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NILU's Strategic Institute Initiatives (SIS)

2016

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ABSTRACT Each of NILU's Strategic Institute Initiatives(SIS) is required to deliver a popular science report annually to the Research Council. This report contains NILU's final reports for the SIS-projects that ended in 2016, and annual SIS-reports for 2016 for the other SIS-projects.		
NORWEGIAN TITLE NILUs strategiske instituttsatsinger (SIS) - 2016		
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ABSTRACT (in Norwegian) Alle NILUs strategiske instituttsatsinger (SIS) skal levere en populærvitenskapelig framstilling til Norges forskningsråd hvert år. Denne rapporten inneholder NILUs sluttrapporter for SIS-prosjekter som ble avsluttet I 2016, og årlige SIS-rapporter for 2016 for de andre SIS-prosjektene.		
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Preface

NILU receives basic funding from the Ministry of Climate and Environment through the Norwegian Research Council. 40 % of the basic funding is allocated to Strategic Institute Initiatives (SIS). After an initial process at NILU, the topic of each new Strategic Institute Initiative is discussed with the Norwegian Environment Agency before it is accepted as a SIS by the Norwegian Research Council.

Each SIS is required to deliver a popular science report annually to the Research Council. This report contains NILU's final reports for the SIS-projects that ended in 2016 and annual reports for 2016 for the other SIS-projects.

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1 Beskrive kilder, dannelse og transport av kortlevde klimadrivere ved bruk av nye avanserte målemetoder

Sluttrapport

Varighet:	2013 - 2016	**Prosjektleder:**	Wenche Aas
Budsjett 2016:	1,2 MNOK	**NILU prosjekt:**	B-113006
Totalt budsjett:	4,8 MNOK		

Mål og bakgrunn

Det overordnete målet med prosjektet var å karakterisere kildeopphav, transport, dannelse og atmosfærisk omdanning av kortlevde klimadrivere og deres forløpere ved bruk av nye avanserte målinger på Birkenes Observatoriet, kombinert med statistiske beregninger og modeller.

Kortlevde klimadrivere som partikler og ozon, og deres potensial for å bremse den globale oppvarmingen de førstkommende 20 år, har hatt stor oppmerksomhet de senere år. Disse komponentene er også viktige for effektstudier relatert til helse og terrestrisk natur. Effektive utslippsreduksjoner forutsetter god forståelse av hvor disse komponentene kommer fra og hvordan de omdannes og transporteres i atmosfæren. Det er store usikkerheter i dagens estimater av partikkelforurensning i Europa, spesielt siden en stor andel av partikkelmassen består av karbonholdig materiale som er dårlig karakterisert, og som har et betydelig antall menneskeskapte og naturlige kilder. Nyutviklede instrumenter gjør det mulig å spore kildespesifikke partikler med en høy tidsoppløsning, til å estimere andelen av partikler som er primært versus sekundært dannet, og til å studere fordelingen mellom naturlige og menneskeskapte kilder ved å kombinere med statistiske verktøy og andre observasjoner.

En bedre beskrivelse av kildeopphav for kortlevde klimadrivere er av stor nytte for fremtidig politikkutforming, spesielt knyttet opp mot UNECE LTRAP og EUs AQD. Økt kunnskap om klimaendringene og reduksjon av utslipp er sentrale behov beskrevet i ulike meldinger og strategier også for norsk forvaltning og forskning.

For NILU er overvåking og kjemisk og fysisk karakterisering av luftforurensninger en grunnpilar i instituttets virksomhet. Det var derfor av strategisk betydning for instituttet å øke kompetansen innen dette feltet, som også er et satsingsområde i europeisk miljøforskning, hvor NILU er en sentrale aktør.

Aktiviteter

En «Aerosol Chemical Speciation Monitor» (ACSM) ble installert på Birkenesobservatoriet i 2012 for permanent drift. Instrumentet måler konsentrasjoner av partikulært nitrat, sulfat, ammonium, klorid og organisk karbon med høy tidsoppløsning (timesmiddel). Mye tid har blitt brukt til å sette instrumentet i operasjonell drift og for å sikre høy kvalitet på målingene. Dette inkluderer deltagelse i feltsammenligninger, etablering av kalibreringsrutiner og rapportering av data, og det har vært gjort i nært samarbeid med EUs infrastrukturprosjektet ACTRIS. ACSM-instrumentet på Birkenes var med på den første europeiske interkalibreringen for slike målinger avholdt i Paris (Crenn et al., 2015; Fröhlich et al., 2015). Et rapporteringsformat for ACSM-instrumenter har blitt utviklet i samarbeid med Paul Scherrer Institute (PSI) i Sveits, slik at målingene kan rapporteres på en harmonisert måte til den internasjonale databasen EBAS som NILU besitter.

