sound like an irresistible temptation.

Katsogiannis' PhD is from the Aristotle University of Thessaloniki, Greece, where he studied persistent organic pollutants, so called POPs, at different stages of the wastewater treatment process. In the eight years that followed, his research changed focus from water to air pollution, both indoors and outdoors.

"POPs are chemicals that degrade very slowly; including dioxins, industrial chemicals (PCB), brominated flame retardants and insecticides like DDT. They have been widely used in the past, but have been phased out from production. There are few new sources in the western world, but a lot of old products in circulation in developing countries means that these substances are still emitted into the air, usually in the warmer parts of the globe. Because it takes these chemicals so long to degrade, they tend to be transported slowly northwards, where they condensate and precipitate", Katsogiannis explains.

In his research, Katsogiannis is trying to understand how these chemicals behave when they are let out into the environment: how they react, how, and at what speed, they are transported, and how they move between the air and the soil. It is the latter which particularly interests Katsogiannis at the moment. And this is also an area of research which has become more pertinent as global warming uncovers areas that were previously hidden under the snow.



Senior Scientist Athanasios Katsogiannis has done the same as the POPs he is analysing: he has moved slowly northwards. Photo: Mikael Harju, NILU.

"When soil which has previously been covered by snow again sees the light of day, chemicals deposited in this soil a long time ago can be remobilised", explains the researcher. Together with a colleague from IDAEA-CSIC in Spain, he is due to start a new project in this area of research. By measuring the air-soil exchange of key organic pollutants in Tromsø and Svalbard, they will try to establish how these chemicals behave in the Arctic region and how they move between air and soil.

– Both my master's degree and my PhD focused on atmospheric measurements, but here at NILU I work on evaluating measurements from three satellites which gauge soil moisture, Griesfeller explains. Photo: Ingunn Trones.

Looking at soil from space

Alexandra Griesfeller started her career high up in the atmosphere. The meteorologist's new job at NILU is more grounded. She measures soil moisture.

Hilde Syversen, journalist

Soil moisture has a big impact on our weather, and measurements of soil moisture are used in models to forecast droughts, extreme rain and flooding.

"Both my master's degree and my PhD focused on atmospheric measurements, but here at NILU I work on evaluating measurements from three satellites which gauge soil moisture", Griesfeller explains. She took up her job as a post doc at NILU's Atmosphere and Climate Department in March 2012.

NILU uses the information from the satellites in its own research, but also share it with other institutes, like the Norwegian Meteorological Institute. NILU is responsible for monitoring the quality of the measurements.

"It is particularly difficult to measure soil moisture in Norway from a satellite, because the ground is often covered by ice and snow, there is a lot of forest, many lakes and a long coastline relative to the land mass."

Working with two colleagues, Griesfeller has looked at measurements from the SMOS, ASCAT and AMSR-E satellites for six different places in Norway, to see how they compare to measurements done in situ.

The physical soil measurements are carried out by the Norwegian Water Resource and Energy Directorate. When Griesfeller and her colleagues compared the measurements, they found a high correlation, despite the difficulties.

"This opens up new possibilities when it comes to measuring soil moisture. Instead of relying on point measurements, we are now able to map large areas", says a very pleased Griesfeller.

Nina Iren Kristiansen

Nina Iren Kristiansen gained her PhD at the Department of Geosciences at the University of Oslo in September 2012. Her doctoral thesis mainly concerned gases and particles released from volcanic eruptions like Eyjafjallajökull in 2010 and from nuclear power stations, like Fukushima during the 2011 accident.

Nina Iren Kristiansen, NILU. Photo: Ingar Næss.

Sonja Grossberndt
Scientist

Powerful volcanic eruptions can send large quantities of sulphur dioxide – SO_2 – up into the stratosphere, and can affect the climate in the years that follow. By the use of satellite data and model simulations, Kristiansen was able to reconstruct the strength and variations in the SO_2 emissions from the Kasatochi eruption in Alaska in 2008. One year into her doctorate studies, the Eyjafjallajökull volcano in Iceland erupted, sending large amounts of volcanic ash towards Europe, paralysing much of the air transport system.
During the eruption, Kristiansen, along with many others at NILU, observed and modelled the ash clouds. One problem was that during the eruption the ash emissions were not well characterized and this unknown affected the accuracy of the model forecasts. Only afterwards the ash emission strengths and variations were reconstructed using all available observation data which lead to better model simulations. During the Grimvötn eruption a year later, Nina was part of the national volcanic ash evaluation group (EVA), along with the Meteorological Institute, NILU and the Norwegian aviation authorities. It was the work of this group, notably their analysis of satellite data, which enabled air traffic over Norway to operate as normal, one of few countries in Europe in which that was possible.
Kristiansen is now working in a team that will develop an improved volcanic ash forecasts system where observation data are utilized and emissions are estimated more accurately during an eruption.

How long do aerosols live?

The other part of Kristiansen's doctorate concerned estimating the lifetime of aerosols, based on measurements of radioactivity. The study analysed radioactive substances which were released during the 2011 Fukushima accident in Japan. These radioactive substances attached to ambient aerosols (mainly sulphate) which were present in the surrounding air. Henceforth, the aerosols and the radioactivity were transported together across the whole Northern hemisphere and the radioactivity was detected on measurement stations. When radioactivity was measured, aerosols were also measured. Observations from a dozen stations were analysed, and the lifetime of aerosols was estimated to be ten to twelve days. This estimate is longer than what is reported as the global lifetime for sulphate aerosols in most global air quality and climate models.

Kyrre Sundseth

On 5 October 2012, Kyrre Sundseth defended his doctoral thesis on reducing mercury levels in Europe, at Gdansk University of Technology. The work is an important contribution to the debate on reducing mercury emissions.

Sonja Grossberndt
Scientist

Kyrre Sundseth, NILU. Photo: Ingunn Trones, NILU.

Mercury is highly poisonous, long lived and can be transported over large distances, mainly via the atmosphere. As mercury can be deposited far from where it originates, it is seen as a global problem.

A tool for environmental policy making

As early as 2007, a team from NILU was asked to coordinate the research required as a basis for negotiations about a global agreement on mercury. The research contained an overview of mercury emissions past and present, future emission scenarios, technological and non-technological measures to reduce emissions, and a cost benefit analysis of the implementation of these measures.

Kyrre Sundseth's thesis, "A novel combination of methods developed for decision support on abatement of mercury in Europe", aimed to put together a political decision making tool for environmental policy making, in order to find the most efficient solutions for the reduction of mercury emissions locally, regionally and globally. The study demonstrated a comprehensive analysis of the global benefit of lower mercury emissions in the EU, and listed the most cost effective future measures.

The largest emission source is stationary coal combustion, followed by metal production. Substantial financial savings can be achieved globally by reducing mercury emissions in the EU. The analysis demonstrated the importance of a comprehensive approach reducing emissions, of implementing planned emission reductions, and of taking further steps to reduce emissions. The cost benefit analysis revealed that the costs of further technological reductions of mercury emissions in the energy sector (coal plants) in the EU, is likely to exceed the benefit. However, it also showed that it could be economical for the EU to invest in measures to reduce emissions in (and hence atmospheric transport from) developing countries, where the marginal cost of reducing emissions reductions is lower. The local co- benefit of at the same time reducing other environmental toxins (like PM, NOx and SO_2) in these developing countries are also greater than if the same type of investment were done in the EU.

Research for a cleaner atmosphere

NILU – the Norwegian Institute for Air Research was established in 1969. The aim of our research is to increase the understanding of processes and consequences in our core areas: atmospheric composition, climate change, air quality and hazardous substances. We hold strong national and international positions in these areas. We also deliver services closely linked to our research.

National and international activities

NILU has extensive experience of coordinating national and international research projects, and undertakes a range of assignments both in Norway and abroad. More than 30 per cent of our revenues are from international research assignments.

Our main clients are the EU, The Research Council of Norway, national and local authorities and industry.

Major international NILU clients

- The European Commission
- European Environmental Agency
- Environment Agency Abu Dhabi
- World Bank
- World Meteorological Organization
- World Health Organisation
- UN Environmental Programme
- UN Economic Commission for Europe

The Institute takes an active part in EU's Framework Programmes for research, and has a central role as a Chemical Coordinating Centre under EMEP (Programme for Monitoring and Evaluation of the Long-Range Transmission of Air Pollutants in Europe).

NILU also provides support to other international organisations, like the World Meteorological Organization (WMO) and Global Atmosphere Watch (GAW). Within GAW, NILU operates the World Data Centre for Aerosols, and our researchers are represented in several of the programme's scientific advisory groups. NILU's Zeppelin Observatory is one of the most significant global GAW stations.

NILU has established a research department in the United Arab Emirates, located at Abu Dhabi University. The department runs research projects and supplies research-based services. The main activities are consultancy and services concerning air pollution, climate change, noise and indoor air quality.

NILU also part owns environmental research companies in Poland and South Africa.

Air quality

Research into local air pollution is one of our core activities. Traditional air pollutants are decreasing in industrialised countries, but at the same time there is an increase in new substances and in known gases which are detrimental to human health, like nitrogen oxide, NO_2 and ground level ozone. New measures in urban planning can cause new pollution problems, posing dangers to health and the environment, and in fast-growing economies rapid urbanisation and industrialisation can lead to increased air pollution.

We offer research-based consultancy services, drawing on our considerable skills and experience in air research, combined with highly qualified researchers and in-house developed software.

Climate research and surveillance

From observatories in Norway, the Arctic and the Antarctic, NILU monitors climate forcers, greenhouse gases, environmental pollutants, air quality and long-range transport of pollution. The data are available to researchers from all over the world.

There is an increasing national and international geopolitical interest in the Arctic and the northernmost regions of the world. The Arctic can give crucial early warning of global processes, and our monitoring there gives us valuable knowledge. New, growing industries, like oil and gas exploration and shipping and mining in the north, brings to the fore new issues relating to the Arctic environment.

NILU's observatories in Norway, the Arctic and the Antarctic supply scientists around the world with important data about pollution, green house gases and climate forcers. Here: NILU's Troll observatory in the Antarctic. Photo: Are Bäcklund, NILU

NILU has a lot to contribute to Norway's Arctic and Northern Areas Initiative.

Laboratories

NILU's accredited chemical laboratories are among the most advanced in Europe. We are at the forefront of research into, identification of, and impact analysis of new hazardous and other substances harmful to health and the environment. Using advanced analytical tools, including several high-resolution mass spectrometers, we carry out very accurate readings of both organic and inorganic pollution.

Innovation

NILU seeks to contribute to the development of the knowledge based society through innovation. We market our innovations through NILU Innovation AS. This wholly owned subsidiary is also a holding company for Nicarnica AS, Nicarnica Aviation AS and Comet Biotech AS.

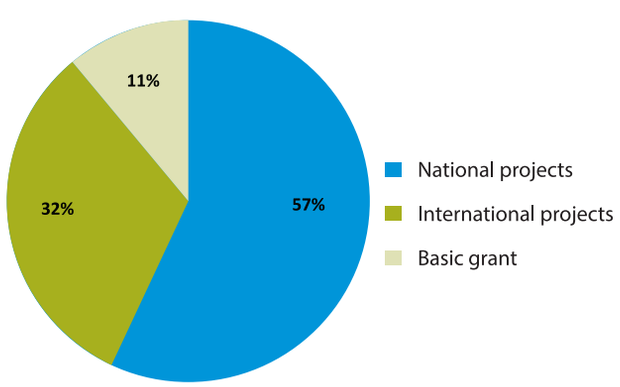
Key figures

Extract from the Annual statements: All figures in MNOK

INCOME STATEMENT (MNOK)	2012	2011
Project revenue	185,1	169,8
Basic grant	23,8	22,8
Other operating income	0,9	0,4
Operating revenue	**209,8**	**193,0**
Wages and social expenses	-133,8	-125,7
Direct project expenses	-34,5	-26,8
Other expenses	-37,8	-38,0
Operating profit	**3,7**	**2,5**
Net financial items	-2,1	1,5
Tax	1,6	0
Profit for the year	**3,2**	**4,0**

BALANCE SHEET (MNOK)	31.12.12	31.12.11
Fixed assets	114,4	99,3
Management funds	39,0	1,2
Current assets	72,4	80,1
Total assets	**225,8**	**180,6**
Total equity	105,3	109,8
Long-term liabilities	20,0	13,0
Management funds	39,0	1,2
Short-term liabilities	61,5	56,6
Total equity and liabilities	**225,8**	**180,6**

PROJECT PORTFOLIO - PERCENTAGE 2012



NUMBER OF MAN-YEARS	2012	2011
Total	180	185
- whereof research man-years	93	98
- whereof man-years of other personnel	87	87
Turnover per research man-year (MNOK)	**2,2**	**2,0**

NUMBER OF EMPLOYEES	2012	2011
Total	200	197
- whereof women	89	83
- whereof men	111	114
Number of employees holding a doctorate	**61**	**58**

PROJECT PORTFOLIO - PERCENT	2012	2011
National projects	57%	54%
International projects	32%	34%
Basic grant	11%	12%
Total	**100%**	**100%**

PROJECT PORTFOLIO - NUMBERS	2012	2011
0 - 100 000	87	106
101 000 - 500 000	113	119
501 000 - 2 000 000	56	54
2 001 000 and over	20	21
Total	**276**	**300**

NILU's PUBLICATIONS	2012	2011
Scientific Papers	151	116
Scientific Reports	43	73
Technical Reports	1	4
EMEP/CCC reports	4	7
Lectures	109	91
Posters	21	18
NILU scientists contributed to the publishing of:		
External reports	16	16
Chapters/articles in books/reports	71	74

Peer-review papers

Aas, W., Tsyro, S., Bieber, E., Bergström, R., Ceburnis, D., Ellermann, T., Fagerli, H., Frölich, M., Gehrig, R., Makkonen, U., Nemitz, E., Otjes, R., Perez, N., Perrino, C., Prévôt, A. S. H., Putaud, J.-P., Simpson, D., Spindler, G., Vana, M., Yttri, K.E. (2012) Lessons learnt from the first EMEP intensive measurement periods. *Atmos. Chem. Phys., 12*, 8073-8094. doi:10.5194/acp-12-8073-2012.

Aleksandropoulou, V., Eleftheriadis, K., Diapouli, E., Tørseth, K., Lazaridis, M. (2012) Assessing PM10 source reduction in urban agglomerations for air quality compliance. *J. Environ. Monit., 14*, 266-278. doi:10.1039/C1EM10673B.

