Annual Magazine

NILU

2008

Boundless

Content

Photos: Unless stated the photos belong to NILU. Front page pictures: Above: Harald Sodemann, NILU, from research trip to Greenland, summer 2008. Below: Øyvind Hagen, StatoilHydro, the Mongstad refinery.

Through its research NILU increases the understanding of climate change, of the composition of the atmosphere, of air quality and of hazardous substances.

Based on its research, NILU markets integrated services and products within analysing, monitoring and consulting.

NILU is concerned with increasing public awareness about climate change and environmental pollution.

Welcome to NILU's annual magazine 2008.
We have chosen to cultivate the magazine line for this edition, focusing on articles and interviews on our activities in 2008.
You may find the accounts and report from the board of directors on www.nilu.no. For the first time, we will publish the magazine both in English and in Norwegian. If you would like to have the magazine in Norwegian, please email us, or you may download it from the above mentioned site.

Pleasant reading!
Anne Nyeggen
Editor

Challenges

The expression that "pollution knows no boundaries" is somewhat worn-out. It is however more relevant than ever: Emission of greenhouse gases – the largest environmental challenge – knows no boundary lines, and long-range pollution is still a problem in several parts of the world. Likewise, it seems that there are no limits for the development of new compounds, technologies or ways of using well-known compounds – with unknown effects on the environment – and eventually on our health. Moreover, the dispersion of environmental pollutants probably will increase due to climate change. Thus there are many reasons why the environmental pollutants should gain attention and priority.

NILU's baseline research in this area is the analyses of new and potential environmental pollutants in all kinds of samples and at extremely low concentrations. The results are utilized in our research and in environmental monitoring for the authorities, and are also important for trade and industry. A recent evaluation of Norwegian chemistry research places NILU on top along with three university groups. This recognition confirms that our decision to invest in both advanced equipment and expertise was correct.

NILU focuses on a wide range of environmental pollutants, both organic and inorganic. A new aspect is nano particles, a promising, technological development, or a threat to our health, depending on who's talking. Health effects – both environmental pollutants and nano particles – are a new subject area that NILU is now moving into by means of our newly established health effects laboratory. Here, we also can work on mixtures of environmental pollutants. One thing is to control emissions and effects of chemicals separately, but what is the combined effect of these chemicals? Are there cumulative effects from our daily exposure to this cocktail of environmental pollutants?

In this annual magazine you can read more about the hunt for environmental pollutants. We also report on research on greenhouse gases; on how to measure the temperature of the earth; and on the work on improving

the air that we breathe – whether in Norway or in Abu Dhabi. NILU's work in atmospheric research ranges widely, both in terms of themes and geography. We are quite proud of this.

Gunnar Jordfald

Higher amounts of GHG

Measurements from Svalbard show that greenhouse gas concentrations continue to rise. Most remarkable is the increased level of methane.

ANNE NYEGGEN
Communication manager

In cooperation with the Norwegian Pollution Control Authority (SFT), NILU is monitoring 23 greenhouse gases and ozone depleting substances at the Zeppelin Mountain close to Ny-Ålesund at Svalbard. Carbon dioxide (CO_2) is measured by the University of Stockholm at the same place.

More methane in the atmosphere

The methane increase in the atmosphere over Svalbard is the most remarkable item in NILU's report for 2008 (figures from 2007). The concentration of methane is the highest ever measured over Svalbard, with a growth of 0.6 per cent from 2006. From 2004 the increase is approximately 1 per cent. Preliminary figures for 2008 confirm the trend.

– This is a rather large increase, especially considering that the level of methane has been at a nearly constant level from 1999 to 2005. The fact that the change is larger at Svalbard than at many other locations, might indicate that the source is located in the Northern Hemisphere, says Cathrine Lund Myhre at NILU, a senior scientist and programme project manager.

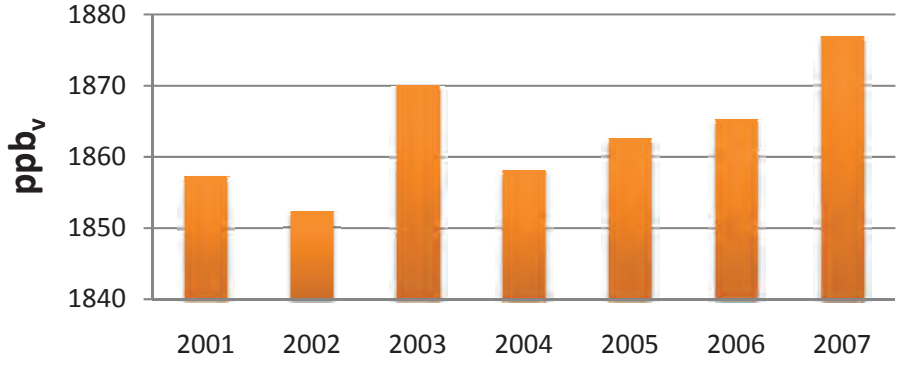
NILU's managing director Gunnar Jordfald is showing the Scandinavian successors to the throne around at NILUs Observatory in Ny-Ålesund, in June 2008. From left: Crown Prince Frederik of Denmark, Crown princess Victoria of Sweden and Crown Prince Haakon Magnus of Norway.

Other measurement locations around the world, including those in the Southern Hemisphere, show an increasing trend. The growth from 2006 to 2007 is especially high at stations in Ireland, Northern Canada and Svalbard.

Close follow up of developments

Currently, the reason for this increase cannot be explained, and it is too early to state that the trend in increased methane will continue. NILU will follow closely this development in collaboration with other research institutions.

– One theory is that the huge amounts of methane stored naturally both in the permafrost layer in Russia and North America, and at the bottom of the Arctic ocean, are released into the atmosphere due to the rise in temperature and the lower amounts of snow and ice cover, says Cathrine Lund Myhre. But this is one of many hypotheses.



Methane development measured at Zeppelin Obervatory, Ny-Ålesund, Svalbard.

Less ozone depleting substances

Many gases are both greenhouse gases and contribute to the depletion of the ozone layer. For the first time since records began, all ozone depleting CFC gases (chlorofluorocarbons) measured at Svalbard show a decrease. This decline confirms the success of the Montreal protocol on protection of the ozone layer.

We will follow closely the methane development, says Catrine L. Myhre at NILU.

– It is positive to finally observe a decrease in all the CFC gases we are monitoring at Zeppelin. Unfortunately, at the same time, we see an increase in the replacement gases, especially regarding second generation replacement gases. For the time being, they constitute a small part of the total greenhouse gas emissions, but they are powerful gases, and an increase is none the less unfortunate, says Cathrine Lund Myhre.