Videre har Birkenesmålingene vært en del av en europeisk studie med 21 stasjoner med målinger av høyoppløselig partikkelkjemi (Bressi et al., 2017). Birkenes har blant de laveste partikkelnivåene i Europa, mens det relative bidraget av organisk masse er høyere enn for de sentraleuropeiske stasjonene. Organisk materiale utgjør mer enn 60 % av masse-konsentrasjonen av PM_1 på Birkenes. Til sammenligning ligger nivået mellom 40 og 50 % på de sentral- og sør-europeiske stasjonene (Bressi et al., 2017).

Kildeopphavet til den store andelen organisk masse i partikler på Birkenes er et sentralt tema for denne SIS-en. For å studere dette, har vi kombinert en rekke observasjoner basert på ACSM-målinger, absorpsjonskoeffisientmålinger, massekonsentrasjonsmålinger av PM_{10} og $PM_{2.5}$, partikkelkjemi, samt målinger av kildespesifikke organiske tracere. I tillegg ble et «Proton-transfer-reaction mass spectrometry» (PTR-ToF-MS) instrument, som måler flyktige organiske forbindelser (VOC), brukt i to målekampanjer på Birkenes sommeren 2012 og vinteren 2013 (Langebner et al., 2014).

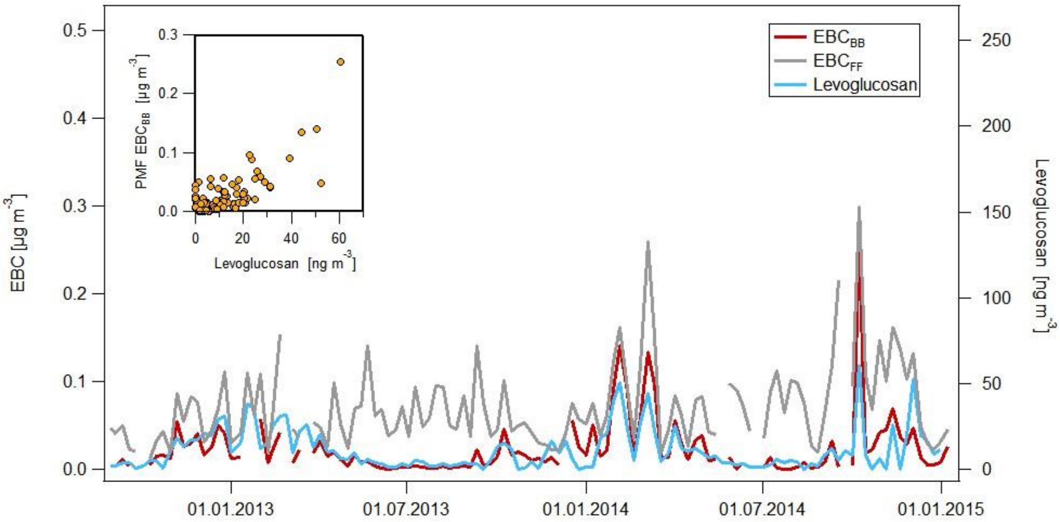
For å beskrive kildeopphav av forurensningen benyttes statistisk verktøy spesielt utviklet for dette (Canonaco et al., 2013, Paatero, 1999). Den statistiske metoden baserer seg på «Positive Matrix Factorization» (PMF). Forskere ved NILU har deltatt på kurs i bruk av dette verktøyet avholdt av PSI i Sveits.

Hovedresultater

Med ACSM-målingene har det vært hovedfokus på å studere kildeopphav til den organiske massen. Ved hjelp av PMF-analyse har det vært mulig å identifisere tre hovedgrupper av organisk masse for små partikler (PM_1) på Birkenes: 1) oksygenerte aerosol partikler (OOA) er den dominerende fraksjonen og knyttes til eldre langtransporterte partikler, 2) partikler fra vedfyring (BBOA) og 3) hydrokarbonlignende organiske partikler (HOA), som typisk er assosiert med primære utslipp fra forbrenning av fossilt brensel. I en studie gjennomført vinteren 2014 (Platt et al., 2015), ble det vist at forholdet mellom disse tre hovedgruppene av organiske partikler var 40 % (OOA), 40 % (BBOA) og 20 % (HOA) for fine partikler (PM_1). På sommeren er andelen OOA større.