Amiridis, V., Zerefos, C., Kazadzis, S., Gerasopoulos, E., Eleftheratos, K., Vrekoussis, M., Stohl, A., Mamouri, R.E., Kokkalis, P., Papayannis, A., Eleftheriadis, K., Diapouli, E., Keramitsoglou, I., Kontoes, C., Kotroni, V., Lagouvardos, K., Marinou, E., Giannakaki, E., Kostopoulou, E., Giannakopoulos, C., Richter, A., Burrows, J.P., N. Mihalopoulos, N. (2012) Impact of the 2009 Attica wild fires on the air quality in urban Athens. *Atmos. Environ., 46*, 536-544. doi:10.1016/j.atmosenv.2011.07.056.

Arnot, J.A., Brown, T.N., Wania, F., Breivik, K., McLachlan, M.S. (2012) Prioritizing chemicals and data requirements for screening level exposure and risk assessment. *Environ. Health Perspect., 120*, 1565-1570. doi:10.1289/ehp.1205355.

Barré, J., Peuch, V.-H., Attié, J.-L., El Amraoui, L., Lahoz, W. A., Josse, B., Claeyman, M., Nédélec, P. (2012) Stratosphere-troposphere ozone exchange from high resolution MLS ozone analyses. *Atmos. Chem. Phys., 12*, 6129-6144. doi:10.5194/acp-12-6129-2012.

Bartonova, A. (2012) How can scientists bring research to use: the HENVINET experience. *Environ. Health, 11*, Suppl. 1, S 2, doi:10.1186/1476-069X-11-S1-S2.

Bartonova, A., Koppe, J.G., Fucic, A., Gutleb, A., van den Hazel, P., Keune, H. (2012) The Health and Environment Network and its achievements. *Environ. Health, 11*, Suppl. 1, S 1, doi:10.1186/1476-069X-11-S1-S1.

Becker, S., Halsall, C.J., Tych, W., Kallenborn, R., Schlabach, M., Manø, S. (2012) Changing sources and environmental factors reduce the rates of decline of organochlorine pesticides in the Arctic atmosphere. *Atmos. Chem. Phys., 12*, 4033-4044. doi:10.5194/acp-12-4033-2012.

Bergkvist, C., Aune, M., Nilsson, I., Sandanger, T.M., Hamadani, J.D., Tofail, F., Odland, J.-Ø., Kabir, I., Vahter, M. (2012) Occurrence and levels of organochlorine compounds in human breast milk in Bangladesh. *Chemosphere, 88*, 784-790. doi:10.1016/j.chemosphere.2012.03.083.

Bergström, R., Denier van der Gon, H. A. C., Prévôt, A. S. H., Yttri, K. E., Simpson, D. (2012) Modelling of organic aerosols over Europe (2002-2007) using a volatility basis set (VBS) framework: application of different assumptions regarding the formation of secondary organic aerosol. *Atmos. Chem. Phys., 12*, 8499-8527. doi:10.5194/acp-12-8499-2012.

Bernhard, G., Manney, G., Fioletov, V., Grooß, J.-U., Heikkilä, A., Johnsen, B., Koskela, T., Lakkala, K., Müller, R., Myhre, C.L., Rex, M. (2012) Ozone and UV radiation. In: State of the climate 2011. *Bull. Amer. Meteor. Soc., 93*, S129-S132.

Blechschmidt, A.M., Kristjánsson, J.E., Ólafsson, H., Burkhart, J.F., Hodnebrog, Ø., Rosenberg, P.D. (2012) Aircraft-based observations and high-resolution simulations of an Icelandic dust storm. *Atmos. Chem. Phys., 12*, 10649-10666. 10.5194/acp-12-10649-2012.

Bouwman, H., Kylin, H., Seredad, B., Bornmane, R. (2012) High levels of DDT in breast milk: Intake, risk, lactation duration, and involvement of gender. *Environ. Pollut., 170*, 63-70. doi:10.1016/j.envpol.2012.06.009.

Bouwman, H., Kylin, H., Yive, N.S.C.K., Tatayah, V., Løken, K., Skaare, J.U., Polder, A. (2012) First report of chlorinated and brominated hydrocarbon pollutants in marine bird eggs from an oceanic Indian Ocean island. *Environ. Res., 118*, 53-64. doi:10.1016/j.envres.2012.05.009.

Breivik, K., Arnot, J.A., Brown, T.N., Wania, F., McLachlan, M.S. (2012) Screening organic chemicals in commerce for emissions in the context of environmental and human exposure. *J. Environ. Monit., 14*, 2028-2037. doi:10.1039/C2EM30259D.

Brito, A.C., Fernandes, T.F., Newton, A., Facca, C., Tett, P. (2012) Does microphytobenthos resuspension influence phytoplankton in shallow systems? A comparison through a Fourier series analysis. *Estuar. Coast. Shelf Sci., 110*, 77-84. doi:10.1016/j.ecss.2012.03.028.

Brito, A.C., Newton, A., Tett, P., Fernandes, T.F. (2012) Changes in the yield of microphytobenthic chlorophyll from nutrients: Considering denitrification. *Ecol. Indicat., 19*, 226-230. doi:10.1016/j.ecolind.2011.07.026.

Brito, A.C., Newton, A., Tett, P., Fernandes, T.F. (2012) How will shallow coastal lagoons respond to climate change? A modelling investigation. *Estuar. Coast. Shelf Sci., 112*, 98-104. doi:10.1016/j.ecss.2011.09.002.

Brito, A.C., Quental, T., Coutinho, T.P., Branco, M.A.C., Falcão, M., Newton, A., Icely, J., Moita, T. (2012) Phytoplankton dynamics in southern Portuguese coastal lagoons during a discontinuous period of 40 years: An overview. *Estuar. Coast. Shelf Sci., 110*, 147-156. doi:10.1016/j.ecss.2012.04.014.

Brown, R.J., Bonadonna, C., Durant, A.J. (2012) A review of volcanic ash aggregation. *Phys. Chem. Earth A/B/C, 45-46*, 65-78. doi:10.1016/j.pce.2011.11.001.

Bustnes, J.O., Moe, B., Hanssen, S.A., Herzke, D., Fenstad, A.A., Nordstad, T., Borgå, K., Gabrielsen, G.W. (2012) Temporal dynamics of circulating persistent organic pollutants in a fasting seabird under different environmental conditions. *Environ. Sci. Technol., 46*, 10287-10294. doi:10.1021/es301746j.

Cañedo-Argüelles, M., Rieradevall, M., Farrés-Corell, R., Newton, A. (2012) Annual characterisation of four Mediterranean coastal lagoons subjected to intense human activity. *Estuar. Coast. Shelf Sci., 114*, 59-69. doi:10.1016/j.ecss.2011.07.017.

Castell-Balaguer, N., Téllez, L., Mantilla, E. (2012) Daily, seasonal and monthly variations in ozone levels recorded at the Turia river basin in Valencia (Eastern Spain). *Environ. Sci. Pollut. Res., 19*, 3461-3480. doi:10.1007/s11356-012-0881-5.

Channa, K., Röllin, H.B., Nøst, T.H., Odland, J.Ø., Sandanger, T.M. (2012) Prenatal exposure to DDT in malaria endemic region following indoor residual spraying and in non-malaria coastal regions of South Africa. *Sci. Total Environ., 429*, 183-190. doi:10.1016/j.scitotenv.2012.03.073.

Channa, K., Röllin, H.B., Wilson, K., Nøst, T.H., Odland, J.Ø., Naik, I., Sandanger, T.M. (2012) Regional variation in pesticide concentrations in plasma of delivering women residing in rural Indian Ocean coastal regions of South Africa. *J. Environ. Monit., 14*, 2952-2960. doi:10.1039/C2EM30264K.

Denby, B. (2012) Source apportionment of PM2.5 in urban areas using multiple linear regression as an inverse modelling technique. *Int. J. Environ. Pollut., 47 (2011)*, 60-69. doi:10.1504/IJEP.2011.047326.

Dickhut, R.M., Cincinelli, A., Cochran, M., Kylin, H. (2012) Aerosol-mediated transport and deposition of brominated diphenyl ethers to Antarctica. *Environ. Sci. Technol., 45*, 3135-3140. doi:10.1021/es204375p.

Dörnbrack, A., Pitts, M. C., Poole, L. R., Orsolini, Y. J., Nishii, K., Nakamura, H. (2012) The 2009-2010 Arctic stratospheric winter - general evolution, mountain waves and predictability of an operational weather forecast model. *Atmos. Chem. Phys., 12*, 3659-3675. doi:10.5194/acp-12-3659-2012.

Durant, A., Villarosa, G., Rose, W.I., Delmelle, P., Prata, A.J., Viramonte, J.G. (2012) Long-range volcanic ash transport and fallout during the 2008 eruption of Chaitén volcano, Chile. *Phys. Chem. Earth A/B/C, 45-46*, 50-64. doi:10.1016/j.pce.2011.09.004.

Durnford, D. A., Dastoor, A. P., Steen, A. O., Berg, T., Ryzhkov, A., Figueras-Nieto, D., Hole, L. R., Pfaffhuber, K. A., Hung, H. (2012) How relevant is the deposition of mercury onto snowpacks? - Part 1: A statistical study on the impact of environmental factors. *Atmos. Chem. Phys., 12*, 9221-9249. doi:10.5194/acp-12-9221-2012.

Dusinska, M., Staruchova, M., Horska, A., Smolkova, B., Collins, A., Bonassi, S., Volkovova, K. (2012) Are glutathione S transferases involved in DNA damage signalling? Interactions with DNA damage and repair revealed from molecular epidemiology studies. *Mutat. Res., 736*, 130-137. doi: 10.1016/j.mrfmmm.2012.03.003.

Dziendzikowska, K., Gromadzka-Ostrowska, J., Lankoff, A., Oczkowski, M., Krawczyńska, A., Chwastowska, J., Sadowska-Bratek, M., Chajduk, E., Wojewódzka, M., Dusinska, M., Kruszewski, M. (2012) Time-dependent biodistribution and excretion of silver nanoparticles in male Wistar rats. *J. Appl. Toxicol., 32*, 920-928. doi:10.1002/jat.2758.

Eqani, S.A.M.A.S., Malik, R.N., Katsoyiannis, A., Zhang, G., Chakraborty, P., Mohammad, A., Jones, K.C. (2012) Distribution and risk assessment of organochlorine contaminants in surface water from River Chenab, Pakistan. *J. Environ. Monit., 14*, 1645-1654. doi:10.1039/c2em11012a.

Forsberg, B., Bråbäck, L., Keune, H., Kobernus, M., von Krauss, M.K., Yang, A., Bartonova, A. (2012) An expert assessment on climate change and health - with a European focus on lungs and allergies. *Environ. Health, 11*, Suppl. 1, S 4, doi:10.1186/1476-069X-11-S1-S4.

Fucic, A., Gamulin, M., Ferencic, Z., Katic, J., von Krauss, M.K., Bartonova, A., Merlo, D.F. (2012) Environmental exposure to xenoestrogens and oestrogen related cancers: reproductive system, breast, lung, kidney, pancreas, and brain. *Environ. Health, 11*, Suppl. 1, S 8, doi:10.1186/1476-069X-11-S1-S8.

Genareau, K., Proussevitch, A.A., Durant, A., Mulukutla, G., Sahagian, D.L. (2012) Sizing up the bubbles that produce very fine ash during explosive volcanic eruptions. *Geophys. Res. Lett., 39*, L15306, doi:10.1029/2012GL052471.

Gimeno, L., Stohl, A., Trigo, R.M., Dominguez, F., Yoshimura, K., Yu, L., Drumond, A., Durán-Quesada, A.M., Nieto, R. (2012) Oceanic and terrestrial sources of continental precipitation. *Rev. Geophys., 50*, RG4003, doi: 10.1029/2012RG000389.

Grøntoft, T. (2012) Performance evaluation for museum enclosures. Measurement, modelling and mitigation of pollutant impact on objects in museum enclosures. *e-Preserv. Sci., 9*, 36-46.

Grøntoft, T., Lopez-Aparicio, S., Scharff, M., Ryhl-Svendsen, M., Andrade, G., Obarzanowski, M., Thickett, D. (2012) Impact loads of air pollutants on paintings: performance evaluation by modeling for microclimate frames. *J. Am. Inst. Conserv., 50 (2011), 2*, 105-122.

Grossberndt, S., van den Hazel, P., Bartonova, A. (2012) Application of social media in the environment and health professional community. *Environ. Health, 11*, Suppl. 1, S 16, doi:10.1186/1476-069X-11-S1-S16.

Gudmundsson, M.T., Thordarson, T., Höskuldsson, A., Larsen, G., Björnsson, H., Prata, F.J., Oddsson, B., Magnússon, E., Högnadóttir, T., Petersen, G.N., Hayward, C.L., Stevenson, J.A., Jónsdóttir, I. (2012) Ash generation and distribution from the April-May 2010 eruption of Eyjafjallajökull, Iceland. *Sci. Rep., 2*, 572, doi:10.1038/srep00572.

Halse, A.K., Schlabach, M., Sweetman, A., Jones, K.C., Breivik, K. (2012) Using passive air samplers to assess local sources versus long range atmospheric transport of POPs. *J. Environ. Monit., 14*, 2580-2590. 10.1039/C2EM30378G.

Handy, R.D., van den Brink, N., Chappell, M., Mühling, M., Behra, R., Dusinska, M., Simpson, P., Ahtiainen, J., Jha, A.N., Seiter, J., Bednar, A., Kennedy, A., Fernandes, T.F., Riediker, M. (2012) Practical considerations for conducting ecotoxicity test methods with manufactured nanomaterials: what have we learnt so far? *Ecotoxicology, 21*, 933-972. doi: 10.1007/s10646-012-0862-y.

Hansen, L.S., Åkerlund, M., Grøntoft, T., Ryhl-Svendsen, M., Schmidt, A.L., Bergh, J.E., Jensen, K.M.V. (2012) Future pest status of an insect pest in museums, Attagenus smirnovi: Distribution and food consumption in relation to climate change. *J. Cult. Herit., 13*, 22-27. doi:10.1016/j.culher.2011.05.005.