Important measurements at Svalbard

The measurements carried out by NILU in cooperation with SFT at the Zeppelin Mountain at Svalbard started out in 2000. The measurements are parts of several global, regional and national monitoring networks.

The data are important in the assessment of compliance with the Montreal protocol on reduction of ozone depleting substances, and will be used in the future to assess compliance with the Kyoto protocol on reduction of greenhouse gases.

Long-term measurements are important in order to observe changes in concentration of both greenhouse gases and ozone depleting substances in the atmosphere. At Svalbard there are very few sources of pollution, which makes the Zeppelin station at Ny-Ålesund a highly suitable location for monitoring global levels and trends of greenhouse gases and ozone depleting substances.

Mercury in the Antarctic – first measurements ready

Data from the two first years of mercury measurements at Troll are now available. The Troll data levels, amounting to 1/3 of the Arctic levels, are the longest time series of mercury from the Antarctic continent.

KATRINE ASPMO PFAFFHUBER
Scientist

In order to extend the global mercury database, NILU has established a long-term, year round monitoring programme of gaseous elemental mercury (GEM) at the Norwegian Antarctic research station Troll. Starting in January 2007, the first two years time series is now ready.

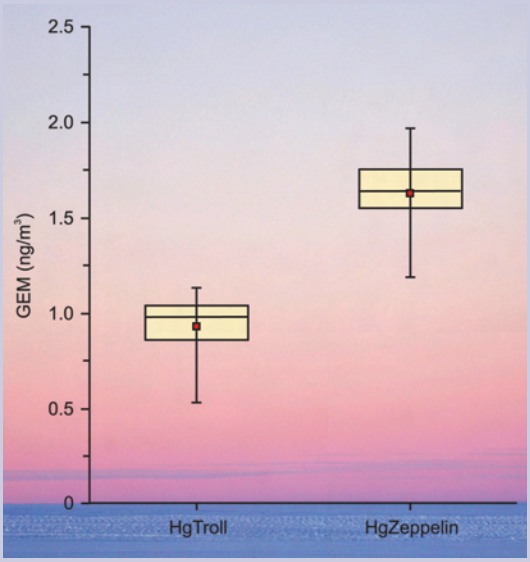
Far-travelling mercury

Mercury has been targeted as an environmental pollutant of global concern, due to its exceptional behaviour in the environment, its toxicity and unusual physical properties. Atmospheric mercury can undergo long-range transport, allowing it to be transported by air currents to remote places like the Arctic and Antarctic, far from its emission sources.

NILU is the only institution with Arctic and Antarctic activities on mercury (mainly gaseous elemental mercury, GEM). A very limited set of measurements exists from the Southern Hemisphere in general, and from the Antarctic especially; thus, the two years mercury data now ready from Troll is a valuable contribution to the global mercury database.

Mercury is emitted into the atmosphere by a variety of natural sources like volcanoes and wildfires, and anthropogenic sources, e.g. from the combustion of coal. While anthropogenic mercury emissions have decreased over North America and Europe during the 1990s, emissions in Asia and

Atmospheric measurements using liquid nitrogen at the Troll station in Antarctica.



A comparison of NILU's Antarctic and Arctic mercury measurements, illustrated by a box and whisker plot which includes data from the years 2007 and 2008. The distribution of concentrations values from both sites is quite similar, but the data from Troll are approximately 1/3 lower compared to Zeppelin, located in the Arctic. This is mainly due to the facts that the majority of mercury sources are situated on the Northern Hemisphere, that strong winds around the Equator prevent transport from the Northern to the Southern Hemisphere and that atmospheric mercury is fairly short-lived.

Africa have strongly increased. China is now the country with the by far largest mercury emissions worldwide. Since the majority of anthropogenic sources of mercury emissions to the atmosphere is located in the Northern Hemisphere, mercury concentrations in the Southern Hemisphere are about 1/3 lower compared to the Northern Hemisphere.

Spring depletion

Mercury bio-accumulates in freshwater ecosystems and in marine wildlife. The so-called atmospheric mercury depletion events (AMDE) may support evidence for this accumulation. AMDE is caused by light induced oxidation reactions where GEM concentrations are suddenly depleted and are converted to short lived mercury forms that, in turn, are deposited onto snow and ice, causing an increased input of mercury to polar ecosystems. AMDEs are a recurring spring phenomenon occurring at a time when the ecosystems are at the start of their annual growth cycle.

Mercury and climate

The effect of climate change on mercury cycling has received little attention hitherto but is a potentially important issue. Temperature rise will increase the volatilization of mercury from ocean and land reservoirs and may transfer mercury between ecosystems via atmospheric transport, re-depositing it in a more mobile and, presumably, more toxic form. In Polar Regions, future warming may thaw permafrost and remobilize mercury stored in snow and soils, and hence create a plume of mercury into the polar oceans. Another effect of a future warming would be the likely increase in mercury methylation (MeHg) production. Since MeHg is the most toxic form of mercury that bioaccumulates and biomagnifies, any increase in the MeHg flux to the polar oceans will exacerbate the potential for mercury accumulation in the tissues of marine mammals.

Well equipped research vessel to Tromsø

In April 2008 one of the world's best equipped research vessels, the R/V Knorr, made port in Tromsø. Scientists from the United States, Norway, and Finland were then mid-way through a two-leg cruise from the United States to Iceland via Tromsø, Svalbard, and the Greenland Sea.

As part of POLARCAT, a NILU-led International Polar Year programme, the scientists were conducting extensive surveys of regional and Arctic air quality. In particular, the objectives of the campaigns were to evaluate long range transport of pollutants into the Arctic, and measure the environmental impact from increased human activity in the region.

The cruise was led by Patricia Quinn from NOAA (National Oceanic and Atmospheric Administration) and John F. Burkhart from NILU.

The research vessel R/V Knorr is owned by the U.S. Navy and operated by WHOI (Woods Hole Oceanographic Institution) for the ocean research community.

For more information, please see http://www.polarcat.no/activities/polarcat-norway, and http://www.polarcat.no/activities/noaa-icealot

R/V Knorr is one of the best equipped research vessels in the world.

Photo: John F. Burkhardt, NILU

CO_2 Capture using amines

NILU and its partners are the first in the world to study the possible effects of amine emissions to air. Initial investigations have been performed which show that there can be environmental effects from the emissions and it is certainly relevant regarding which amine is released to the air, says Project Leader Svein Knudsen.