Absorbsjon måles kontinuerlig med sotfotometer (PSAP) på Birkenes som en del av nasjonale overvåkingsprogrammet, og fra disse målingene kan man utlede «Equivalent Black Carbon» (EBC). Ved bruk av tilnærmingen beskrevet av Sandradewi et al. (2008), kan man separere mellom EBC fra forbrenning av fossilt brensel (EBC_{FF}) og fra biomasse (EBC_{BB}). Tidsserien for 2013 og 2014 (Figur 1) viser at de er en tydelig sesongvariasjon for EBC_{BB} med forhøyede nivåer om vinteren, mens det ikke er noen utpreget sesongvariasjon for EBC_{FF}. Årsgjennomsnittet av EBC_{FF} er tre ganger så høyt som for EBC_{BB}, mens det på vinteren kun er dobbelt så høyt.

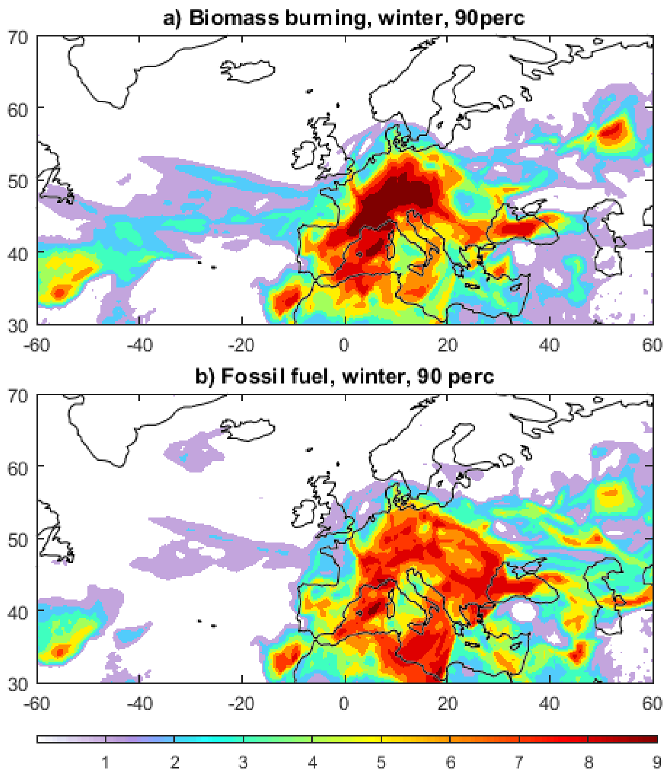
Den kildespesifikke forbindelsen levoglucosan er den best verifiserte og mest brukte forbindelsen for å påvise og kvantifisere partikler fra forbrenning av biomasse. Målinger av levoglucosan på Birkenes har vært gjort siden 2008 og er her benyttet til å verifisere EBC_{BB} Resultatene viser en tydelig sammenheng mellom levoglucosan og EBC_{BB}, hvilket gir tillit til målingene og metoden som er brukt for å beregne EBC_{BB} (Figur 1).



Figur 1: Tidsserier og kildeallokering av Equivalent Black Carbon (EBC) fra forbrenning av fossilt brensel (EBC_{FF}) og fra biomasse (EBC_{BB}) målt med PSAP (sotfotometer), sammenlignet med tracerforbindelsen for biomassebrenning, levoglucosan. Tidsserien til EBC er aggregert for å kunne sammenlignes med ukesmålingene til levoglucosan.

Målinger med høy tidsoppløsning, som sotfotometeret, kan kobles opp mot transportmodeller, slik som FLEXPART, for å studere såkalte «fotavtrykk» for kildespesifikke komponenter som reflekterer kildeområdene. I Figur 2a og b vises fotavtrykket for episodene med de høyeste konsentrasjonene (90. persentilen) for EBC_{FF} og EBC_{BB} for vinterperiodene (desember – februar) fra 2012 til 2014 på Birkenes. Figuren viser tydelig at EBC på Birkenes skyldes kilder i Europa og ikke nasjonale utslipp. Det er et litt ulikt mønster på kildeområdene for biomassebrenning og fossilt brensel. Begge er knyttet til utslipp i Sentral-Europa, men fossilt brensel har et større avtrykk i Øst-Europa. 90. persentilen utgjør 53 % av den totale belastingen av EBC_{BB} på Birkenes og 43 % for EBC_{FF} i denne perioden. Dette viser at langtransportert luftforurensning fra den kontinentale delen av Europa ikke bare er ansvarlig for episodene med de høyeste konsentrasjonene av EBC_{BB} og EBC_{FF}, men også for hovedmengden av den totale belastingen av EBC (Yttri et al., 2017).