Hansen, T., Moe, M.K., Anderssen, T., Strøm, M.B. (2012) Metabolism of small antimicrobial ß2,2-amino acid derivatives by murine liver microsomes. *Eur. J. Drug Metab. Pharmacokinet., 37*, 191-201. doi:10.1007/s13318-012-0086-9.

Hasplova, K., Hudecova, A., Magdolenova, Z., Bjøras, M., Galova, E., Miadokova, E., Dusinska, M. (2012) DNA alkylation lesions and their repair in human cells: Modification of the comet assay with 3-methyladenine DNA glycosylase (AlkD). *Toxicol. Lett., 208*, 76-81. doi:10.1016/j.toxlet.2011.10.005.

Hassan, A.A., Brustad, M., Sandanger, T.M. (2012) Concentrations and geographical variations of selected toxic elements in meat from semi-domesticated reindeer (Rangifer tarandus tarandus L.) in mid- and northern Norway: Evaluation of risk assessment. *Int. J. Environ. Res. Public Health, 9*, 1699-1714. doi: 10.3390/ijerph9051699.

Hassan, A.A., Rylander, C., Brustad, M., Sandanger, T.M. (2012) Level of

selected toxic elements in meat, liver, tallow and bone marrow of young semi-domesticated reindeer (Rangifer tarandus tarandus L.) from Northern Norway. *Int. J. Circumpolar Health, 71*, 18187, doi: 10.3402/ijch.v71i0.18187.

Hassan, A.A., Sandanger, T.M., Brustad, M. (2012) Level of selected nutrients in meat, liver, tallow and bone marrow from semi-domesticated reindeer (Rangifer t. tarandus L.). *Int. J. Circumpolar Health, 71*, 17997, doi: 10.3402/ijch.v71i0.17997.

Hassan, A.A., Sandanger, T.M., Brustad, M. (2012) Selected vitamins and essential elements in meat from semi-domesticated reindeer (Rangifer tarandus tarandus L.) in Mid- and Northern Norway: geographical variations and effect of animal population density. *Nutrients, 4*, 724-739. doi: 10.3390/nu4070724.

Healy, R. M., Sciare, J., Poulain, L., Kamili, K., Merkel, M., Müller, T., Wiedensohler, A., Eckhardt, S., Stohl, A., Sarda-Estève, R., McGillicuddy, E., O'Connor, I. P., Sodeau, J. R., Wenger, J. C. (2012) Sources and mixing state of size-resolved elemental carbon particles in a European megacity: Paris. *Atmos. Chem. Phys., 12*, 1681-1700. doi:10.5194/acp-12-1681-2012.

Hervo, M., Quennehen, B., Kristiansen, N. I., Boulon, J., Stohl, A., Fréville, P., Pichon, J.-M., Picard, D., Labazuy, P., Gouhier, M., Roger, J.-C., Colomb, A., Schwarzenboeck, A., Sellegri, K. (2012) Physical and optical properties of 2010 Eyjafjallajökull volcanic eruption aerosol: ground-based, Lidar and airborne measurements in France. *Atmos. Chem. Phys., 12*, 1721-1736. doi:10.5194/acp-12-1721-2012.

Herzke, D., Olsson, E., Posner, S. (2012) Perfluoroalkyl and polyfluoroalkyl substances (PFASs) in consumer products in Norway - A pilot study. *Chemosphere, 88*, 980-987. doi: 10.1016/j.chemosphere.2012.03.03.

Hodnebrog, Ø., Solberg, S., Stordal, F., Svendby, T. M., Simpson, D., Gauss, M., Hilboll, A., Pfister, G. G., Turquety, S., Richter, A., Burrows, J. P., Denier van der Gon, H. A. C. (2012) Impact of forest fires, biogenic emissions and high temperatures on the elevated Eastern Mediterranean ozone levels during the hot summer of 2007. *Atmos. Chem. Phys., 12*, 8727-8750. doi:10.5194/acp-12-8727-2012.

Hooper, A., Prata, F., Sigmundsson, F. (2012) Remote sensing of volcanic hazards and their precursors. *Proc. IEEE, 100*, 2908-2930. doi:10.1109/JPROC.2012.2196404.

Huber, S., Ahrens, L., Bårdsen, B.-J., Siebert, U., Bustnes, J.O., Víkingsson, G.A., Ebinghaus, R., Herzke, D. (2012) Temporal trends and spatial differences of perfluoroalkylated substances in livers of harbor porpoise (Phocoena phocoena) populations from Northern Europe, 1991-2008. *Sci. Total Environ., 419*, 216-224. doi: 10.1016/j.scitotenv.2011.12.050.

Hudecova, A., Hasplova, K., Kellovska, L., Ikreniova, M., Miadokova, E., Galova, E., Horvathova, E., Vaculcikova, D., Gregan, F., Dusinska, M. (2012) Gentiana asclepiadea and Armoracia rusticana can modulate the adaptive response induced by zeocin in human lymphocytes. *Neoplasma, 59*, 62-69. doi:10.4149/neo_2012_01_008.

Hudecova, A., Hasplova, K., Miadokova, E., Magdolenova, Z., Rinna, A., Collins, A. R., Galova, E., Vaculcikova, D., Gregan, F., Dusinska, M. (2012) Gentiana asclepiadea protects human cells against oxidation DNA lesions. *Cell Biochem. Funct., 30*, 101-107.

Hudecova, A., Kusznierewicz, B., Hasplova, K., Huk, A., Magdolenova, Z., Miadokova, E., Galova, E., Dusinska, M. (2012) Gentiana asclepiadea exerts antioxidant activity and enhances DNA repair of hydrogen peroxide- and silver nanoparticles-induced DNA damage. *Food Chem. Toxicol., 50*, 3352-3359. doi:10.1016/j.fct.2012.06.017.

Hudecova, A., Kusznierewicz, B., Runden-Pran, E., Magdolenova, Z., Hasplova, K., Rinna, A., Fjellsbø, L.M., Kruszewski, M., Lankoff, A., Sandberg, W.J., Refsnes, M., Skuland, T., Schwarze, P., Brunborg, G., Bjøras, M., Collins, A., Miadoková, E., Galova, E., Dusinska, M. (2012) Silver nanoparticles induce premutagenic DNA oxidation that can be prevented by phytochemicals from Gentiana asclepiadea. *Mutagenesis, 27*, 759-769. doi:10.1093/mutage/ges046.

Isaksen, I.S.A., Zerefos, C., Wang, W.-C., Balis, D., Eleftheratos, K., Rognerud, B., Stordal, F., Berntsen, T.K., LaCasce, J.H., Søvde, O.A., Olivié, D., Orsolini, Y.J., Zyrichidou, I., Prather, M., Tuinder, O.N.E. (2012) Attribution of the Arctic ozone column deficit in March 2011. *Geophys. Res. Lett., 39*, L24810, doi:10.1029/2012GL053876.

Karl, M., Dye, C., Schmidbauer, N., Wisthaler, A., Mikoviny, T., D'Anna, B., Müller, M., Borrás, E., Clemente, E., Muñoz, A., Porras, R., Ródenas, M., Vázquez, M., Brauers, Th. (2012) Study of OH-initiated degradation of 2-aminoethanol. *Atmos. Chem. Phys., 12*, 1881-1901. doi:10.5194/acp-12-1881-2012.

Karl, M., Leck, C., Gross, A., Pirjola, L. (2012) A study of new particle formation in the marine boundary layer over the central Arctic Ocean using a flexible multicomponent aerosol dynamic model. *Tellus B, 64*, 17158. doi:10.3402/tellusb.v64i0.17158.

Katsoyiannis, A., Birgul, A., Ratola, N., Cincinelli, A., Sweetman, A.J., Jones, K.C. (2012) Can car air filters be useful as a sampling medium for air pollution monitoring purposes? *Environ. Internat., 48*, 65-70. doi:10.1016/j.envint.2012.06.011.

Katsoyiannis, A., Bogdal, C. (2012) Interactions between indoor and outdoor air pollution - Trends and scientific challenges. Introduction. *Environ. Pollut., 169*, 150-151. doi: 10.1016/j.envpol.2012.04.028.

Kazimirova, A., Magdolenova, Z., Barancokova, M., Staruchova, M., Volkovova, K., Dusinska, M. (2012) Genotoxicity testing of PLGA-PEO nanoparticles in TK6 cells by means of the comet assay and the cytokinesis-block micronucleus assay. *Mutat. Res., 748*, 42-47. doi:10.1016/j.mrgentox.2012.06.012.

Keuken, M.P, Henzing, J.S., Zandveld, P., van den Elshout, S., Karl, M. (2012) Dispersion of particle numbers and elemental carbon from road traffic, a harbour and an airstrip in the Netherlands. *Atmos. Environ., 54*, 320-327. doi:10.1016/j.atmosenv.2012.01.012.

Keune, H., Gutleb, A.C., Zimmer, K.E., Ravnum, S., Yang, A., Bartonova, A., von Krauss, M.K., Ropstad, E., Eriksen, G.S., Saunders, M., Magnanti, B., Forsberg, B. (2012) We're only in it for the knowledge? A problem solving turn in environment and health expert elicitation. *Environ. Health, 11*, Suppl. 1, S 3, doi:10.1186/1476-069X-11-S1-S3.

Keune, H., Ludlow, D., van den Hazel, P., Randall, S., Bartonova, A. (2012) A healthy turn in urban climate change policies; European city workshop proposes health indicators as policy integrators. *Environ. Health, 11*, Suppl. 1, S 14, doi:10.1186/1476-069X-11-S1-S14.

Kim, J., Li, S., Mühle, J., Stohl, A., Kim, S.-K., Park, S., Park, M.-K., Weiss, R.F., Kim, K.-R. (2012) Overview of the findings from measurements of halogenated compounds at Gosan (Jeju Island, Korea) quantifying emissions in East Asia. *J. Integr. Environ. Sci., 9*, suppl. 1, 71-80. doi:10.1080/1943815X.2012.696548.

Klein, T., Kukkonen, J., Dahl, Å., Bossioli, E., Baklanov, A., Vik, A.F., Agnew, P., Karatzas, K.D., Sofiev, M. (2012) Interactions of physical, chemical, and biological weather calling for an integrated approach to assessment, forecasting, and communication of air quality. *Ambio, 41*, 851-864. doi:10.1007/s13280-012-0288-z.

Kogler, C., Pinnock, S., Arino, O., Casadio, S., Corlett, G., Prata, F., Bras, T. (2012) Note on the quality of the (A)ATSR land surface temperature record from 1991 to 2009. *Int. J. Remote Sens., 33*, 4178-4192. doi:10.1080/01431161.2011.645085.

Koo, J.-H., Wang, Y., Kurosu, T. P., Chance, K., Rozanov, A., Richter, A., Oltmans, S. J., Thompson, A. M., Hair, J. W., Fenn, M. A., Weinheimer, A. J., Ryerson, T. B., Solberg, S., Huey, L. G., Liao, J., Dibb, J. E., Neuman, J. A., Nowak, J. B., Pierce, R. B., Natarajan, M., Al-Saadi, J. (2012) Characteristics of tropospheric ozone depletion events in the Arctic spring: analysis of the ARCTAS, ARCPAC, and ARCIONS measurements and satellite BrO observations. *Atmos. Chem. Phys., 12*, 9909-9922. doi:10.5194/acp-12-9909-2012.

Kristiansen, N. I., Stohl, A., Wotawa, G. (2012) Atmospheric removal times of the aerosol-bound radionuclides 137Cs and 131I measured after the Fukushima Daiichi nuclear accident - a constraint for air quality and climate models. *Atmos. Chem. Phys., 12*, 10759-10769. doi:10.5194/acp-12-10759-2012.

Kristiansen, N.I., Stohl, A., Prata, F., Bukowiecki, N., Dacre, H., Eckhardt, S., Henne, S., Hort, M., Johnson, B., Marenco, F., Neininger, B., Reitebuch, O., Seibert, P., Thomson, D., Webster, H., Weinzierl, B. (2012) Performance assessment of a volcanic ash transport model mini-ensemble used for inverse modelling of the 2010 Eyjafjallajökull eruption. *J. Geophys. Res., 117*, D00U11, doi:10.1029/2011JD016844.

Kusznierewicz, B., Baczek-Kwinta, R., Bartoszek, A., Piekarska, A., Huk, A., Manikowska, A., Antonkiewicz, J., Namiesnik, J., Konieczka, P. (2012) The dose-dependent influence of zinc and cadmium contamination of soil on their uptake and glucosinolate content in white cabbage (Brassica oleracea var. capitata f. alba). *Environ. Toxicol. Chem., 31*, 2482-2489. doi:10.1002/etc.1977.

Kvissel, O.-K., Orsolini, Y.J., Stordal, F., Isaksen, I.S.A., Santee, M.L. (2012) Formation of stratospheric nitric acid by a hydrated ion cluster reaction: Implications for the effect of energetic particle precipitation on the middle atmosphere. *J. Geophys. Res., 117*, D16301, doi:10.1029/2011JD017257.

Kvissel, O.-K., Orsolini, Y.J., Stordal, F., Limpasuvan, V., Richter, J.H., Marsh, D.R. (2012) Mesospheric intrusion and anomalous chemistry during and after a major stratospheric sudden warming. *J. Atmos. Sol. Terr. Phys., 78-79*, 116-124. doi:10.1016/j.jastp.2011.08.015.

Kylin, H., Bouwman, H. (2012) Hydration state of the moss Hylocomium splendens and the lichen Cladina stellaris governs uptake and revolatilization of airborne α- and γ-hexachlorocyclohexane. *Environ. Sci. Technol., 46*, 10982-10989. doi:10.1021/es302363g.

Lahoz, W.A., Peuch, V.-H., Orphal, J., Attié, J.-L., Chance, K., Liu, X., Edwards, D., Elbern, H., Flaud, J.-M., Claeyman, M., El Amraoui, L. (2012) Monitoring air quality from space: the case for the geostationary platform. *Bull. Am. Meteorol. Soc., 93*, 221-233. doi:10.1175/BAMS-D-11-00045.1.

Leijs, M.M., ten Tusscher, G.W., Olie, K., van Teunenbroek, T., van Aalderen, W.M.C., de Voogt, P., Vulsma, T., Bartonova, A., von Krauss, M.K., Mosoiu, C., Riojas-Rodriguez, H., Calamandrei, G., Koppe, J.G. (2012) Thyroid hormone metabolism and environmental chemical exposure. *Environ. Health, 11*, Suppl. 1, S 10, doi:10.1186/1476-069X-11-S1-S10.