SCOTT RANDALL
Scientist

In spring 2008, NILU was commissioned to research the consequences of establishing new technologies for using amines during CO2 capture. The results will be important for future CO_2 capture development and for emissions permits for relevant industrial organizations. This Phase I theoretical study was in cooperation with NINA (Norwegian Institute for Nature Research), FHI (Norwegian Institute of Public Health), UiO-CTCC (University of Oslo, Center for Theoretical and Computational Chemistry), and NIVA (Norwegian Institute for Water Research). Funding for the project was granted by StatoilHydro, Gassnova and Shell Technologies Norway.

The final results from Phase I clearly show that effects can be produced from the emissions of amines to air. The study also shows that it is not the amines themselves which are necessarily the problem, but the products that are produced during the chemical reactions after the emissions have left the stack. These reactions produce nitrosamines, amides, and nitramines, but the theoretical computations do not give an indication to what degree these products are formed. To answer this question, it is necessary to undergo actual experiments which can generate the reaction rates – this work is proposed in Phase II to begin in late 2009.

Capture with amines

CO_2 capture from industry is a high priority on the Norwegian social agenda both with politicians, industry and environmental organizations. CO_2 capture using amine technology is seen as the most promising method to efficiently capture CO_2 during industrial processes. Amines are injected into the industrial emissions and are able to remove most of the CO_2, and while the CO_2 is then stored, the amines are recycled back into the process. But some of these amines will inadvertently be released out into the atmosphere. Amine emissions will then contribute to raised nitrogen deposits and increase the potential for eutrophication in sensitive ecosystems. The amines will also undergo complex reactions in the air and produce unwanted byproducts. The theoretical study shows that some of these products can be toxic, independent of which type of amine is used and to what degree the products are produced.

– We know by now that it is certainly relevant regarding which amine is released to the air, says Project Leader Svein Knudsen from NILU.

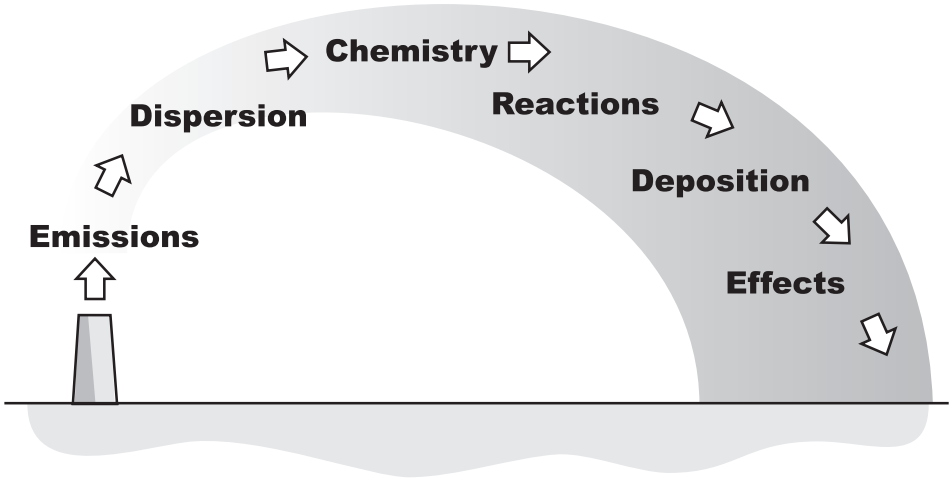
StatoilHydro will build a test plant for carbon capture in connection with their Combined Heat and Power plant (CHP) at Mongstad. Foto: Øyvind Hagen, StatoilHydro

Research cooperation

NILU's initial research has focused on the goal to raise the knowledge regarding atmospheric amine chemistry, and to investigate whether the emissions from CO_2 capture actually create a potential health and environmental risk. The study has shown that there is great

need for additional information and analysis of the chemical relationships which are formed in the atmosphere from amine emissions. This especially concerns chemical reactions, concentrations, deposition, and the relative quantification of the toxicity and other possible effects.

More information regarding the potential effects from amines can be found in the 10 reports generated from the Phase I theoretical study, which can be downloaded from http://co2.nilu.no.



Schematic illustration of the process.

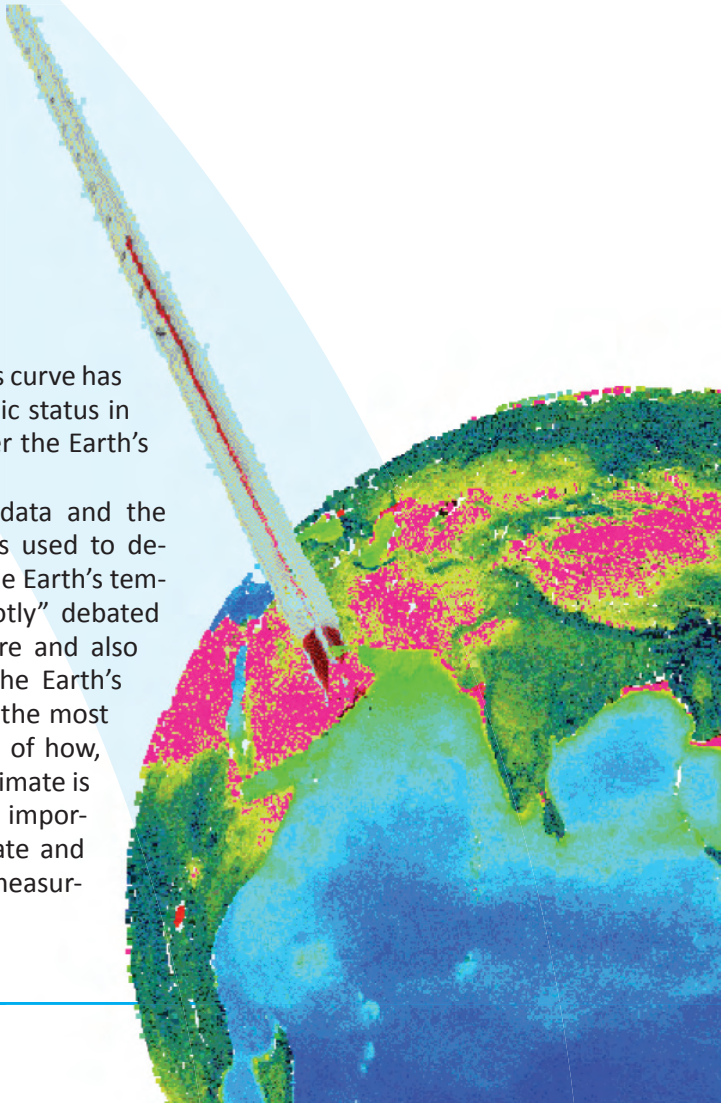
Taking the temperature of the planet

The Earth's temperature is rising, due to climate change and global warming. But how do we know this? When a person is sick we can use a thermometer to measure her temperature and we can do this at regular intervals to see if the temperature is going up or down. But the Earth is a big place and we don't have enough thermometers to measure the temperature everywhere, so how is it done?