Det er flere organiske tracere som kan brukes til å kildeallokere den organiske partikkelmassen og dette gir muligheter til å skille mellom naturlige og menneskeskapte kilder. I det regulære overvåkingsprogrammet på Birkenes samles ukentlig filtre for bestemmelse av PM_{10}- og $PM_{2.5}$-massekonsentrasjon, og elementært og organisk karbon (EC/OC). I tillegg er det blitt gjort analyser av kildespesifikke tracere som f.eks. levoglucosan, arabitol, mannitol og 2-methyltetrol på disse filtrene, hvilket gjør det mulig å identifisere og kvantifisere bidraget av partikler fra biomassebrenning, primære biologiske aerosol partikler (PBAP), samt biogene sekundære aerosoler som dannes fra oksidasjon av isopren. Noe overraskende viser foreløpige resultater at det relative bidraget av PBAP til PM_{10} er like stort som fra biomassebrenning. Dette er interessant da PBAP typisk ikke adresseres når man snakker om kilder til partikler, i motsetning til vedfyring og annen biomassebrenning som har vært mye diskutert, med rette, de seneste 20 årene.



Figur 2: Fotavtrykkskart som angir hvor luftmassene har vist størst sensitivitet til å fange opp utslipp for de 10 % høyeste episodene for EBC_{FF} og EBC_{BB} målt på Birkenes. Fargekoden indikerer oppholdstiden.

Oppsummering og betydning av SIS arbeidet

SIS-en har ført til mye ny kunnskap om kilder til partikler på Birkenes, spesielt de karbonholdige. Kombinasjonen av instrumenter med høy tidsoppløsning og filteranalyser for mer kildespesifikke komponenter, sammen med transportmodellering og statistiske verktøy (PMF), har vist seg svært nyttig for å identifisere og kvantifisere kilder til partikulær luftforurensning, samt deres kildeområder. Metoder og kunnskap som har blitt ervervet og utviklet i dette arbeidet vil bli videreført i nye forskningsprosjekter og vil også være til hjelp for beslutningstakere som arbeider med utslippsreduksjoner.

Gjennom SIS-en har NILU fått styrket det internasjonale samarbeidet på et europeisk satsingsområde. Det har blant annet blitt opprettet en ny COST action (Chemical On-Line cOmpoSition and Source Apportionment of fine aerosoL: (COLOSSAL)) hvor NILU har flere aktive medlemmer.

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2 TOXROS - Chemical and toxicological characterization of reactive atmospheric species

Final Report

Duration:	2013 - 2016	**Project leader:**	Elise Rundèn Pran
Budget 2016:	1,2 MNOK	**NILU-project:**	B-113064
Total budget:	4,8 MNOK		

Background and objectives
For human risk assessment, both exposure and hazardous potential have to be taken into consideration. For testing of human hazard potential, it is inevitable to develop *in vitro* models reflecting the *in vivo* situation as close as possible, in compliance with the 3R´s to reduce, replace and refine use of animal experiments. Besides the ethical perspective with use of research animals, there are many other advantages with *in vitro* models. *In vitro* models enables use of human cells, as well as highly controlled experimental settings, underlying mechanisms for toxicity can easier be studied, and it is time- and cost efficient. The striving lies within development of more advanced *in vitro* models for better prediction of human risk. For hazard assessment of exposure to chemicals and pollutants by inhalation, there has been a need to develop better and more reliable *in vitro* respiratory test methods, better reflecting the *in vivo* situation.