Leknes, H., Sturtzel, I.E., Dye, C. (2012) Environmental release of oseltamivir from a Norwegian sewage treatment plant during the 2009 influenza A (H1N1) pandemic. *Sci. Total Environ., 414*, 632-638.

Letasiova, S., Medvedova, A., Sovcikova, A., Dusinska, M., Volkovova, K., Mosoiu, C., Bartonova, A. (2012) Bladder cancer, a review of the environmental risk factors. *Environ. Health, 11*, Suppl. 1, S 11, doi:10.1186/1476-069X-11-S1-S11.

Limpasuvan, v., Richter, J.H., Orsolini, Y.J., Stordal, F., Kvissel, O.-K. (2012) The roles of planetary and gravity waves during a major stratospheric sudden warming as characterized in WACCM. *J. Atmos. Sol. Terr. Phys., 78-79*, 84-98. doi:10.1016/j.jastp.2011.03.004.

Liu, H.-Y., Bartonova, A., Neofytou, P., Yang, A., Kobernus, M.J., Negrenti, E., Housiadas, C. (2012) Facilitating knowledge transfer: decision support tools in environment and health. *Environ. Health, 11*, Suppl. 1, S 17, doi:10.1186/1476-069X-11-S1-S17.

Liu, H.-Y., Bartonova, A., Pascal, M., Smolders, R., Skjetne, E., Dusinska, M. (2012) Approaches to integrated monitoring for environment and health impact assessment. *Environ. Health, 11*, 88, doi:10.1186/1476-069X-11-88.

Liu, H.Y., Halvorsen, R. (2012) Single-tree influence on understorey vegetation in five Chinese subtropical forests. *iForest, 5*, 179-187. doi:10.3832/ifor0623-005.

Magdolenova, Z., Bilanicova, D., Pojana, G., Fjellsbø, L.M., Hudecova, A., Hasplova, K., Marcomini, A., Dusinska, M. (2012) Impact of agglomeration and different dispersions of titanium dioxide nanoparticles on the human related in vitro cytotoxicity and genotoxicity. *J. Environ. Monit., 14*, 455-464. doi: 10.1039/C2EM10746E.

Magdolenova, Z., Lorenzo, Y., Collins, A., Dusinska, M. (2012) Can standard genotoxicity tests be applied to nanoparticles? *J. Toxicol. Environ. Health A, 75*, 800-806. doi:10.1080/15287394.2012.690326.

Mazzola, M., Stone, R.S., Herber, A., Tomasi, C., Lupi, A., Vitale, V., Lanconelli, C., Toledano, C., Cachorro, V.E., O'Neill, N.T., Shiobara, M., Aaltonen, V., Stebel, K., Zielinski, T., Petelski, T., Ortiz de Galisteo, J.P., Torres, B., Berjon, A., Goloub, P., Li, Z., Blarel, L., Abboud, I., Cuevas, E., Stock, M., Schulz, K.H., Virkkula, A. (2012) Evaluation of sun photometer capabilities for retrievals of aerosol optical depth at high latitudes: The POLAR-AOD intercomparison campaigns. *Atmos. Environ., 52*, 4-17. doi:10.1016/j.atmosenv.2011.07.042.

Merlo, D.F., Filiberti, R., Kobernus, M., Bartonova, A., Gamulin, M., Ferencic, Z., Dusinska, M., Fucic, A. (2012) Cancer risk and the complexity of the interactions between environmental and host

factors: HENVINET interactive diagrams as simple tools for exploring and understanding the scientific evidence. *Environ. Health*, *11*, Suppl. 1, S 9, doi:10.1186/1476-069X-11-S1-S9.

Miffre, A., David, G., Thomas, B., Rairoux, P., Fjæraa, A.M., Kristiansen, N.I., Stohl, A. (2012) Volcanic aerosol optical properties and phase partitioning behavior after long-range advection characterized by UV-Lidar measurements. *Atmos. Environ.*, *48*, 76-84. doi:10.1016/j.atmosenv.2011.03.057.

Miñarro, M.D., Castell-Balaguer, N., Téllez, L., Mantilla, E. (2012) The use of experimental data and their uncertainty for assessing ozone photochemistry in the Eastern Iberian Peninsula. *Chemosphere*, *89*, 796-804. doi:10.1016/j.chemosphere.2012.04.056.

Moe, M.K., Huber, S., Svenson, J., Hagenaars, A., Pabon, M., Trümper, M., Berger, U., Knapen, D., Herzke, D. (2012) The structure of the fire fighting foam surfactant Forafac®1157 and its biological and photolytic transformation products. *Chemosphere*, *89*, 869-875. doi:10.1016/j.chemosphere.2012.05.012.

Naiker, Y., Diab, R.D., Zunckel, M., Hayes, E.T. (2012) Introduction of local Air Quality Management in South Africa: overview and challenges. *Environ. Sci. Polit.*, *17*, 62-71. doi:10.1016/j.envsci.2011.11.009.

Newton, N., Carruthers, T., Icely, J. (2012) The coastal syndromes and hotspots on the coast. *Estuar. Coast Shelf Sci.*, *96*, 39-47. doi:10.1016/j.ecss.2011.07.012.

Nordstad, T., Moe, B., Bustnes, J.O., Bech, C., Chastel, O., Goutte, A., Sagerup, K., Trouvé, C., Herzke, D., Gabrielsen, G.W. (2012) Relationships between POPs and baseline corticosterone levels in black-legged kittiwakes (Rissa tridactyla) across their breeding cycle. *Environ. Pollut.*, *164*, 219-226. doi:10.1016/j.envpol.2012.01.044.

Nøst, T.H., Helgason, L.B., Harju, M, Heimstad, E.S., Gabrielsen, G.W., Jenssen, B.M. (2012) Halogenated organic contaminants and their correlations with circulating thyroid hormones in developing Arctic seabirds. *Sci. Total Environ.*, *414*, 248-256. doi:10.1016/j.scitotenv.2011.11.051.

Nygård, T., Steinnes, E., Røyset, O. (2012) Distribution of 32 elements in organic surface soils: Contributions from atmospheric transport of pollutants and natural sources. *Water Air Soil Pollut.*, 669-713. doi:10.1007/s11270-011-0895-5.

Orsolini, Y.J., Senan, R., Benestad, R.E., Melsom, A. (2012) Autumn atmospheric response to the 2007 low Arctic sea ice extent in coupled ocean-atmosphere hindcasts. *Clim. Dyn.*, *38*, 2437-2448. doi:10.1007/s00382-011-1169-z.

Papayannis, A., Mamouri, R.E., Amiridis, V., Giannakaki, E., Veselovskii, I., Kokkalis, P., Tsaknakis, G., Balis, D., Kristiansen, N.I., , Stohl, A., Korenskiy, M., Allakhverdiev, K., Huseyinoglu, M.F., Baykara, T. (2012) Optical properties and vertical extension of aged ash layers over the Eastern Mediterranean as observed by Raman lidars during the Eyjafjallajökull eruption in May 2010. *Atmos. Environ.*, *48*, 56-66. doi:10.1016/j.atmosenv.2011.08.037.

Perrone, M. R., De Tomasi, F., Stohl, A., Kristiansen, N. I. (2012) Integration of measurements and model simulations to characterize Eyjafjallajökull volcanic aerosols over south-eastern Italy. *Atmos. Chem. Phys.*, *12*, 10001-10013. doi:10.5194/acp-12-10001-2012.

Pfaffhuber, K. A., Berg, T., Hirdman, D., Stohl, A. (2012) Atmospheric mercury observations from Antarctica: seasonal variation and source and sink region calculations. *Atmos. Chem. Phys.*, 12, 3241-3251. doi:10.5194/acp-12-3241-2012.

Pikridas, M., Riipinen, I., Hildebrandt, L., Kostenidou, E., Manninen, H., Mihalopoulos, N., Kalivitis, N., Burkhart, J.F., Stohl, A., Kulmala, M., Pandis, S.N. (2012) New particle formation at a remote site in the eastern Mediterranean. *J. Geophys. Res.*, *117*, D12205, doi:10.1029/2012JD017570.

Prata, A.J., Prata, A.T. (2012) Eyjafjallajökull volcanic ash concentrations determined using Spin Enhanced Visible and Infrared Imager measurements. *J. Geophys. Res.*, *117*, D00U23, doi:10.1029/2011JD016800.

Quennehen, B., Schwarzenboeck, A., Matsuki, A., Burkhart, J.F., Stohl, A., Ancellet, G., Law, K.S. (2012) Anthropogenic and forest fire pollution aerosol transported to the Arctic: observations from the POLARCAT-France spring campaign. *Atmos. Chem. Phys.*, *12*, 6437-6454. doi:10.5194/acp-12-6437-2012.

Quinn, C.L., Armitage, J.M., Breivik, K., Wania, K. (2012) A methodology for evaluating the influence of diets and intergenerational dietary transitions on historic and future human exposure to persistent organic pollutants in the Arctic. *Environ. Int.*, *49*, 83-91. doi:10.1016/j.envint.2012.08.014.

Ratola, N., Cincinelli, A., Alves, A., Katsoyiannis, A. (2012) Occurrence of organic microcontaminants in the wastewater treatment process. A mini review. *J. Hazard. Mater.*, *239-240*, 1-18. doi: 10.1016/j.jhazmat.2012.05.040.

Rauthe-Schöch, A., Weigelt, A., Hermann, M., Martinsson, B. G., Baker, A. K., Heue, K.-P., Brenninkmeijer, C.A.M., Zahn, A., Scharffe, D., Eckhardt, S., Stohl, A., van Velthoven, P.F.J. (2012) CARIBIC aircraft measurements of Eyjafjallajökull volcanic clouds in April/May 2010. *Atmos. Chem. Phys.*, *12*, 879-902. doi:10.5194/acp-12-879-2012.

Ravnum, S., Zimmer, K.E., Keune, H., Gutleb, A.C., Murk, A.J., Koppe, J.G., Magnanti, B., Lyche, J.L., Eriksen, G.S., Ropstad, E., Skaare, J.U., Kobernus, M., Yang, A., Bartonova, A., von Krauss, M.K. (2012) Policy relevant results from an expert elicitation on the human health risks of decabromodiphenyl ether (decaBDE) and hexabromocyclododecane (HBCD). *Environ. Health*, *11*, Suppl. 1, S 7, doi:10.1186/1476-069X-11-S1-S7.

Rodríguez, E., Toledano, C., Cachorro, V.E., Ortiz, P., Stebel, K., Berjón, A., Blindheim, S., Gausa, M., de Frutos, A.M. (2012) Aerosol characterization at the sub-Arctic site Andenes (69°N, 16°E), by the analysis of columnar optical properties. *Q. J. Roy. Meteorol. Soc.*, *138*, 471-482. doi:10.1002/qj.921.

Rudge, C.V.V., Sandanger, T., Röllind, H.B., Calderona, I.M.P., Volpatoa, G., Silvaf, J.L.P., Duarteg, G., Netoh, C.M., Sassi, N., Nakamuraj, M.U., Odland, J.Ø., Rudgea, M.V.C. (2012) Levels of selected persistent organic pollutants in blood from delivering women in seven selected areas of São Paulo State, Brazil. *Environ. Int.*, *40*, 162-169. doi:10.1016/j.envint.2011.07.006.

Rylander, C., Lund, E., Frøyland, L., Sandanger, T.M. (2012) Predictors of PCP, OH-PCBs, PCBs and chlorinated pesticides in a general female Norwegian population. *Environ. Int.*, *43*, 13-20. doi: 10.1016/j.envint.2012.02.008.

Saikawa, E., Rigby, M., Prinn, R. G., Montzka, S. A., Miller, B. R., Kuijpers, L. J. M., Fraser, P. J. B., Vollmer, M. K., Saito, T., Yokouchi, Y., Harth, C. M., Mühle, J., Weiss, R. F., Salameh, P. K., Kim, J., Li, S., Park, S., Kim, K.-R., Young, D., O'Doherty, S., Simmonds, P. G., McCulloch, A., Krummel, P. B., Steele, L. P., Lunder, C., Hermansen, O., Maione, M., Arduini, J., Yao, B., Zhou, L. X., Wang, H. J., Elkins, J. W., Hall, B. (2012) Global and regional emission estimates for HCFC-22. *Atmos. Chem. Phys.*, *12*, 10033-10050. doi:10.5194/acp-12-10033-2012.

Saunders, M., Magnanti, B.L., Carreira, S.C., Yang, A., Alamo-Hernández, U., Riojas-Rodriguez, H., Calamandrei, G., Koppe, J.G., von Krauss, M.K., Keune, H., Bartonova, A. (2012) Chlorpyrifos and neurodevelopmental effects: a literature review and expert elicitation on research and policy. *Environ. Health*, *11*, Suppl. 1, S 5, doi:10.1186/1476-069X-11-S1-S5.

Schneider, P., van der A., R.J. (2012) A global single-sensor analysis of 2002-2011 tropospheric nitrogen dioxide trends observed from space. *J. Geophys. Res.*, *117*, D16309, doi:10.1029/2012JD017571.

Schuster, J.K., Gioia, R., Harner, T., Lee, S.C., Breivik, K., Jones, K.C. (2012) Assessment of sorbent impregnated PUF disks (SIPs) for long-term sampling of legacy POPs. *J. Environ. Monit.*, *14*, 71-78. doi:10.1039/C1EM10697J.

Seibert, P., Kristiansen, N.I., Richter, A., Eckhardt, S., Prata, A.J., Stohl, A. (2012) Uncertainties in the inverse modelling of sulphur dioxide eruption profiles. Corrigendum. *Geomatics Nat. Hazard Risk*, *3*, 97. doi:10.1080/19475705.2011.635854.

Sekovski, I., Newton, A., Dennison, C. W. (2012) Erratum to "Megacities in the coastal zone: Using a driver-pressure-state-impact-response framework to address complex environmental problems" [Estuar. Coast. Shelf Sci. 96 (2012) 48-59]. *Estuar. Coast Shelf Sci.*, *104-105*, 123. doi:10.1016/j.ecss.2012.05.001.

Sekovski, I., Newton, A., Dennison, C. W. (2012) Megacities in the coastal zone: Using a driver-pressure-state-impact-response framework to address complex environmental problems. *Estuar. Coast Shelf Sci.*, *96*, 48-59. doi:10.1016/j.ecss.2011.07.011.