FRED PRATA
Senior Scientist

For about 150 years or so, meteorologists have been measuring the temperature of the air about 1.5 m above the ground at many places around the world and at regular intervals. Before about 1800 there were very few direct measurements of the Earth's temperature and we have had to rely on ingenious methods to extract temperatures based on tree ring growth, ice cores or coral growth, i.a.,– so-called "proxy temperatures". Using these methods we can trace the Earth's temperature back about 1000 years. A graph of this record appears in the IPCC 2004 climate change assessment and has been called the "Hockey stick curve", because of its resemblance to the profile of a hockey stick. This curve has taken on an almost iconic status in the debate over whether the Earth's climate is warming.

The validity of the data and the veracity of the methods used to determine this record of the Earth's temperature have been "hotly" debated in the scientific literature and also in the popular press. The Earth's temperature is perhaps the most obvious of all indicators of how, and by how much, the climate is changing, so it is rather important to continually update and improve methods for measuring Earth's temperature.

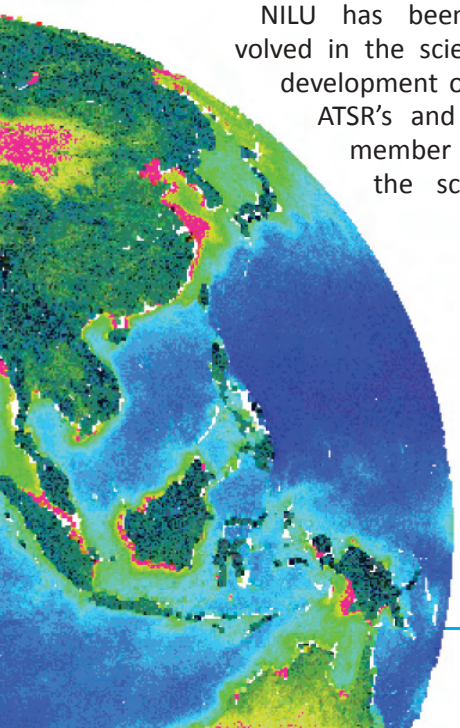


High precision thermometers

Since the late 1960's orbiting satellites have had the capability to monitor vast tracts of the Earth's land and ocean. Clever thermometers, called "radiometers", that can measure the Earth's temperature by recording the heat it emits, have been built and placed on satellites to look down at the Earth. In the early 1990's these radiometers achieved precisions of less than 0.3 K and can measure the temperature of the entire planet in 1-2 days. The most precise of these radiometers is the Along-Track Scanning Radiometer (ATSR) and it's successors, ATSR-2 and the Advanced ATSR, built by a European/Australian consortium and housed on European environmental satellites.

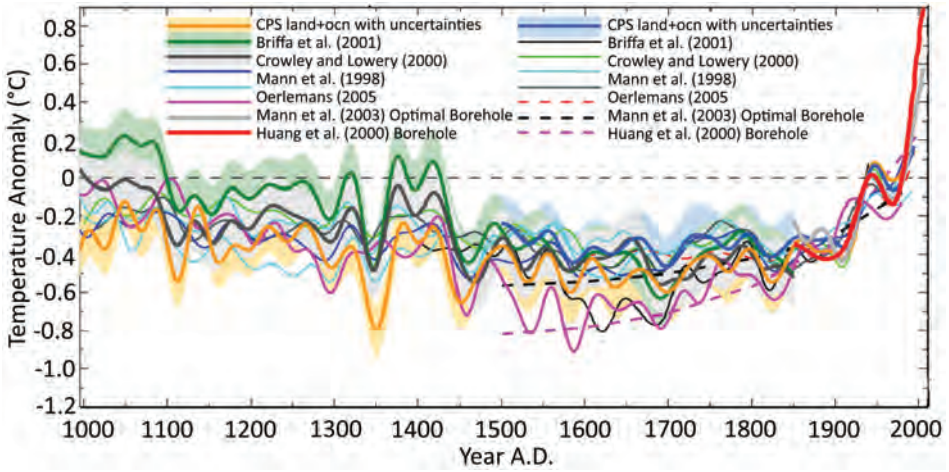
Ocean measurement for the first time

A 3rd generation radiometer is now being built: the Sea and Land Surface Temperature Radiometer (SLST-R), for Europe's premier future environmental satellite program Sentinel-3. When this is launched in 2016, a 25-year high precision satellite-based record of the Earth's temperature will be available for climate scientists to study and utilize in climate models. Because the data are collected over the whole planet at kilometer scale, it is possible to investigate regional changes. It is also possible to measure accurately, for the first time, the 70% of the Earth's surface covered by the oceans.



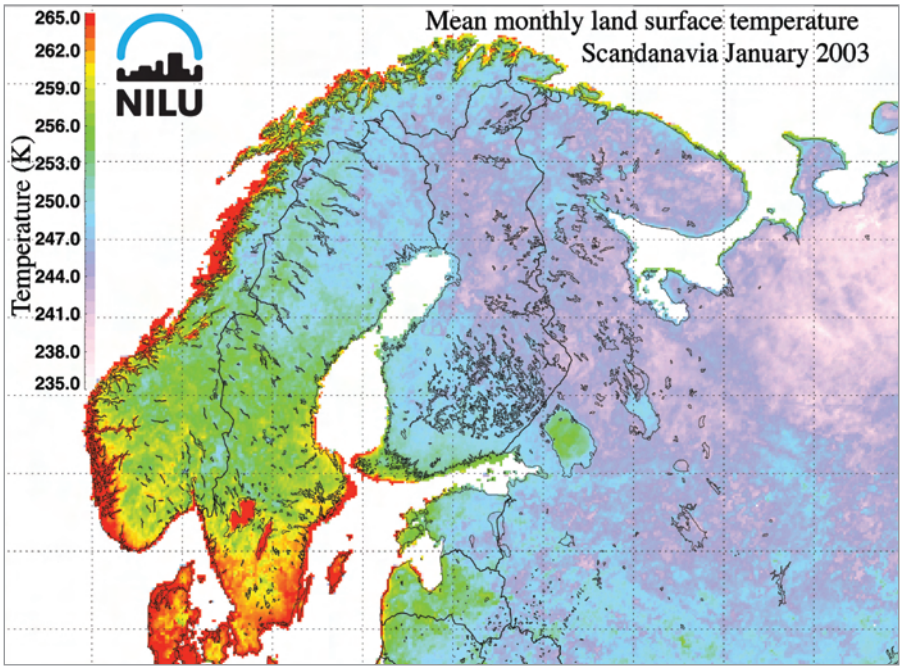
NILU has been involved in the scientific development of the ATSR's and is a member of the science team. NILU has also received funds to develop the algorithms needed to turn the SLST-R measurements into calibrated land surface temperature records for use by climate scientists.