The objective of this interdisciplinary project was to develop an advanced *in vitro* respiratory model for inhalation exposure**.** The model can be applied to explore effects of indoor and outdoor air pollutants for hazard characterization as a basis for human health risk assessment**.** To obtain knowledge about health effects of emerging pollutants, as well as other chemical compounds, it is essential to develop a combined exposure-effect model, mimicking real exposure on cells of first target, which is lung for airborne compound. *More specifically, the aim of the project was to develop an in vitro respiratory model based on exposure of human cells at the air-liquid interphase (ALI) to investigate potential toxicity of various chemical pollutants related to human health.*

Objectives
1. Develop an advanced *in vitro* human lung model for inhalation exposure (Air-Liquid Interphase (ALI)-model)
2. Develop an exposure system (controllable and measurable) for the ALI model
3. Study toxicity and underlying mechanisms of toxicity of:
    a. volatile or semi-volatile organic compounds
    b. Nanoparticles

Development of an advanced in vitro human model for respiratory exposure

For inhalation studies *in vitro*, a challenge has been that the cells are cultivated and exposed submerged in cell culture medium. Thus, an *in vitro* respiratory model closer mimicking the *in vivo* situation would be comprised of cells cultivated on the interface between air and liquid, as the lung cells *in situ* on one side are exposed to the air only separated by a thin aqueous lining layer with a surfactant film.

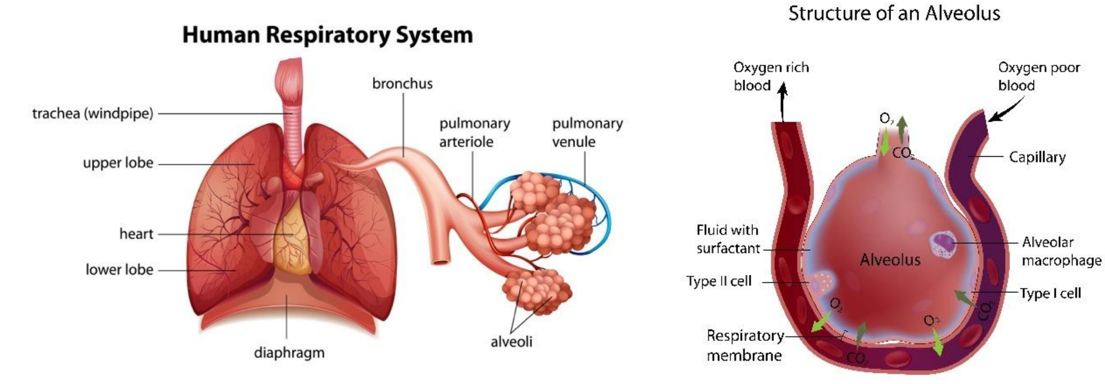

Figure 1: The figure shows the anatomy of the human respiratory system, where gas exchange occurs in the deepest layer in the alveoli. To the right is a magnification of the alveolus, visualizing the lung epithelial cells separated from air only by a thin surfactant layer, and on the other side encapsulated in network of blood vessels for gas exchange. (Photo: Shutterstock).

Our main aim was to set up an air-liquid interphase (ALI) model based upon CULTEX® exposure system for mimicking atmospheric, respiratory exposure conditions. The ALI exposure model is technically challenging because: i) the cells must be adapted to new conditions, ii) a defined aerosol at constant composition and flow has to be generated, iii) exposure concentrations must be measurable, and iv) the temperature and humidity conditions for the cells should be at physiological level for the whole exposure period.

<u>Cultivation of human lung cells on membranes at the air-liquid interphase</u>

Standard operating procedure (SOP) for cultivation of human lung epithelial cells, A549, under submerged conditions was developed and validated (Figure 2).

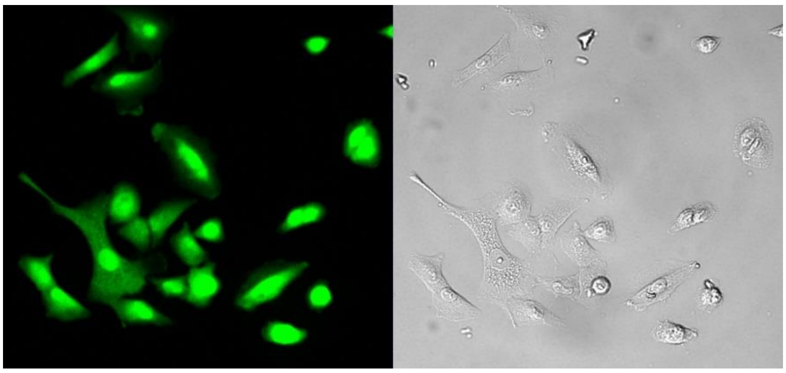

Figure 2: Microscopy images of A549 human lung epithelial cells after cultivation. Fluorescent image after staining the cells with cell tracker green (left image), with the corresponding transmitted differential inter-ference contrast (DIC) microscopy acquired image (right image). Images were obtained with Zeiss laser scanning microscope (LSM 700).