Sivertsen, B., Bartonova, A. (2012) Air quality management planning (AQMP). *Chem. Ind. Chem. Eng. Quart.*, *18*, 667-674. doi:10.2298/CICEQ120110111S.

Sjostedt, S.J., Leaitch, W.R., Levasseur, M., Scarratt, M., Michaud, S., Motard-Côté, J., Burkhart, J.H., Abbatt, J.P.D. (2012) Evidence for the uptake of atmospheric acetone and methanol by the Arctic Ocean during late summer DMS-Emission plumes. *J. Geophys. Res.*, *117*, D12303, doi:10.1029/2011JD017086.

Smita, S., Gupta, S.K., Bartonova, A., Dusinska, M., Gutleb, A.C., Rahman, Q. (2012) Nanoparticles in the environment: assessment using the causal diagram approach. *Environ. Health*, *11*, Suppl. 1, S 13, doi:10.1186/1476-069X-11-S1-S13.

Sobek, A., Arnot, J.A., Breivik, K., Brown, T.N., Wania, F., McLachlan, M.S. (2012) Using models to screen the domain of industrial chemicals for potential environmental contaminants. *Organohalogen Compd.*, *74*, 375-378.

Sonne, C., Bustnes, J.O., Herzke, D., Jaspers, V.L.B., Covaci, A., Eulaers, I., Halley, D.J., Moum, T., Ballesteros, M., Eens, M., Ims, R.A., Hanssen,S.A., Erikstad, K.E., Johnsen, T.V., Rigét, F.F., Jensen, A.L., Kjelgaard-Hansen, M. (2012) Blood plasma clinical-chemical parameters as biomarker endpoints for organohalogen contaminant exposure in Norwegian raptor nestlings. *Ecotoxicol. Environ. Saf.*, *80*, 76-83. doi: 10.1016/j.ecoenv.2012.02.012.

Stjernberg, A.-C. E., Skorokhod, A., Paris, J.D., Elansky, N., Nédélec, P., Stohl, A. (2012) Low concentrations of near-surface ozone in Siberia. *Tellus B*, *64*, 11607, doi:10.3402/tellusb.v64i0.11607.

Stohl, A., Seibert, P., Wotawa, G. (2012) The total release of xenon-133 from the Fukushima Dai-ichi nuclear power plant accident. *J. Environ. Radioact.*, *112*, 155-159. doi:10.1016/j.jenvrad.2012.06.001.

Stohl, A., Seibert, P., Wotawa, G., Arnold, D., Burkhart, J. F., Eckhardt, S., Tapia, C., Vargas, A., Yasunari, T. J. (2012) Xenon-133 and caesium-137 releases into the atmosphere from the Fukushima Dai-ichi nuclear power plant: determination of the source term, atmospheric dispersion, and deposition. *Atmos. Chem. Phys.*, *11*, 2313-2343. doi:10.5194/acp-12-2313-2012.

Sundseth, K., Pacyna, J.M., Pacyna, E.G., Panasiuk, D. (2012) Substance flow analysis of mercury affecting water quality in the European Union. *Water Air Soil Pollut.*, *223*, 429-442. doi:10.1007/s11270-011-0871-0.

Surono, Jousset, P., Pallister, J., Boichu, M., Buongiorno, M.F., Budisantoso, A., Costa, F., Andreastuti, S., Prata, F., Schneider, D., Clarisse, L., Humaida, H., Sumarti, S., Bignami, C., Griswold, J., Carn, S., Oppenheimer, C. (2012) The 2010 explosive eruption of Java's Merapi volcano - a '100-year' event. *J. Volcanol. Geoth. Res.*, *241/242*, 121-135. doi: 10.1016/j.jvolgeores.2012.06.018.

Tegtmeier, S., Krüger, K., Quack, B., Atlas, E. L., Pisso, I., Stohl, A., Yang, X. (2012) Emission and transport of bromocarbons: from the West Pacific ocean into the stratosphere. *Atmos. Chem. Phys.*, *12*, 10633-10648. doi:10.5194/acp-12-10633-2012.

Thorsteinsson, T., Johannsson, T., Stohl, A., Kristiansen, N.I. (2012) High levels of particulate matter in Iceland due to direct ash emissions by the Eyjafjallajökull eruption and resuspension of deposited ash. *J. Geophys. Res.*, *117*, B00C05. doi:10.1029/2011JB008756.

Tidblad, J., Kucera, V., Ferm, M., Kreislova, K., Brüggerhoff, S., Doytchinov, S., Screpanti, A., Grøntoft, T., Yates, T., de la Fuente, D., Roots, O., Lombardo, T., Simon, S., Faller, M., Kwiatkowski, L., Kobus, J., Varotsos, C., Tzanis, C., Krage, L., Schreiner, M., Melcher, M., Grancharov, I., Karmanova, N. (2012) Effects of air pollution on materials and cultural heritage: ICP Materials celebrates 25 years of research. *Internat. J. Corrosion, 2012*, Art ID 496321. doi:10.1155/2012/496321.

Toledano, C., Bennouna, Y., Cachorro, V., Ortiz de Galisteo, J.P., Stohl, A., Stebel, K., Kristiansen, N.I., Olmo, F.J., Lyamani, H., Obregón, M.A., Estellés, V., Wagner, F., Baldasano, J.M., González-Castanedo, Y., Clarisse, L., de Frutos, A.M. (2012) Aerosol properties of the Eyjafjallajökull ash derived from sun photometer and satellite observations over the Iberian Peninsula. *Atmos. Environ.*, *48*, 22-32. doi:10.1016/j.atmosenv.2011.09.072.

Toledano, C., Cachorro, V., Gausa, M., Stebel, K., Aaltonen, V., Berjón, A., Ortiz de Galisteo, J.P., de Frutos, A.M., Bennouna, Y., Blindheim, S, Myhre, C.L., Zibordi, G., Wehrli, C., Kratzer, S., Hakansson, B., Carlund, T., de Leeuw, G., Herber, A., Torres, B. (2012) Overview of sun photometer measurements of aerosol properties in Scandinavia and Svalbard. *Atmos. Environ.*, *52*, 18-28. doi: 10.1016/j.atmosenv.2011.10.022.

Tørseth, K., Aas, W., Breivik, K., Fjæraa, A.M., Fiebig, M., Hjellbrekke, A.G., Lund Myhre, C., Solberg, S., Yttri, K.E. (2012)

Introduction to the European Monitoring and Evaluation Programme (EMEP) and observed atmospheric composition change during 1972-2009. *Atmos. Chem. Phys., 12*, 5447-5481. doi:10.5194/acp-12-5447-2012.

Ubl, S., Scheringer, M., Stohl, A., Burkhart, J.F., Hungerbuhler, K. (2012) Primary source regions of polychlorinated biphenyls (PCBs) measured in the Arctic. *Atmos. Environ., 62*, 391-399. doi:10.1016/j.atmosenv.2012.07.061.

van den Hazel, P., Keune, H., Randall, S., Yang, A., Ludlow, D., Bartonova, A. (2012) The challenge of social networking in the field of environment and health. *Environ. Health, 11*, Suppl. 1, S 15, doi:10.1186/1476-069X-11-S1-S15.

Veyhe, A.S., Hansen, S., Sandanger, T.M., Nieboer, E., Odland, J.Ø. (2012) The Northern Norway mother-and-child contaminant cohort study: implementation, population characteristics and summary of dietary findings. *Int. J. Circumpolar Health, 71*, 18644, doi: 10.3402/ijch.v71i0.18644.

Vieweg, I., Hop, H., Brey, T, Huber, S., Ambrose jr., W.G., Locke, W.L., Gabrielsen, G.W. (2012) Persistent organic pollutants in four bivalve species from Svalbard waters. *Environ. Pollut., 161*, 134-142. doi:10.1016/j.envpol.2011.10.018.

Volkovova, K., Bilanicova, D., Bartonova, A., Letasiova, S., Dusinska, M. (2012) Associations between environmental factors and incidence of cutaneous melanoma. Review. *Environ. Health, 11*, Suppl. 1, S 12, doi:10.1186/1476-069X-11-S1-S12.

Walker, S.E. (2012) WORM - A new open road line source model for low wind speed conditions. *Int. J. Environ. Pollut., 47 (2011)*, 348-357. doi:10.1504/IJEP.2011.047348.

Webster, H.N., Thomson, D.J., Johnson, B.T., Heard, I.P.C., Turnbull, K., Marenco, F., Kristiansen, N.I., Dorsey, J., Minikin, A., Weinzierl, B., Schumann, U., Sparks, R.S.J., Loughlin, S.C., Hort, M.C., Leadbetter, S.J., Devenish, B.J., Manning, A.J., Witham, C.S., Haywood, J.M., Golding, B.W. (2012) Operational prediction of ash concentrations in the distal volcanic cloud from the 2010 Eyjafjallajökull eruption. *J. Geophys. Res., 117*, D00U08. doi:10.1029/2011JD016790.

Weinbruch, S., Wiesemann, D., Ebert, M., Schütze, K., Kallenborn, R., Ström, J. (2012) Chemical composition and sources of aerosol particles at Zeppelin Mountain (Ny-Ålesund, Svalbard): an electron microscopy study. *Atmos. Environ., 49*, 142-150. doi:10.1016/j.atmosenv.2011.12.008.

Wiedensohler, A., Birmili, W., Nowak, A., Sonntag, A., Weinhold, K., Merkel, M., Wehner, B., Tuch, T., Pfeifer, S., Fiebig, M., Fjæraa, A. M., Asmi, E., Sellegri, K., Depuy, R., Venzac, H., Villani, P., Laj, P., Aalto, P., Ogren, J. A., Swietlicki, E., Williams, P., Roldin, P., Quincey, P., Hüglin, C., Fierz-Schmidhauser, R., Gysel, M., Weingartner, E., Riccobono, F., Santos, S., Grüning, C., Faloon, K., Beddows, D., Harrison, R. M., Monahan, C., Jennings, S. G., O'Dowd, C. D., Marinoni, A., Horn, H.-G., Keck, L., Jiang, J., Scheckman, J., McMurry, P. H., Deng, Z., Zhao, C. S., Moerman, M., Henzing, B., de Leeuw, G., Löschau, G., Bastian, S. (2012) Mobility particle size spectrometers: harmonization of technical standards and data structure to facilitate high quality long-term observations of atmospheric particle number size distributions. *Atmos. Meas. Tech., 5*, 657-685. doi:10.5194/amt-5-657-2012.

Worton, D.R., Sturges, W.T., Reeves, C.E., Newland, M.J., Penkett, S.A., Atlas, E., Stroud, V., Johnson, K., Schmidbauer, N., Solberg, S., Schwander, J., Barnola, J.-M. (2012) Evidence from firn air for recent decreases in non-methane hydrocarbons and a 20th century increase in nitrogen oxides in the northern hemisphere. *Atmos. Environ., 54*, 592-602. doi:10.1016/j.atmosenv.2012.02.084.

Yang, M.Y.M., Vay, S.A., Stohl, A., Choi, Y., Diskin, G.S., Sachse, G.W., Blake, D.R. (2012) Chemical composition of tropospheric air masses encountered during high altitude flights (>11.5 km) during the 2009 fall Operation Ice Bridge field campaign. *J. Geophys. Res., 117*, D17306, doi:10.1029/2012JD017858.

Zhang, D., Aunan, K., Seip, H.M., Larssen, T., Vennemo, H., Larssen, S., Feng, L., Wu, C., Xie, R. (2012) Air pollution reduction during China's 11th Five-Year Plan period - Local implementation and achievements in Shanxi province. *Environ. Dev., 4*, 36-53. doi:10.1016/j.envdev.2012.09.002.

Zimmer, K., Gutleb, A., Ravnum, S., von Krauss, M.K., Murk, A.J., Ropstad, E., Skaare, J., Eriksen, G., Lyche, J., Koppe, J.G., Magnanti, B.L., Yang, A., Bartonova, A., Keune, H. (2012) Policy relevant results from an expert elicitation on the health risks of phthalates. *Environ. Health, 11*, Suppl. 1, S 6, doi:10.1186/1476-069X-11-S1-S6.

Scientific reports

Tønnesen, D., Haugsbakk, I. (2012) Monitoring of air and precipitation quality at Tjeldbergodden October 2009 - September 2010. Kjeller, NILU (NILU OR, 01/2012). N

Haugsbakk, I. (2012) Monitoring meteorological and air quality parameters in Sauda during the period of 01.04. - 30.09.2011. Kjeller, NILU (NILU OR, 02/2012). N

Tønnesen, D., Haugsbakk, I. (2012) E16 Bjørum - Skaret. Evaluating air quality around openings of tunnels. Kjeller, NILU (NILU OR, 03/2012). N

Tønnesen, D., Berglen, T.F. (2012) Air quality in Hamar. Monitoring program December 2010 - June 2011. Kjeller, NILU (NILU OR, 04/2012). N

Stebel, K., ed. (2012) 10th Ny-Ålesund seminar. Proceedings and presentations from the 10th Ny-Ålesund seminar, Lillestrøm Centre of Expertises, Kjeller, Norway, October 25 -26, 2011. IN PRESS. Kjeller, NILU (NILU OR, 05/2012).

Haugsbakk, I., Tønnesen, D. (2012) Dispersion calculations Toten Metall AS. Kjeller, NILU (NILU OR, 06/2012). N

Sivertsen, B., Castell-Balaguer, N. (2012) Air quality impact assessment, Kinyerezi, Dar Es Salaam, Tanzania. Kjeller, NILU (NILU OR, 07/2012).

Hak, C. (2012) Measurement data. July 2010 - June 2011. Environmental monitoring of emissions to air from Snøhvit-Hammerfest LNG. Kjeller, NILU (NILU OR, 08/2012). N

Dahlin, E., Grøntoft, T. (2012) Measurement of air quality in exhibition and storage rooms at Wawel Royal Castle, Krakow, Poland. Kjeller, NILU (NILU OR, 09/2012).

Kylling, A. (2012) Rotational Raman scattering in the O2-A and O2-B bands: simulations for Carbonsat, FLEX/FLORIS, MERIS and OLCI. Kjeller, NILU (NILU OR, 10/2012).

El-Araby, T. (2012) Ambient air quality in Abu Dhabi. 2011 annual report. Kjeller, NILU (NILU OR, 11/2012).