In preparation for the Sentinel-3 mission, NILU is reprocessing the 18-year ATSR, ATSR-2 and (A)ATSR record of land surface temperatures for regional studies. ATSR-2 monthly mean land surface temperatures processed for the Scandinavian region can be used to observe changes in particular habitats and to isolate long-term climate changes from climate "noise" induced by anomalous synoptic-scale weather or localized human-induced land changes, which affect surface temperatures.



Graph of temperature record used by IPCC called the hockey stick curve, due to its shape. This curve has taken on an almost iconic status in the debate over whether the Earth's climate is warming.

For more information on the ATSR's see: http://www.leos.le.ac.uk/aatsr/
For more information on the Sentinel-3 program see: http://www.esa.int/esaLP/SEMT-ST4KXMF_LPgmes_0.html



NILU is now reprocessing the records of the three 18-years ATSR's of land surface temperatures for regional studies.

Red in Ålesund ...

What do the Abu Dhabi Emirate and the town of Ålesund on the west coast of Norway have in common? They are two of many cities where NILU monitors air quality. Also, in 2008 pollution level limits were markedly exceeded in both cities.

Aalesund seen from the mountain of Aksla. Photo: Frode Inge Helland.

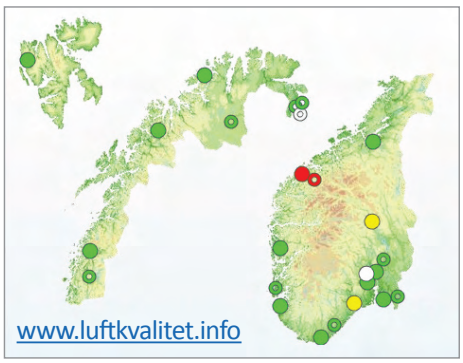
Photo: Ålesund kommune

–We take the bad air quality in Ålesund very seriously, says Mirza Begic, municipality of Ålesund

SUSANNE M. STEPHANSEN
Journalist

Despite the fact that Ålesund is situated by the coast and has a lot of wind from the sea, the city had the worst air quality in Norway on a number of occasions in 2008. The bad quality air could easily be seen from the hot-tempered red colour on the air quality map at www.lufkvalitet.info, an online monitoring service developed by NILU for the Norwegian Pollution Control Authority and the Norwegian Public Roads Administration.

– When the amount of, e.g., particulate matter or nitrogen oxides exceed the pollution regulation limit, it will be marked by a red point at the appropriate place on the map of Norway. If the air quality is good, it will be marked green, whereas a red point tells you that the air quality is very poor, and that allergy sufferers and people with severe cardiovascular or breathing disorders should keep away from outdoor activity, explains Dag Tønnesen, senior researcher at NILU.



Colour codes indicate the level of pollution. Ålesund exceeded the limit of polution 24 times in the winter of 2008.

– This was the case in Ålesund several times last year, all in all 24 times to be more specific, says Mirza Begic, Head of group for road and traffic regulations in Ålesund.

– One particular monitoring station situated near a central intersection in the city has "measured red". Despite the fact that the intersection area is both swept and washed several times a week, there is a lot of dust here, he says.

Worse when cold and calm

The air quality is particularly poor in Ålesund on cold days with little wind and rain.

– The main reason for poor air quality with high values of particulate matter (PM_{10}) is the use of studded tires, says Tønnesen. 75 percent of all cars in Ålesund still use studded tires during the winter season, according to measurements made by the Norwegian Public Roads Administration. And this in a city where frost and snow is relatively rare! In comparison, the proportion of cars with studded tires was measured to be 45 percent in snowy Lillehammer in 2008.

– A car with studded tires produces up to 100 times more particulates than a car with regular tires, due to the increased wear of the road surface, says Dag Tønnesen. – A reduction in the use of studded tires will no doubt help to improve the air quality.

Will take action

– We take the bad air quality in Ålesund very seriously, says Begic. – But in spite of all the red point measurements, we are still far below the limit of when we have to take action, according to the EU directive on air quality. The limit is 35, and we measured red 24 times in 2008, he says. However, Ålesund still wants to do something about this.

– The measurements are discussed at a political level and we have already decided to initiate a study in which various measures for improved air quality, such as a studded tire fee and a reduced speed limit, will be evaluated. The study will start in the near future, says Begic.

–The main reason for the poor air quality is the use of studded tires, says Dag Tønnessen, NILU.

... Red in Abu Dhabi

Dust from the Desert

In the oil-producing nation of Abu Dhabi, the largest of the seven emirates in the United Arab Emirates, the number of overruns (red points) are significantly higher than 24. The area, situated on the Persian Gulf coast, has one of the highest CO_2 emissions per person in the world. It also has to deal with dust levels which in many places are far higher than acceptable.

– In certain areas air pollution is high, says Trond Bøhler, Head of NILU's Abu Dhabi office. In the cities, traffic is a major contributor, but high proportions of particulate matter also have natural causes, namely the desert sand in the area, explains Bøhler. But the pollution is obviously also caused by the huge oil industry in the Emirates.

In certain areas in Abu Dhabi, air pollution is high, says Trond Bøhler, Head of NILU's Abu Dhabi office.

– One of our tasks now is to find out which of the three identified pollution sources are guilty of what, and by how much. A separate project has been initiated on this topic.

Monitors the Air Quality in Abu Dhabi

On January 1st 2008 NILU's office in Abu Dhabi took over the responsibility for managing Abu Dhabi's air quality, and thus resumed the task of establishing the Abu Dhabi Air and Climate Institute (ADACI). The current contract is for five years, and the first year has just ended.

The traffic in Abu Dhabi is one of three main sources for air pollution.