Further, A549-cells were adapted for cultivation on transwell membranes for the ALI-system, and SOP worked out. In this system, the cells are growing at the air-liquid interface (ALI), where the upper part of the cells is directly in contact with air and the basal part of the cells is directly in contact with liquid medium, similarly as *in situ* in the lungs (figure 3). This configuration mimics the conditions found in the human airway, and drives differentiation of the cells towards a mucociliary phenotype. We have investigated different media and semi-porous transwell membranes to find optimal conditions for cultivating the cells at the air-liquid interphase, and for the cells to exhibit morphological and functional characteristics similar to the human epithelium.

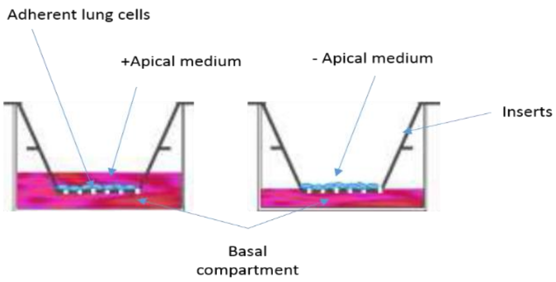

Figure 3: Human adherent lung epithelial cells (A549) were seeded onto porous cell culture inserts (transwell) as submerged cells (medium in both basal and apical part) (left) or at the air liquid interphase (ALI) where cells were directly exposed to air from above (apical medium removed) and fed from the medium below (right).

In the alveoli *in situ,* many different cell types are present. Thus, a model comprising co-cultures of different cell types would be more advanced and thus better resembling the *in situ* situation. In the alveoli, lung epithelial cells are co-localized with immune cells. THP-1 is a monocytic cell line, which can be differentiated in culture to macrophages, a type of white blood cells with an important role in excretion of foreign components recognized by the immune system. A SOP for cultivation of THP-1 cells was established, as well as SOP for co-cultivation of A549 and THP-1 cells on the membrane inserts. When the cells in co-culture were exposed to nanoparticles (submerged exposure), the sensitivity was changed compared to exposure of single cultures, as the different cell types are interplaying in the response. The work with co-cultures will be continued also for exposure at the air-liquid interphase.

<u>CULTEX exposure system for cells grown at the air-liquid interphase</u>

For exposure of the cells cultivated on membranes at the air-liquid interphase, a sort of chamber is needed. The CULTEX exposure chamber was applied. A protocol for cultivation of A549 cells in the CULTEX device was developed. In this set-up, transwell inserts with cells were transferred from conventional 6-well cultivation plates into their corresponding position inside the CULTEX device (figure 4) before the exposure. Standard operating procedure was written for cultivation, adaptation before exposure, as well as for proper cytotoxicity assays.

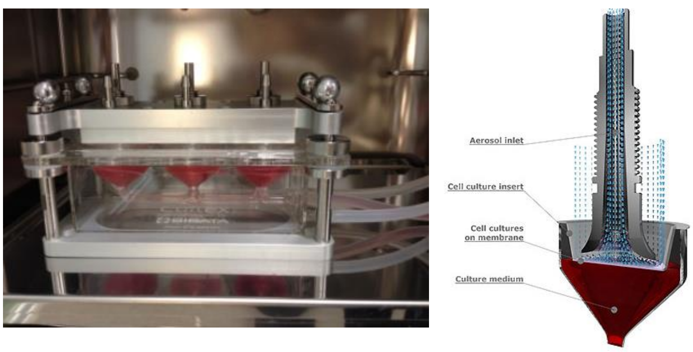

Figure 4: CULTEX device for ALI-exposure of lung cells (left). Circulating water keeps temperature constant. A tubing with a nozzle goes into each well. The nozzle shape ensure even distribution of the aerosol to the cell layer (right).

Exposure of cells in the CULTEX system
The cells cultivated at the ALI needs to be exposed to the compounds in a controllable manner. It is important to be able to measure what the cell are being exposed to, as well as the exposure concentrations. There are different possibilities for exposure systems for CULTEX, and we have been visiting other laboratories working with the ALI-system for getting increased knowledge on this challenging aspect of the model. We have also attended an ALI workshop in Berlin, where many issues and challenges connected to both cultivation of cells and exposure were discussed efficiently.

We have designed an exposure system consisting of two main parts. One part is for exposing the cells to aerosolized nanoparticles and the other part is for exposing the cells to common indoor volatile and semi-volatile organic compounds (VOCs/SVOCs).