Randall, S., Sivertsen, B. (2012) BAPMAN Mission 4: Project planning and further AQ screening. 18-23 February 2012, Dhaka, Bangladesh. Kjeller, NILU (NILU OR, 12/2012).

Gjerstad, K.I. (2012) Calculation of dispersion and deposition, April 2010 - April 2011. Kjeller, NILU (NILU OR, 13/2012). N

Myhre, C.L., Hermansen, O., Fjæraa, A.M., Lunder, C., Fiebig, M., Schmidbauer, N., Krognes, T., Stebel, K. (2012) Monitoring of greenhouse gases and aerosols at Svalbard and Birkenes: Annual report 2010. Kjeller, NILU (SPFO. Rapport 1117/2012. TA-2902/2012) (NILU OR, 14/2012).

Steinnes, E., Schlabach, M. (2012) Moss survey in Norway 2010. Kjeller, NILU (SPFO. Rapport 1120/2012. TA-2914/2012) (NILU OR, 15/2012). N

NILU. (2012) Environmental management report 2011. Kjeller, NILU (NILU OR, 16/2012).

Hak, C. (2012) Indoor air quality at Life Technologies AS. Measurement of particulate matter. Kjeller, NILU (NILU OR, 17/2012).

Tønnesen, D. (2012) Impact of particles and PAH at Mongstad. Kjeller, NILU (NILU OR, 18/2012). N

Aas, W., Solberg, S., Manø, S., Yttri, K.E. (2012) Monitoring of long-range transported air pollutants. Annual report for 2011. Kjeller, NILU (SPFO. Rapport 1126/2012. TA-2940/2012) (NILU OR, 19/2012). N

Pillay, B. (2012) Emissions Inventory forecast for Khalifa Industrial Zone Abu Dhabi. Kjeller, NILU (NILU OR, 20/2012).

Guerreiro, C. (2012) Review of air quality standards. Kjeller, NILU (NILU OR, 21/2012).

Uggerud, H.T., Lyrån, B. (2012) Screening of contaminants in fruit and vegetables. Determination of lead, cadmium and tin. Kjeller, NILU (NILU OR, 22/2012). N

Denby, B.R., Sundvor, I. (2012) NORTRIP model development and documentation: NOn-exhaust Road TRaffic Induced Particle emission modelling. Kjeller, NILU (NILU OR, 23/2012).

Tønnesen, D., Berglen, T.F. (2012) SK-1401 Mongstad. Dispersion calculations. Kjeller, NILU (NILU OR, 24/2012). N

Berglen, T.F., Andresen, E., Arnesen, K., Nilsson, L.O., Ofstad, T., Rode, A., Tønnesen, D., Vadset, M. (2012) Air quality monitoring in the border areas of Norway and Russia - progress report April 2011-March 2012. Kjeller, NILU (SPFO. Rapport 1128/2012. TA 2951/2012) (NILU OR, 25/2012). N

Randall, S., Sivertsen, B., Dam, V.T., Dauge, F. (2012) BAPMAN Mission 5: Continuous air monitoring operations and advanced emissions training. Kjeller, NILU (NILU OR, 26/2012).

Hak, C., Castell Balaguer, N. (2012) Measurements and calculations of air pollution in Øvre Årdal. Survey of SO2 during the reconstruction period. Kjeller, NILU (NILU OR, 27/2012). N

Hak, C., Castell Balaguer, N. (2012) Measurements and calculations of air pollution in Øvre Årdal. 2. Dispersion during regular operation. Kjeller, NILU (NILU OR, 28/2012). N

Svendby, T.M., Myhre, C.L., Stebel, K., Edvardsen, K., Orsolini, Y., Dahlback, A. (2012) Monitoring of the atmospheric ozone layer and natural ultraviolet radiation. Annual report 2011. Kjeller, NILU (SPFO. Rapport 1129/2012. TA-2952/2012) (NILU OR, 29/2012).

Dahlin, E., ed. (2012) Cultural heritage preservation, EWCHP-2012. Proceedings of the 2nd European Workshop on Cultural Heritage Preservation, Kjeller, Norway 2012. Kjeller, NILU (NILU OR, 30/2012).

Hak, C. (2012) Air quality measurements in the vicinity of Finnfjord AS. Kjeller, NILU (NILU OR, 31/2012). N

Solberg, S., Svendby, T., Gjerstad, K.I., Liu, L., Wathne, B.M., Skjelkvåle, B.L., Høgåsen, T., Aarrestad, P.A., Gjershaug, J.O. (2012) Possible future petroleum activity around Jan Mayen. Consequences of emissions to air. Kjeller, NILU (NILU OR, 32/2012). N

Solberg, S., Svendby, T., Gjerstad, K.I., Liu, L., Wathne, B.M., Skjelkvåle, B.L., Høgåsen, T., Aarrestad, P.A., Gjershaug, J.O. (2012) Possible future petroleum activity west of the delimitation line in the Barents Sea South. Consequences of emissions to air. Kjeller, NILU (NILU OR, 33/2012). N

Tibi, N., Gopinath, V. (2012) BASELINE ambient air quality monitoring at KPIZ, Abu Dhabi. Kjeller, NILU (NILU OR, 34/2012).

Tibi, N., Sheikh Elhadadeen, T. (2012) Indoor air quality study for the Norwegian Embassy in Abu Dhabi. Kjeller, NILU (NILU OR, 35/2012).

Tibi, N., Daham, B., Shinbin, N. (2012) Assessment of traffic noise and mitigation options for Al Salam Street. Kjeller, NILU (NILU OR, 36/2012).

Tibi, N., Sheikh Elhadadeen, T. (2012) Indoor air quality investigation sector E3-02. Kjeller, NILU (NILU OR, 37/2012).

Dye, C., Bjerke, A., Sturtzel, I. (2012) Acrylamid in selected nutrients 2011. IN PRESS. Kjeller, NILU (NILU OR, 38/2012). N

Katsogiannis, A., Breivik, K., Schlabach, M. (2012) Estimating the contribution of long-range transport to the atmospheric deposition of selected organic contaminants over Norway. Kjeller, NILU (NILU OR, 39/2012).

Randall, S., Sivertsen, B., Dauge, F., Gjerstad, K.I., Clemetsen, T. (2012) BAPMAN Mission 6: Continuous air monitoring operations, measurement data training, and data acquisition interface development. Kjeller, NILU (NILU OR, 40/2012).

Aas, W., Hjellbrekke, A., Hole, L., Tørseth, K. (2012) Deposition of major inorganic compounds in Norway 2007-2011. Kjeller, NILU (SPFO. Rapport 1136/2012) (NILU OR, 41/2012).

Tønnesen, D., Borgnes, D. (2012) Guideline. Calculation of stack height. IN PRESS. Kjeller, NILU (NILU OR, 42/2012). N

Gjerstad, K.I., Sundvor, I., Tønnesen, D. (2012) Assessment of air quality and mitigation analysis. IN PRESS. Kjeller, NILU (NILU OR, 43/2012). N

Technical reports

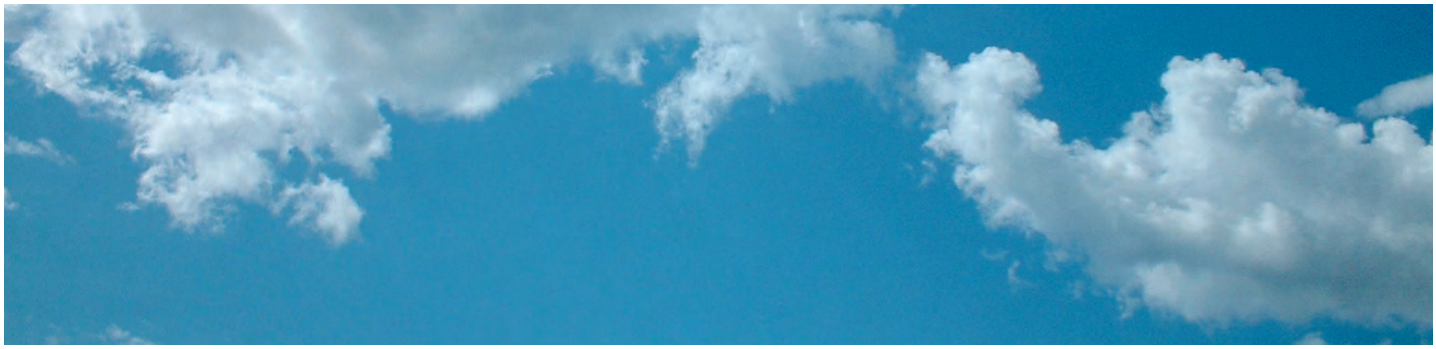
Lahoz, W.A., Orsolini, Y.J., Manney, G.L., Minschwaner, K., Allen, D.R., Errera, Q., Jackson, D.R., Lambert, A., Lee, J., Pumphrey, H., Schwartz, M., Wu, D. (2012) Spatio-temporal variability of the polar middle atmosphere. Insights from over 30 years of research satellite observations. Kjeller, NILU (NILU TR, 01/2012).

Denby, B.R. (2012) NORTRIP emission model user guide. Kjeller, NILU (NILU TR, 02/2012).■

NILU

Årsberetning og -regnskap

2012



NILUs forskning

har som formål å øke forståelsen for prosesser og effekter knyttet til klimaendringer, atmosfærens sammensetning, luftkvalitet og miljøgifter.

På bakgrunn av forskningen leverer NILU integrerte tjenester og produkter innenfor analyse, overvåkning og rådgivning.

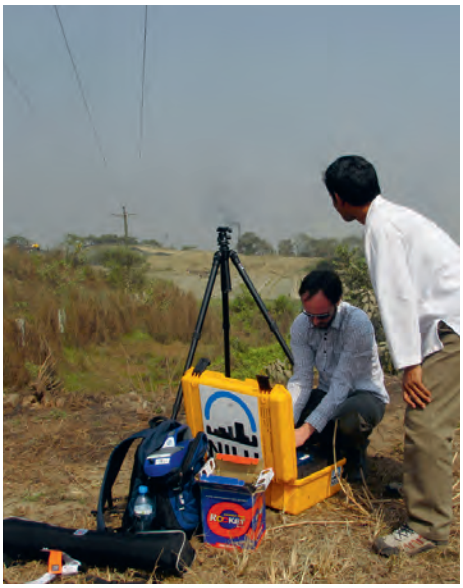
NILU er opptatt av å opplyse og gi råd til samfunnet om klimaendringer og forurensning og konsekvensene av dette.

NILU har 200 ansatte; blant annet forskere, ingeniører og teknikere som utfører prosjekter for forskningsrådet, for industri både i Norge og offshore, og for lokale og statlige myndigheter i inn- og utland. NILU tar også aktivt del i EUs forskningsprogrammer. NILU er blant de ledende fagmiljøer i verden innenfor deler av sitt fagfelt.

NILUs arbeidsområder

- Atmosfærens sammensetning
- Drivhusgasser og klimaendringer
- Ozonlaget og UV-stråling
- Langtransportert luftforurensning
- Industri- og byforurensning
- Aerosoler og partikler
- Miljøgifter
- Studier av helseeffekter
- Økologi og økonomi

NILU har drevet feltmålinger av luftkvalitet i Bangladesh.



Årsberetning 2012

Virksomhetens art og hvor den drives

NILU – Stiftelsen Norsk institutt for luftforskning utfører forskning innenfor hovedområdene luftkvalitet, klima, miljøgifter og økologisk økonomi. NILU har også en sentral rolle i overvåkning og miljøteknologisk utvikling, og har stor aktivitet knyttet til overvåkning av klimadrivere både nasjonalt og internasjonalt. Instituttet er miljørådgiver for norske og internasjonale myndigheter, og legger vekt på at forskningen skal publiseres i internasjonalt velrenommerte tidsskrifter. Vi er også opptatt av at forskningen gjøres kjent i samfunnet generelt.

NILUs virksomhet drives fra eget forretningsbygg på Kjeller i Skedsmo kommune og har distriktskontor i Framsenteret i Tromsø, kontorer på CIENS i Oslo og en avdeling i det arabiske emiratet Abu Dhabi. De nasjonale inntektene utgjør 68 % og de internasjonale 32 % av omsetningen i 2012. Basisbevilgningen fra Norges forskningsråd utgjør ca 11 % av instituttets omsetning. Av dette var ca 23 % øremerket strategiske instituttsatsinger (SIS). NILU mottar støtte til nasjonale oppgaver fra Miljøverndepartementet (MD) som rådgivende forskningsinstitutt for myndighetene. NILU er sertifisert etter kvalitetsstandarden ISO 9001:2008 og miljøstandarden ISO 14001:2004 og akkreditert etter ISO 17025:2005 for måling av luftforurensning, meteorologiske parametere og avanserte kjemiske analyser.

Sentrale oppgaver i 2012

Det har vært stor innsats i 2012 knyttet til arbeidet med NILUs nye strategi 2013-2017. I forkant av strategiprosessen ble det utarbeidet egne strategier for hvert av NILUs sentrale FoU-områder og for innovasjon og kommunikasjon.

NILU er synlig i media både knyttet til miljøgiftproblematikk, luftkvalitetsutfordringer i våre byer, klimaforskning og innovasjon.

Forskning knyttet til klimarelaterte problemstillinger er sentral for NILU. På Zeppelin-observatoriet ved Ny-Ålesund på Svalbard målte vi i 2012 for første gang luftkonsentrasjon av CO_2 (karbondioksid) over 400 ppm. Dette er en negativ milepæl som kan bety at tiden er i ferd med å renne ut for å muligheten til å nå togradersmålet. Etter karbondioksid er metan den viktigste bidragsyteren til menneskeskapt global oppvarming. Målinger som NILU har gjort ved Zeppelinobservatoriet har også vist en stadig økning i luftkonsentrasjonen av metan de siste årene.

Overvåking er en viktig plattform for mye av NILUs arbeid og har stått i fokus i enda større grad enn vanlig dette året, spesielt med hensyn på lange tidsserier og utfordringer knyttet til finansiering og utvikling av disse. Dette er arvesølvet vårt og viktig for NILUs fremtidige utvikling. Fra 2013 vil vi få en direkte bevilgning over post 70 i statsbudsjettet fra MD på 3,9 MNOK til å ivareta noen av de lange tidsseriene som nasjonale oppgaver. Samtidig blir Klifs bevilgning til overvåkning redusert med et nesten tilsvarende beløp.