– It has been a busy year during which we have put down a lot of work, says Bøhler, the only Norwegian who remains at the office on a permanent basis. Helping him at the pink concrete house just outside the centre of Abu Dhabi city, he has a team of about 20 Arabic – and English – speaking employees.

Website on Air

One of the most visible results of NILU's work in Abu Dhabi so far, is a web portal that presents information on air quality for residents of Abu Dhabi.

– www.adairquality.ae provides information on air pollution in general, about health effects and about the laws related to air pollution. But the most important service we offer is probably the presentation of the online measurements from various monitoring stations around the country, says Bøhler.

– This site is also marked with the same air quality colour codes as in Norway.

Standardized measurements

NILU and the Abu Dhabi Air and Climate Institute have also established a standardized unit to evaluate all the networks measuring outdoor air quality in Abu Dhabi. The unit will, among other things, ensure that all instruments in the monitoring stations are calibrated relative to a national standard.

How clean is the air you breathe?

Does your city have clean air? NILU is involved in several projects dealing with monitoring and modelling, assessment and forecasting of air quality in Norwegian cities. The air quality does not always comply with National targets or EU regulations.

INGRID SUNDVOR
Scientist

www.luftkvalitet.info is a web portal developed and hosted by NILU, providing information to the public, authorities and stakeholders. Online monitoring data for many Norwegian localities, together with general information about air quality, regulations, health effects and abatement measures are part of the accessible information.

Forecasts of the air quality for Norwegian cities are given every day during the winter season. People can receive these forecasts by signing up at Luftkvalitet.info. If the forecast is alerting red conditions, perhaps you should leave the car at home that day!

NO_2 and Particulate matter (PM) are the main problem pollutants. Model studies performed by NILU show that as much as 35% of the population in Oslo in 2007 were exposed to concentrations of PM_{10} above the limit values set in the National targets. By modelling the relative importance of the different sources in Oslo and Trondheim it was found that 60-80% of the PM_{10} exceedances were due to road traffic. The second largest source to PM_{10} concentrations was domestic wood burning.

Environmental control actions have been taken by the authorities. For instance, reduced speed limits on some of the main roads, tax on the use of studded tyres, and financial aid to replace old stoves and open fireplaces seem to have improved the air quality in Oslo. Comparison of model results for 2005 and 2007 indicates that there has been a reduction in the number of people exposed to high concentrations of PM. However, we still have not yet reached the national targets.

Hunting high and low

New chemicals are continuously introduced to us in the shape of more advanced products. The intentions are good, but these chemicals may very well be the pollutants of the future. NILU's High Tech Laboratory has both the competence and equipment to map the new threats.

SUSANNE M. STEPHANSEN
Journalist

We all want them: Those great, new products that promise to do wonders to our health, our skin, our skiing abilities and our houses. Over several years, new chemical products have given us better cosmetics, textiles, pharmaceuticals and building materials, just to mention a few.

It is certainly great working out in clothes that can breathe and control odour, but is it possible that there is an extra cost to these products that we still do not know about?

– In principle all chemicals may represent an environmental threat, says Ole-Andres Braathen. He is the Director of the Department for Environmental Chemistry at NILU. For a number of the chemicals in active use today, however, the environmental data is limited or non-existent. Our job is to continuously reduce the gap in knowledge.

Global strength

The scientific community is continuously discovering new threatening pollutants with a consequent need for environmental monitoring data. NILU is taking an active part in the hunt for these pollutants, and has been central in establishing both datasets and knowledge on new pollutants such as brominated flame-retardants, polyfluorinated organic compounds, pharmaceuticals, triclosan and siloxanes (see fact frame for use).

– The most recent example is sucralose, an artificial sweetener. Sucralose is about 600 times sweeter than sugar, and can be found in a number of diet products, says Braathen.

Laboratory technician Iren E. Sturtzel is hunting for new environmental hazards.

In principle all chemicals may represent an environmental threat, says Director of Department of Environmental Chemistry, Ole-Anders Braathen.

– The yearly emission of sucralose in Norway is large, and research shows that it can take up to five to ten years for it to disappear from waters and lakes.

– Another substance we are looking closer at as a new and possible environmental threat is silver, says Braathen. Silver ions or nanosilver, is known for its supposed "germ killing" abilities. It is found in consumer products such as workout gear, washing machines and refrigerators (see accompanying article on this).

Stepping up to new methods

–The discovery and analysis of new potential pollutants is a complicated process, explains Braathen.

– For a start, the scientific community has to detect and characterize a new chemical compound. If there is any indication that the compound is found in nature, we take samples. In order to investigate a new compound, however, we may need to develop new methods. All chemicals behave differently, which in turn means that we have to develop new and more sophisticated methods continuously, says Braathen.

– Thus the work continues step by step to a solution.

– In our work we find compounds that prove harmless, while others prove to be environmental pollutants. Then we need more advanced methods to get as much information of the compound as possible.

Braathen and his colleagues are focusing strongly on finding out just how much of a chemical can be found in the environment, if it is taken up in humans and animals and how it behaves. A different research group at NILU is looking at how these environmental stressors affect human and animal health. – We are about to establish a brand new Effect Laboratory at NILU, where the health effects of environmental and anthropogenic stressors will be studied, says Braathen.

People and equipment

About forty people are working at The Department of Environmental Chemistry at NILU, situated both in Kjeller outside of Oslo, and in Tromsø in Northern Norway. Braathen mentions that they have one of the best labs for environmental analysis in Norway. The expertise here also puts NILU on the international map.

– We have state-of-the art advanced scientific equipment in our lab, but first and foremost we have extremely competent and highly dedicated people working here, says the director.

– We have also tracked down the international researchers that have the competence we need. Luckily they want to come and work here at NILU. I see that as a testament to the fact that NILU can offer both a challenging and exciting research environment, concludes Braathen.

Facts
Brominated flame-retardants:
– Electronic equipment, textiles
Polyfluorinated organic compounds:
– All Weather Coats and other textiles, foam fire protection systems
Triclosan:
–Toothpaste and dishwashing liquid (some)
Siloxanes:
–Cosmetics, joint-fillers

Silver – old metal in new wrapping

Silver has been known and used by man since ancient times. In recent years, nanotechnology has multiplied its use in manifold ways: sportswear, refrigerators, make-up and toothpaste, to name a few. But is it as harmless as previously supposed?