Exposure to nanoparticles
For exposing the cells to nanoparticles, the nanoparticles were dispersed by sonication into solution. Calibration of the sonicator was performed to obtain optimal conditions for dispersing different nanoparticles. The exposure setup was designed within the project. The nanoparticle dispersion will be aerosolized using an atomizer, which can be connected to the CULTEX chamber for exposure of the cells. When the particles are airborne, they are wet and charged. A diffusion dryer will be needed to dry the particles so that only the pure, dried particles will continue in the airstream. As the particles are charged, it is possible to use an electric field for depositing the particles onto the cells. This is necessary as particles in the size range up to 300 nm have very low deposition efficiency. They are too large for diffusion deposition and too small for gravitational deposition or impaction.

The system is designed as to determination of exposure concentration using an open source software quartz microbalance. The microbalance measures a mass variation per unit area by measuring the change in frequency of a quartz crystal resonator. The building of the drawn and designed system is ongoing. By this approach, it will be possible to define specific exposure concentration using the output of the microbalance as input for the atomizer. The exposure system will additionally have a flow control and a calibration unit.

Exposure of the cells to volatile organic compounds (VOCs)
For exposing the cells to VOCs, we have built an exposure unit, which consists of small vials containing a pure liquid VOC and a capillary. This setup utilizes the same principle as a permeation tube. By using a pure component, there will be always some molecules in liquid phase and some in gas phase. The amount of molecules in gas phase is depending on the vapour pressure of the component and is highly influenced by temperature, which was monitored. The molecules in the gas phase diffuse out of the capillary only by diffusion. We exposed A549 cells to different VOCs, and the exposure concentration was calculated based on the vapour pressure. Humidity control in the system was found to be important for the cells not to dry out during exposure.

Cytotoxicity testing of nanoparticles on A549 human lung epithelial cells
We have by submerged exposure tested cytotoxicity of different engineered nanoparticles on A549 human lung epithelial cells. It is important to validate protocols for testing of potential toxicity of nanoparticles on these cells cultivated conventionally before moving on

to ALI exposure. We have established a method and developed a protocol for cytotoxicity-testing by colony-forming efficiency (CFE), measuring cell survival by colony-formation. We have tested many different reference nanoparticles from the European depository (reference laboratory, Joint research Center – EC JRC) by CFE assay on A549 cells to standardize the protocol.

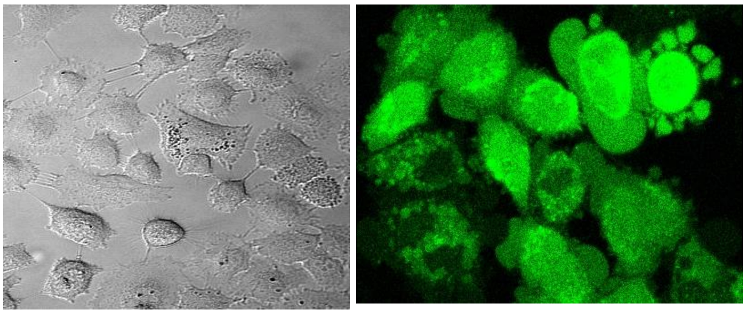

Figure 6: Uptake of TiO_2 nanoparticles into A549 cells in relation to toxicity studies. Images obtained by laser scanning microscope (Zeiss LSM 700 confocal microscope). In the left image, TiO_2 nanoparticles can be seen as black dots on top of and around the cells. On the right, the exposed cells are labeled with a fluorescent probe (cell tracker green), and are apoptotic (programmed cell death).

Summary of results

- Protocols for ALI cultivation of A549 human epithelial lung cells, THP-1 and co-cultures of A549 and THP-1 were developed and validated
- Protocols for cytotoxicity assays were further developed and validated for the ALI model
- Exposure system for aerosols was custom designed
- Exposure of A549 cells to different reference nanoparticles under submerged system was performed
- Exposure system for gas exposure was developed and tested for several VOCs
- Review paper on the ALI model for respiratory exposure is in progress

3 AMOM - Advanced modelling of organic contaminants

Annual Report 2016

Duration:	2013 - 2017	**Project leader:**	Knut Breivik
Budget 2016:	1,2 MNOK	**NILU-project:**	B-113014
Total budget:	6,0 MNOK		

Background and objectives

The overall goal with the AMOM SIS is to understand and predict relationships between sources and emissions of organic contaminants and environmental and human exposures with emphasis on long range atmospheric transport.