NILU har satset i nord i en årrekke og er en viktig partner i Framsenteret i Tromsø. Den norske politiske satsingen i nordområdene har medført at NILU planlegger utvidelse av denne aktiviteten. NILU leder flaggskipet 'Miljøgifter og klimaendringer', et av fem flaggskip i FRAM-senteret, og dette er en viktig satsing for NILU. Vi har også bidratt mye til planleggingen av et nytt bygg i Framsenteret, spesielt innen planleggingen av laboratoriearealer. I 2012 publiserte NIFU en rapport om Norsk polarforskning – forskning på Svalbard. Rapporten viser at NILUs arktiske forskning har høy relevans og vekker stor internasjonal interesse. Antall publikasjoner er bra i forhold til vår størrelse, men vi utmerker oss med å være best i verden og langt over snittet i antall siteringer av våre publikasjoner.

Store luftkvalitetsutfordringer i flere av våre største byer er et vedvarende problem i vintersesongen. NILU har en sentral rolle i overvåkning, kvalitetssikring og tilgjengeliggjøring av informasjon knyttet til disse utfordringene. Byluftproblematikk er et tema som opptar både lokalpolitikere, media og folk flest. I 2012 var det høy temperatur i diskusjonene i media knyttet til bruk av dieselbiler og utslipp av nitrogendioksid (NO_2).

NILU spiller en sentral rolle i flere europeiske initiativ knyttet til luftforurensning, blant annet i EMEP (The European Monitoring and Evaluation Programme) og i temasenteret for luftkvalitet og tiltak mot klimaendringer (ETC-ACM) under EEA (EUs miljøbyrå). NILU har siden 1979 hatt

oppgaven å være sekretariat og koordinator for "The EMEP Chemical Coordinating Centre" (EMEP-CCC). Hovedoppgaven er å koordinere måleprogrammet for EMEP, å gi anbefalinger om metodebruk, kvalitetssikring og opplæring, i tillegg til data validering, rapportering og å være datavert. Høsten 2012 kom EEA rapporten "Air Quality in Europa" som viser at ozon, PAH og partikler er et vedvarende helseproblem i Europa. Dette er en sentral EEA-rapport som klart viser relevansen av et av NILUs eldste kjerneområder.

NILU driver en rekke målestasjoner, men noen er spesielt strategisk plassert og har omfattende måleprogram og forskningsaktiviteter. Disse målestasjonene kalles observatorier og omfatter Zeppelinobservatoriet ved Ny-Ålesund på Svalbard, Trollobservatoriet i Antarktis og Birkenesobservatoriet i Aust-Agder. Observatoriene er strategisk svært viktige for NILU og det har vært arbeidet mye for å sikre videreutvikling av infrastrukturen. Det fokuseres også kontinuerlig på å skaffe forskningsprosjekter som utnytter observatorienes potensial.

NILU har stort fokus på måling og overvåkning av atmosfærens sammensetning ved Trollobservatoriet i Antarktis. På grunn av økende aktivitet og kontamineringsproblemer lokalt er det behov for å flytte observatoriet på Troll til Trollhaugen like ovenfor forskningsstasjonen.

NILU har gjennom mange år hatt stor suksess med EU prosjekter. I 2012 hadde NILU 27 aktive EU-prosjekter hvorav 6 ble startet i løpet av året. Disse prosjektene er innenfor våre kjerneområder; atmosfæriske prosesser, klima- og miljøpåvirkning, nanosikkerhet og jordobservasjoner.

NILUs aktivitet i Abu Dhabi (AD) har hatt mye fokus i 2012 da 5-årskontrakten med EAD (Environmental Agency – Abu Dhabi) gikk ut i desember. Vi har bygget opp et godt fagteam i AD og det er viktig for oss å få til en god utvikling fremover. NILU er nå i anbudsfasen om videre overvåkning i AD. En Memorandum of Understanding om forskningssamarbeid med Abu Dhabi University (ADU) er på plass og vi har flyttet vår avdeling til ADU.

NILU har vært aktive i CIENS i 2012. Et nybygget toppsenter for tverrfaglig forskning er i ferd med å ta form, miljøprøvebanken for miljøgiftprøver ble åpnet i november 2012 og det har vært mange interessante arrangementer. NILU har deltatt i en rekke aktiviteter og leder både Kommunikasjonsforum og CIENS Innovasjonsforum.

NILU satser på innovasjon, både gjennom datterselskapet Innovation NILU (IN) og gjennom en egen avdeling som jobber spesielt med å utvikle de gode ideene. NILU har flere gode innovasjoner i utvikling og flere av selskapene under IN viser en interessant og positiv utvikling. Et godt eksempel er samarbeidet med Airbus om testing av askekameraet AVOID.

Fortsatt drift

Forutsetningen om fortsatt drift er til stede og årsregnskapet for 2012 er satt opp på dette grunnlaget.

Styret mener at årsberetningen og -regnskap gir et rettvisende bilde av selskapets eiendeler og gjeld, finansielle stilling og resultat.

Utsiktene til videre drift anses tilfredsstillende basert på en betydelig kontrakts¬reserve ved årets utgang i tillegg til den direkte støtten gjennom basisbevilgningen og en rimelig forventning om nye kontrakter i 2013.

Likestilling

NILU legger vekt på en balansert kjønnsmessig sammensetning av ansatte og i styret. Virksomhetens retningslinjer, lønnssystem osv. er kjønnsnøytrale. Av 200 ansatte er 89 kvinner og 111 menn; av de 200 er 71 med utenlandsk bakgrunn fra 22 nasjoner. Ledelsen består av 7 kvinner og 8 menn. Styret består av 3 kvinner og 4 menn.

Arbeidsmiljø

Instituttet har prosedyrer for HMS-arbeidet, og det er gjennomført revisjoner av systemet i tråd med "Forskrift om internkontroll – helse, miljø og sikkerhet". NILU er IA-bedrift.

Det har ikke vært arbeidsuhell i 2012 som har medført fravær.

Det totale sykefraværet var 4,75 % i 2012. Fraværet er jevnt fordelt på korttids- og langtidssykefravær.

Ytre miljø

Virksomheten forurenser i ubetydelig grad det ytre miljø. NILU har strenge regler for kontroll av avfall, og det praktiseres kildesortering for ordinært avfall og farlig avfall som i sin helhet leveres til godkjente mottak.

Disponering av overskudd

Årets overskudd på kr 3 225 553 overføres til annen egenkapital.

Kjellet, 29. april 2013

I styret for Norsk institutt for luftforskning

Lisbet Rugtvedt
Styrets leder

Lars Holden
Nestleder

Hans Aasen
Styremedlem

Hanne Greiff Johnsen
Styremedlem

Kim Holmén
Styremedlem

Thor Ofstad
Styremedlem

Christina Guerreiro
Styremedlem

Kari Nygaard
Daglig leder

Resultatregnskap

	Note	2012	2011
DRIFTSINNTEKTER			
Prosjektinntekter		185 041 773	169 790 857
Basisbevilgning	1	23 828 000	22 765 000
Diverse inntekter		896 928	350 393
Driftsinntekter		**209 766 701**	**192 906 250**
DRIFTSKOSTNADER			
Lønn og sosiale kostnader	2	-133 759 871	-125 672 421
Direkte prosjektkostnader		-34 526 244	-26 766 770
Endring prosjekter i arbeid	8	-23 472	-1 230 520
Avskrivninger	3	-9 612 203	-8 034 333
Husleie, lys, brensel o.l.		-6 621 282	-6 766 430
Forbruksmateriell, drift og vedlikehold		-13 962 880	-14 881 024
Andre innkjøps-, salgs- og adminstrasjonskostnader		-7 523 554	-7 052 899
Driftskostnader		**-206 029 506**	**-190 404 397**
DRIFTSRESULTAT		**3 737 195**	**2 501 853**
FINANSINNTEKTER OG FINANSKOSTNADER			
Resultat av investeringer i datterselskapet	5	-605 711	788 574
Renteinntekter		614 278	716 520
Kursgevinst		1 601 832	2 161 223
Rentekostnader	4	-560 143	-457 094
Kurstap		-3 162 716	-1 662 580
Netto resultat finansposter		**-2 112 461**	**1 546 643**
ORDINÆRT RESULTAT FØR SKATTEKOSTNAD		**1 624 734**	**4 048 496**
Skattekostnad på ordinær resultat	6	1 600 819	-37 579
ÅRSOVERSKUDD		**3 225 553**	**4 010 917**
DISPONERING AV ÅRSRESULTATET			
Til annen egenkapital	11	3 225 553	4 010 917

Balansen

EIENDELER	Note	31.12.2012	31.12.2011
Anleggsmidler			
Immatrielle eiendeler:			
Patenter	3	1 182 038	420 405
Utsatt skattefordel	6	44 161 384	42 560 565
Sum immatrielle eiendeler		**45 343 422**	**42 980 970**
Varige driftsmidler:			
Forretningsbygg, Kjeller	3	20 773 647	20 628 170
Byggteknisk anlegg	3	6 146 089	5 000 758
Birkenes-observatoriet	3	1 966 992	2 360 706
Instrumenter	3	15 845 808	14 622 774
IKT-utstyr, programvare etc.	3	3 340 276	1 397 497
Inventar	3	1 101 489	1 017 370
Biler	3	37 427	56 140
Sum varige driftsmidler		**49 211 728**	**45 083 415**
Finansielle anleggsmidler:			
Investeringer i datterselskap	5	1 917 223	2 522 934
Lån til datterselskap	7	10 860 131	1 820 000
Investeringer i CIENS-bygget, Oslo	5	5 174 727	5 175 409
Investeringer i aksjer	5	1 651 890	1 651 890
Depositum/div. andeler		247 950	75 450
Sum finansielle anleggsmidler		**19 851 921**	**11 245 683**
Sum anleggsmidler		**114 407 071**	**99 310 068**
Omløpsmidler			
Prosjekter i arbeid	8	14 936 755	14 981 325
Kundefordringer		22 005 960	15 637 939
Fordring på konsernselskap		3 769 245	4 887 468
Andre kortsiktige fordringer		5 999 432	3 571 399
Bankinnskudd og kassebeholdning	9, 10	64 729 429	42 216 992
Sum omløpsmidler		**111 440 821**	**81 295 123**
SUM EIENDELER		**224 847 892**	**180 605 190**
EGENKAPITAL OG GJELD			
Innbetalt egenkapital:			
Grunnkapital		10 000 000	10 000 000
Opptjent egenkapital:			
Annen egenkapital	11	95 357 450	99 776 489
Sum egenkapital		**105 357 450**	**109 776 489**
Gjeld			
Langsiktig gjeld			
Avsetning for forpliktelser:			
Pensjonsforpliktelser	12	9 980 924	2 040 403
Annen langsiktig gjeld:			
Gjeld til kredittinstitusjon	13	10 015 474	10 987 500
Sum langsiktig gjeld		**19 996 398**	**13 027 903**
Kortsiktig gjeld			
Leverandørgjeld		11 884 292	7 734 279
Forskudd fra oppdragsgivere		26 563 026	26 161 407
Forvaltningsprosjekt	10	39 027 079	1 210 520
Betalbar skatt	6	0	0
Skyldige offentlige avgifter		11 150 712	11 071 071
Påløpt feriepenger/lønn		10 633 858	10 967 245
Annen kortsiktig gjeld		1 235 077	656 276
Sum kortsiktig gjeld		**100 494 044**	**57 800 798**
Sum gjeld		**120 490 442**	**70 828 701**
SUM EGENKAPITAL OG GJELD		**225 847 892**	**180 605 190**

Kontantstrømanalyse

		2012	2011
KONTANTSTRØM FRA OPERASJONELLE AKTIVITETER			
Ordinært resultat før skattekostnad		1 624 734	4 048 496
Periodens betalte skatt		0	0
Ordinære avskrivninger		9 612 203	8 034 333
Resultat i datterselskap		605 711	-788 574
Endring i prosjektbeholdning		44 570	1 230 520
Endring i kundefordringer		-6 368 021	1 301 372
Endring fordring på konsernselskap		1 118 223	-4 335 366
Endring i leverandørgjeld		4 150 013	-1 498 107
Endring forskudd i prosjekter		401 619	525 014
Endring forvaltningsprosjekter		37 816 559	0
Endring i pensjonsforpliktelse		295 929	691 893
Endring i andre tidsavgrensninger		-2 102 978	4 149 240
Netto kontantstrøm fra operasjonelle aktiviteter	**A**	**47 198 562**	**13 358 821**
KONTANTSTRØM FRA INVESTERINGSAKTIVITETER			
Utbetaling ved patentrettigheter		-761 633	-420 405
Innbetaling vedrørende CIENS-investering		682	0
Utbetaling ved investering i varige driftsmidler		-13 740 517	-14 706 445
Netto kontantstrøm fra investeringsaktiviteter	**B**	**-14 501 468**	**-15 126 850**
KONTANTSTRØM FRA FINANSIERINGSAKTIVITETER			
Økt pantelån		0	2 500 000
Utbetaling ved nedbetaling av langsiktig gjeld		-972 026	-485 000
Innbetalt fra datterselskap		0	1 700 00
Økt lån i datterselskap		-9 040 131	0
Økt depositum/div.andeler		172 500	3 000
Netto kontantstrøm fra finansieringsaktiviteter	**C**	**-10 184 657**	**-688 000**
Netto endring i kontanter og bankinnskudd gjennom året	**A+B+C**	22 512 437	1 949 970
Beholdning av kontanter og bankinnskudd 1.1		42 216 992	40 267 022
Beholdning av kontanter og bankinnskudd 31.12		**64 729 429**	**42 216 992**

Noter til regnskapet 2012

Det er ikke utarbeidet konsernregnskap fordi aktiviteten i datterselskapet Innovation NILU AS er av mindre omfang. Aksjebesittelsen hos morselskapet er vurdert etter egenkapitalmetoden.

Årsregnskapet er satt opp etter regnskapsloven og god regnskapsskikk. Regnskapet er basert på de grunnleggende prinsipper som historisk kost, sammenlignbarhet, fortsatt drift og forsiktighet. Transaksjonene regnskapsføres til verdien av vederlaget på transaksjonstidspunktet. Inntekt inntektsføres når den er opptjent.