HILDE UGGERUD
Senior scientist

Nanotechnology has opened up novel uses of silver, taking advantage of key properties such as antibacterial effects, and the reputation silver has as being non-toxic to humans. The increased ability to combine silver with other materials, providing products with desirable properties such as elasticity and transparency, has lead to an explosion of new silver-containing products.

The silver content in these products varies significantly, and so does the amount of silver leached. NILU has examined sportswear and found that 0.5-2 µg of silver leached during one hour wash. Until recently, industry and photographic activities have been the main emitters of silver. These sources of silver have been well known and regulated by specific rules and procedures to keep emissions low. Now we have a new situation: nanosilver and silver are used in an increasing number of consumer products and may start to emit from all outlets serving urban customers. Consequently, silver can end up in our waste water and sewage sludge. This is not desirable as the latter is used as a soil additive. Silver ions and nanosilver are biologically active. Published studies show that silver ions reduce denitrification of the soil, and that nanosilver reduces photosynthesis yields in freshwater algae.

Silver and nanosilver is found in a wide range of products, from stuffed toys and sports wear to beauty products and water cleansing systems.

Currently, we have no evidence of negative effects of the nanosilver occurring in the environment, but this may change. If one consumer product containing nanosilver gains widespread popularity, we may have substantial releases of silver.

NILU's activities concerning silver encompass several projects, including the Norwegian and Swedish screening projects METSPEC and NORPOL, where the aim is to study the effects of nanosilver on human health.

Denitrification= the reduction of nitrates to nitrogen gas

New helth effect laboratory:

Going full circle

With the establishment of a brand new health effects laboratory, NILU goes full circle in environmental research. In addition to collecting data, monitoring and measuring pollution, researchers will also investigate the direct health impact of pollution, climate change and new materials on humans and animals.

ANITA T. MUNCH
Journalist

In daily life we are surrounded by environmental and anthropogenic stressors such as combustion particles, synthetic fabrics, industrial toxins, chemical additives and food preservatives, just to mention a few.

The relative risk of developing environmental diseases such as heart disease or cancer from these pollutants is small compared to the impact of established risk factors such as smoking, obesity, or high blood pressure. The fact still remains, however, that an enormous number of people are exposed to these pollutants over their lifetime. Thus, these pollutants have become a serious public health problem. The potential health impacts of climate change represent another challenge which needs to be addressed.

With the establishment of a brand new Health Effects Laboratory at NILU, senior researcher Dr. Maria Dusinska and her research group will find out more about just how serious the impact is on both humans and ecosystems.

Looking for the source

The Health Effects Laboratory will officially open in the first half of 2009. A large part of 2008 was spent establishing the lab and organizing the set up.

Maria Dusinska is proud of the new health effect laboratory.

– With this laboratory we will study the health effects of both environmental and anthropogenic stressors on biological systems. Our aim is to find the main pathways and mechanisms that can lead to the development of diseases such as cancer, cardiovascular, metabolic diseases and ageing diseases, says Dusinska.

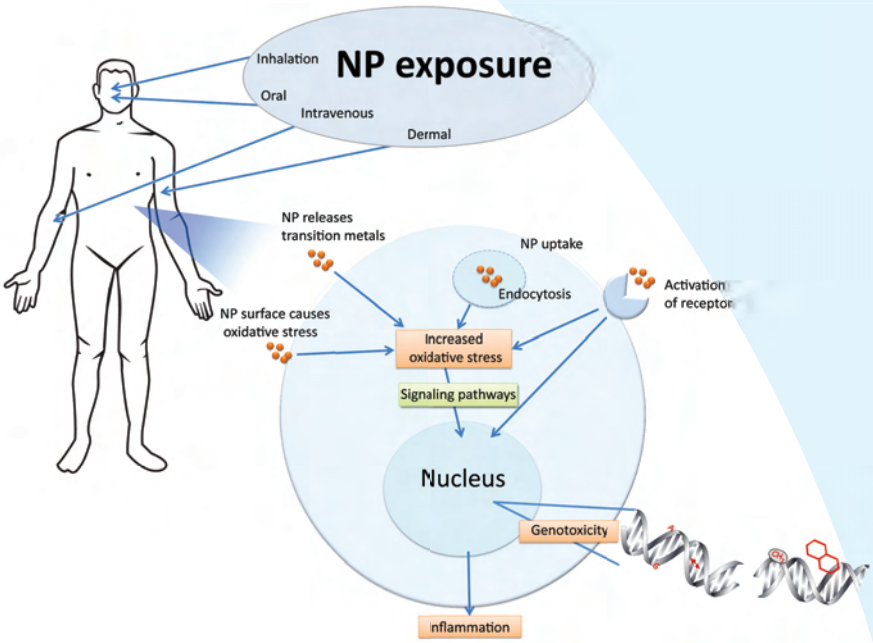
The researchers will use different molecular and cellular markers and endpoints to do toxicological studies. They will also develop new methodologies for investigating cytotoxicity, oxidative stress, genotoxicity, neurotoxicity and possible carcinogenicity.

– As a starting point we are intensifying the research on the toxicity of nanoparticles, Dusinska says.

Big on nano

Nanomaterials have unique properties and applications, i.e. in diagnostics and drug delivery in medicine. However, the properties that make nanoparticles so useful could also be associated with unintentional health effects.

– As particle size decreases the surface area increases, as does the reactivity. Thus, the particles can generate an effect not seen with the same material in a larger form, and access tissues that are normally protected by biological barriers, explains Dusinska.



Nanoparticles (NP) can influence the cell in different ways, either externally via receptors or internally by direct or indirect uptake into the cell. This may lead to oxidative stress and inflammation. Resent research also investigates whether the NPs can affect the genes.

By studying the impact of natural and engineered nanoparticles on health, a new area of expertise has taken shape at NILU. The groundbreaking research is performed in several experimental research projects on nanoparticles such as the EU Seventh Framework Programmes (FP7) NanoTEST and NanoImpactNet, as well as a Norwegian Polish EEA grant. All three projects started in 2008.

– Thanks to the expertise and the success in the FP7 projects, NILU is part of the European network of leading institutions in nanotoxicology, and recognized as one of the leading Norwegian institutions in the area, says Dusinska.

– We also have extensive collaboration with researchers in Central and Western Europe and institutions outside of Europe such as India, and Africa, she adds.

Interdisciplinary research

The laboratory will be useful to many of NILU's researchers, also to those outside her own discipline, thinks Dusinska.

– It will give us a unique possibility for collaboration between the departments at NILU, she says.

– NILU has extensive expertise both in local air pollution, pollutants and global climate changes. With the new laboratory, NILU expands its expertise and goes full circle in its research topics. From monitoring, analysing and data collection to also include studies on the direct health impact of environmental and human made stressors, concludes Dusinska.

Katarína Hašplová uses the microscope to look at live cells that have been exposed to nanoparticles.

Local and regional air pollution – looking to the future

Sources and agents of environmental pollution are manifold and complex. It requires comprehensive understanding to see the particular exposure pathways as a whole and to intervene to reduce the impact of pollution. NILU contributes to the development of methods and tools for this intervention within a range of different projects.

SONJA GROSSBERNDT
Scientist

One of them is the EU-funded project HEIMTSA (Health and Environment Integrated Methods and Toolbox for Scenario Assessment). It is designed to develop methods and tools for assessing health impacts that are mediated via the environment. The project aims at providing useful information for the development of policies at the European level by enabling policy makers and other stakeholders to understand the public health effects of policies or measures before they are put in place. HEIMTSA also contributes to the Environment and Health Action Plan (EHAP) 2004-2010 in EU.

HEIMTSA uses the full chain approach. This means tracking the fate of pollutants from the point of how policies affect emissions, through to changes in concentrations, exposures and risks to health. These exposures and risks are combined with demographic data and background rates of mortality and morbidity to give estimated annual health impacts attributable to the (changes in) emissions. Finally, these health impacts are aggregated in HEIMTSA principally via a cost assessment, which also allows comparison with costs of policies, but also via DALYs (Disability-Adjusted Life Years). This method was chosen in order to use an integrated approach to the assessment of environmental health risks and consequences.

NILU takes on an important role in HEIMTSA by leading two sub-projects; furthermore, it is participating in other sub-projects and work packages.

See also http://www.heimtsa.eu/

The research team of HEIMSTA develops new methods for the assessment of health and environmental impacts. Photo: Kinga Lancz.

NILU – making a difference

NILU is an independent, non-profit institution established in 1969. The institute holds a strong position both on the national and international level within its core fields. NILU's 185 researchers, technicians and other experts are primarily commissioned by the Norwegian research council, by industry in Norway and offshore, and by governmental institutions at local, national and international level.

From Pole to Pole

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

Laboratories

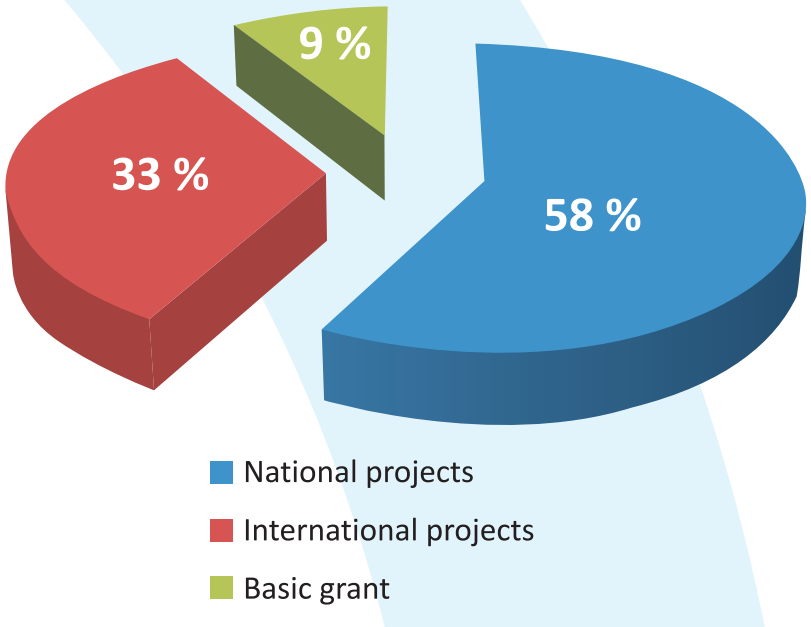
NILU's chemical laboratories are among the most advanced in Europe. The laboratories have a range of state-of-the art analytical equipment, including a series of high-resolution mass spectrometers to determine a broad range of organic and inorganic pollutants.

Health effect laboratory

With the new health effect laboratory, NILU will investigate the direct health impact of pollution, climate change and new materials on humans and animals. Its establishment completes the "circle" of monitoring, modelling, analysing, evaluation and effects implemented at NILU.

NILU topics:

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



for the environment

International activities

NILU has a long experience in co-ordinating international research projects. The institute takes an active part in the EU's 6th and 7th framework programmes for research. It is also co-ordinating the Programme for Monitoring and Evaluation of the Long-Range Transmission of Air Pollutants in Europe (EMEP).

NILU also has a leading international role in collecting and storing measurement data from atmospheric research and monitoring programmes, and is responsible for several international databases.

from the Troll station in Antarctica; NILUs observatory on the top of the picture.

Some major international NILU clients:

- United Nations Economic Commission for Europe (UN-ECE),
- European Environmental Agency (EEA)
- European Commission (EC)
- World Bank (IBRD)
- World Meteorological Organization (WMO)
- World Health Organization (WHO)
- United Nations Environment Programme (UNEP)

Services

NILU offers a range of services and products to customers in Norway and internationally, among them:

Air Quality Consulting Services
NILU has 40 years of experience in handling air pollution issues. By combining highly qualified scientific researchers and in-house software developers, NILU has introduced a complete range of air quality consulting services.

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

Innovation

NILU markets its innovations through affiliates such as

Nicarnica – a company specializing in the development of UV and IR imaging camera technologies for the detection of hazardous substances in pollution.

EIFAir – the only existing web based tool for simulation of Environmental Impact Factors of emissions to air.

Key Numbers

Turnover	164.1 MNOK
Revenue from projects	146.9 MNOK
Basic grant	15.3 MNOK
Number of employees	181
Employees with Ph.D.	48

In 2008 NILU published

82	scientific reports
3	technical reports
7	EMEP/CCC reports
95	lectures
27	posters

NILU scientists contributed to the publications of

127	scientific papers
25	external reports
23	papers in books/reports
2	electronic publications

A complete list of NILU 2008 publications can be found at www.nilu.no/NILU2008

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OR 03/2008

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OR 28/2008

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OR 30/2008

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OR 33/2008

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OR 35/2008

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OR 36/2008

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OR 37/2008

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OR 38/2008

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OR 45/2008

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OR 47/2008

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OR 48/2008

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OR 50/2008

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OR 52/2008

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OR 54/2008

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OR 55/2008

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OR 58/2008

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OR 59/2008

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OR 64/2008

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OR 81/2008

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