Kundefordringer og andre fordringer oppføres til pålydende etter fradrag for avsetning til mulige tap. Avsetning til tap gjøres på grunnlag av en individuell vurdering av de enkelte fordringene. I tillegg gjøres en uspesifisert avsetning av kundefordringer for å dekke antatt tap. Den generelle tapsavsetningen er på 0,4 MNOK per 31.12.12.

NOTE 1 BASISBEVILGNING

	2012	2011	2010	2009	2008
Grunnbevilgning	18 337 000	17 644 000	15 556 000	14 741 000	10 543 000
Instituttprogrammer	5 491 000	5 121 000	5 185 000	3 850 000	4 797 000
Sum	**23 828 000**	**22 765 000**	**20 741 000**	**18 591 000**	**15 340 000**

NOTE 2 ANSATTE, GODTGJØRELSE M.M.

	2012	2011
Lønn	105 826 180	100 238 291
Arbeidsgiveravgift	14 848 298	14 041 919
Statens Pensjonskasse (SPK)	11 850 806	8 886 846
Andre personalkostnader	1 234 587	2 505 365
Sum lønn og sosiale kostnader	**133 759 871**	**125 672 421**

	2012
Daglig leder mottok en samlet godtgjørelse på:	1 100 320
Det er utbetalt en samlet godtgjørelse til styret på:	269 200
Gjennomsnittlig antall ansatte:	180
Revisorhonorar gjelder kun revisjon (inkl avd. i Abu Dhabi):	154 951

NOTE 3 VARIGE DRIFTSMIDLER

	Anskaffelses-kostnad 01.01.2012	Tilgang i året	Avgang i året	Anskaffelses-kostnad 31.12.2012	Akkumulerte avskrivn. 01.01.2012	Årets ordin. avskrivn.	Tilbakef. ved avgang.	Akkumulerte avskrivn. 31.12.2012	Bokført verdi, 31.12.2012
Forretningsbygg, Kjeller	76 796 987	145 477	0	76 942 464	56 168 817	0	0	56 168 817	20 773 647
Byggteknisk anlegg	6 623 175	2 029 452	0	8 652 627	1 622 418	884 120	0	2 506 538	6 146 089
Birkenes-observatoriet	3 937 137	0	0	3 937 137	1 576 431	393 714	0	1 970 145	1 966 992
Instrumenter	93 804 167	7 767 715	0	101 571 883	79 181 394	6 544 681	0	85 726 075	15 845 808
IKT, programvare etc	18 564 562	3 477 887	0	22 042 449	17 167 065	1 535 108	0	18 702 173	3 340 276
Inventar	6 705 704	319 986	0	7 025 690	5 688 333	235 867	0	5 924 200	1 101 490
Biler i UAE	138 016	0	0	138 016	81 876	18 713	0	100 589	37 427
Sum	**206 569 748**	**13 740 517**	**0**	**220 310 265**	**161 486 334**	**9 612 203**	**0**	**171 098 537**	**49 211 728**

Fra og med 01.01.09 avskrives ikke forretningsbygget på Kjeller da markedsverdi er langt høyere enn bokført verdi. Øvrige bygg avskrives årlig og lineært med 10 %, instrumenter med 20 %, IKT-utstyr med 25 %, programvare med 20 %, inventar med 12,5 % og biler med 25 %.

I 2012 er det investert i patentrettigheter med kr 761 633 mot kr 420 405 i 2011. Patentrettighetene vil bli kostnadsført over 5 år når investeringene er ferdigstilt.

NOTE 4 RENTEKOSTNAD

Rentekostnadene gjelder hovedsakelig pantelån.

NOTE 5 AKSJER

Innovation NILU AS er heleid av NILU med kr 750 000 i aksjekapital. Egenkapital i Innovation NILU AS var 31.12.2012 kr 1 917 223 mot kr 2 522 933 pr. 31.12.2011. Årsunderskuddet på kr 605 711 er kostnadsført i morselskapet.

NILU har pr. 31.12.2012 aksjer i følgende selskaper:

	Aksjekapital	Antall aksjer eid	Pålydende pr.aksje	Bokført
Kjeller Innovasjon AS	8 830 399	32 856	100	1 585 990
Miljøalliansen AS	150 000	30	1 000	30 000
Diverse mindre aksjeposter				35 900
Sum				**1 651 890**

NILU har investert via CIENS Eiendom KS en eierandel på 6,5 % i CIENS-bygget på Blindern.

NOTE 6 SKATTER

NILU har siden stiftelsen ikke blitt betraktet som skattepliktig. Skattemyndighetene har i de siste årene begynt å skattlegge forskningsselskaper og NILU har fått vedtak om skatteplikt. NILU ble i 2007 pålagt å levere selvangivelse for 2006 og har siden sendt inn selvangivelse.

Grunnlag for årets skatter er:	
Resultat før skattekostnad	1 624 734
Inntektsført SkatteFUNN for 2012	-121 762
Resultatført underskudd i datterselskap	605 711
Ikke fradragsberettiget kostnader	59 329
Endring i forskjell mellom regnskaps- og skattemessig verdier på varige driftsmidler	-6 218 180
Endring i pensjonsforpliktelse	295 929
Redusert nedskrivning prosjekter i arbeid	124 589
Skattemessig underskudd i Ciens Eiendom KS	-240 630
Årets skattegrunnlag = underskudd til fremføring	**-3 870 280**
Ligningsmessig underskudd til fremføring fra tidligere år	-34 434 219
Ligningsmessig underskudd for 2012	-3 870 280
Akkumulert ligningsmessig underskudd til fremføring	**-38 304 499**

Årets inntekstførte skatt består av:

Endring utsatt skattefordel	**1 600 819**

Utsatt skattefordel framkommer som følger:

	01.01.2012	31.12.2012	Endring
Varige driftsmidler	110 267 795	104 049 615	6 218 180
Pensjonsforpliktelse	2 040 403	9 980 924	-7 940 521
Prosjektbeholdning	3 359 600	3 484 189	-124 589
Kundefordringer	400 000	400 000	0
Ciens Eiendom KS	1 500 000	1 500 000	0
Underskudd til fremføring	34 434 219	38 304 499	-3 870 280
Grunnlag utsatt skattefordel	152 002 017	157 719 227	-5 717 210
Utsatt skattefordel = 28 %	**42 560 565**	**44 161 384**	**-1 600 819**

NOTE 7 LÅN TIL DATTERSELSKAP

Morselskapet hadde et lån pr. 01.01.12 på kr 1 820 000 til Innovation NILU AS i forbindelse med aksjekjøp. Lånet er økt pr. 31.12.12 til kr 10 860 131 for å finansiere datterselskapets deltagelse i emisjoner i underliggende selskap (Nicarnica AS) i 2012. Den økte andelen av lånet renteberegnes og renten er lagt til i balansesummen.

NOTE 8 PROSJEKTER I ARBEID

Verdien av prosjekter i arbeid består av utført prosjektarbeid som ikke er fakturert ved årets slutt. Hvert enkelt prosjekt er vurdert med hensyn til risiko for overskridelse og det er foretatt nødvendig nedskrivning. I tillegg er det som i tidligere år foretatt en generell nedskrivning.

	2012	2011
Fakturerbar verdi	18 420 944	18 340 925
Generell nedskrivning	-3 484 189	-3 359 600
Sum prosjekter i arbeid	**14 936 755**	**14 981 325**
Generell nedskrivning i %	19 %	18 %

NOTE 9 BUNDNE MIDLER

Av bankinnskudd er kr 4 551 383 bundet til skattetrekk og depositum.

NOTE 10 FORVALTNINGSMIDLER

	2012	2011
Omløpsmidler:		
Bankinnskudd og kassebeholdning	64 729 429	42 216 992
– herav forvaltningsmidler	39 027 079	1 210 520
Kortsiktig gjeld:		
Forvaltningsprosjekt (kortsiktig gjeld)	39 027 079	1 210 520

NOTE 11 ANNEN EGENKAPITAL

	2012	2011
Annen egenkapital pr. 01.01.	99 776 489	98 542 534
Prinsippendring pensjonsmidler	-7 644 592	-2 776 962
Årets resultat	3 225 553	4 010 917
Annen egenkapital pr. 31.12.	**95 357 450**	**99 776 489**

NOTE 12 PENSJONSFORPLIKTELSE

Selskapets pensjonsforpliktelse dekkes via Statens Pensjonskasse (SPK) som alle ansatte i Norge er medlem i. De lokalt ansatte i NILUs avdeling i Abu Dhabi har en lokal avtale hvor det avsettes et kombinert slutt-/pensjonsvederlag som utbetales ved arbeidsavtalens opphør.

	31.12.2012	31.12.2011
Brutto påløpte pensjonsforpliktelser	-243 154 355	-248 494 716
Pensjonsmidler	177 534 868	164 070 576
Ikke resultatførte estimatendringer	65 619 486	84 337 489
Forsikret pensjonsforpliktelser i Norge	**-1**	**-86 651**
Avsatt pensjonsforpliktelse i Abu Dhabi	-2 249 681	-1 953 752
Balanseførte netto pensjonsmidler	**-2 249 682**	**-2 040 403**

I forbindelse med innføring av gjeldende regnskapslov har selskapet beregnet sin netto pensjonsforpliktelse etter ny norsk regnskapsstandard. Aktuarberegningen er utført av Statens Pensjonskasse og bygger på forventet avkastning 5 %, diskonterings¬rente på 4 %, årlig lønnsvekst 4 % og årlig G-regulering på 3 %.

SPK fakturerer løpende årets pensjonspremie som er kostnadsført, jfr. note 2. Ved aktuarberegningen av pensjonsforpliktelsen ovenfor har beregningene fra SPK vist store variasjoner fra år til år. Siden det er knyttet usikkerhet til disse beregningen er årets endring i pensjonsforpliktelsen som i 2011 ført direkte mot annen egenkapital, jfr. note 11.

NOTE 13 PANTSTILLELSER – NEDBETALING AV LÅN

Av selskapets gjeld er kr 10 015 474 sikret med pant i forretningsbygget på Kjeller som pr. 31.12.2012 hadde en bokført verdi på kr 20 628 170. Et eldre lån er pr. 31.12.12 på kr 8 003 411 og nedbetales med halvårlige avdrag frem til 30.06.2030. Selskapet tok opp et nytt lån i 2011 som er på kr 2 012 063 pr. 31.12.12. Lånet nedbetales med halvårlige fradrag frem til 30.11.2016.

Revisors beretning

Uttalelse om årsregnskapet

Jeg har revidert årsregnskapet for Stiftelsen Norsk institutt for luftforskning, som består av balanse pr. 31. desember 2012, resultatregnskap som viser overskudd på kr 3.225.553,- og kontantstrømoppstilling for regnskapsåret avsluttet pr. denne datoen, og en beskrivelse av vesentlige anvendte regnskapsprinsipper og andre noteopplysninger.

Styret og daglig leders ansvar for årsregnskapet
Styret og daglig leder er ansvarlig for å utarbeide årsregnskapet og for at det gir et rettvisende bilde i samsvar med regnskapslovens regler og god regnskapsskikk i Norge, og for slik intern kontroll som styret og daglig leder finner nødvendig for å muliggjøre utarbeidelsen av et årsregnskap som ikke inneholder vesentlig feilinformasjon, verken som følge av misligheter eller feil.

Revisors oppgaver og plikter
Min oppgave er a gi uttrykk for en mening om dette årsregnskapet på bakgrunn av min revisjon. Jeg har gjennomført revisjonen i samsvar med lov, forskrift og god revisjonsskikk i Norge, herunder International Standards on Auditing. Revisjonsstandardene krever at jeg etterlever etiske krav og planlegger og gjennomfører revisjonen for å oppnå betryggende sikkerhet for at årsregnskapet ikke inneholder vesentlig feilinformasjon.

En revisjon innebærer utførelse av handlinger for å innhente revisjonsbevis for beløpene og opplysningene i årsregnskapet. De valgte handlingene avhenger av revisors skjønn, herunder vurderingen av risikoene for at årsregnskapet inneholder vesentlig feilinformasjon, enten det skyldes misligheter eller feil. Ved en slik risikovurdering tar revisor hensyn til den interne kontrollen som er relevant for selskapets utarbeidelse av et årsregnskap som gir et rettvisende bilde. Formålet er å utforme revisjonshandlinger som er hensiktsmessige etter omstendighetene, men ikke for a gi uttrykk for en mening om effektiviteten av selskapets interne kontroll. En revisjon omfatter også en vurdering av om de anvendte regnskapsprinsippene er hensiktsmessige og om regnskapsestimatene utarbeidet av ledelsen er rimelige, samt en vurdering av den samlede presentasjonen av årsregnskapet.

Etter min oppfatning er innhentet revisjonsbevis tilstrekkelig og hensiktsmessig som grunnlag for min konklusjon.

Konklusjon
Etter min mening er årsregnskapet avgitt i samsvar med lov og forskrifter og gir et rettvisende bilde av den finansielle stillingen til Stiftelsen Norsk institutt for luftforskning pr. 31. desember 2012 og av resultater for regnskapsåret som ble avsluttet per denne datoen i samsvar med regnskapslovens regler og god regnskapsskikk i Norge.

Uttalelse om øvrige forhold

Konklusjon om årsberetningen
Basert på min revisjon av årsregnskapet som beskrevet ovenfor, mener jeg at opplysningene i årsberetningen om årsregnskapet, forutsetningen om fortsatt drift er konsistente med årsregnskapet og er i samsvar med lov og forskrifter.

Konklusjon om registrering og dokumentasjon
Basert på min revisjon av årsregnskapet som beskrevet ovenfor, og kontrollhandlinger jeg har funnet nødvendig i henhold til internasjonal standard for attestasjonsoppdrag (ISAE) 3000 «Attestasjonsoppdrag som ikke er revisjon eller begrenset revisjon av historisk finansiell informasjon», mener jeg at ledelsen har oppfylt sin plikt til å sørge for ordentlig og oversiktlig registrering og dokumentasjon av selskapets regnskapsopplysninger i samsvar med lov og god bokføringsskikk i Norge.

Konklusjon om forvaltning
Basert på min revisjon av årsregnskapet som beskrevet ovenfor, og kontrollhandlinger jeg har funnet nødvendige i henhold til internasjonal standard for attestasjonsoppdrag (ISAE) 3000, mener jeg stiftelsen er forvaltet i samsvar med lov, stiftelsens formal og vedtektene for øvrig.

Oslo, 29. april 2013

Helge Thorvik
Statsautorisert revisor

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