In 2016, we have made considerable steps forward in developing a new integrated multimedia fate and exposure model. A key goal with the new modelling tool is to better predict the behaviour of organic contaminants in both the abiotic and biotic part of the Nordic and Arctic environments. Because of AMOM, we have been able to secure additional research funds to study air-exposure relationships of new airborne organic contaminants of emerging concern (NFR Miljøforsk #267574, 2017-2020). Relevant modelling tools have facilitated increasing collaboration across institutes within the Fram Centre, Tromsø (Flagship hazardous substances – effects on ecosystems and human health) and with relevant institutions abroad, e.g. by supporting a model analysis of temporal trends of per- and polyflourolkyl substances (PFASs) in Arctic circumpolar air in collaboration with Canadian scientists.

4 REEs-PGM - Rare Earth Elements (REEs) and Platinum Group Metals (PGM) - Application in new technologies and environmental and human health implications

Annual Report 2016

Duration:	2015 - 2019	**Project leader:**	Kyrre Sundseth
Budget 2016:	1,65 MNOK	**NILU-project:**	B-115009
Total budget:	8,3 MNOK		

Background and objectives

The main objective of the SIS REEs-PGM project is to increase the understanding of environmental and human health implications of REEs and PGM used in new industrial technology applications. The SIS-project aims at generating knowledge on global and regional flows of REEs and PGM applied in technologies, how they are released to the environment from their entire value chain and how they affect environmental concentrations and risk of human health damage. Development of a methodology for Material/Substance Flow Analysis (MFA) of these materials in combination with the development of sampling and analytical techniques for environmental studies of contamination levels are central to the project. Activities performed in 2016 have included i) literature reviews on REEs and PGM environmental effects and on analytic lab methods, ii) the establishment of a database to accommodate collected and estimated information on the global and regional occurrence, material flows, and technical applications of REEs and PGM, as well as iii) the collection and analysis of environmental samples of contrast fluids and moss (including methodology development). Understanding substance flows of REEs and PGM caused by their industrial technology applications, highlights current and future problem-flows and accumulations in the society. This will assist industrial actors and public administration in taking strategic decisions towards environmental sound solutions.

5 ChemInAir - Characterization of the Chemical composition of Non-industrial Environment

Årsrapport

Varighet:	2015 - 2019	**Prosjektleder:**	Britt Ann Høiskar
Budsjett 2016:	1,5 MNOK	**NILU prosjekt:**	B-115019
Totalt budsjett:	7,5 MNOK		

Mål og bakgrunn
ChemInAir har som hovedformål å utvikle og teste målemetoder som egner seg til måling av kjemiske komponenter i innemiljø, og som kan benyttes i omfattende kartlegginger av miljøet innendørs. I 2016 ble det arbeidet med å knytte kontakter med sentrale aktører i byggebransjen for å diskutere mulig samarbeid om kartlegging av innemiljø i nye boliger. Som et direkte resultat av dette arbeidet, ble det i 2016 startet opp målinger av VOC og Formaldehyd i flere nye boliger på Sørenga og i et nytt næringsbygg i Bergen. I tillegg ble også støv samlet inn for å se på mindre flyktige komponenter med non-target metodikk. Målingene ble foretatt før boligene/lokalene ble tatt i bruk og skal følges opp med jevnlige målinger for å se hvordan nivåene endrer seg over tid.

I forbindelse med NM i langrenn i Tromsø 2016 ble passive prøvetakere for flyktige PFAS testet ut. Passive prøvetakere ble plassert i smørebua sammen med en aktiv prøvetaker. Målingene ble foretatt før, under og etter NM. Prøvene er under pågående analyse.

I 2016 ble resultater fra prøvetaking av innemiljøene på NILUs laboratorier og Miljøprøvebankens lokaler ferdige. I luft og støvprøver målte man regulerte komponenter (PCBs, PBDEs) og uregulerte komponenter (klorparafiner, nye flammehemmere og siloksaner). Resultatene viser at de regulerte komponentene finnes i lave nivåer mens det ble funnet forhøyede nivåer av de uregulerte komponentene.

NILU har i 2016 deltatt i en laboratorie-interkalibrering for non-target screening av husstøv-prøver. Interkalibreringen er arrangert av NORMAN-nettverket og NILU har hatt en sentral rolle i evalueringsarbeidet. Det er planlagt en snarlig publikasjon av resultatene.

6 SOCA - Signals from the ocean to the arctic atmosphere

Annual Report 2016

Duration:	2015 - 2019	**Project leader:**	Stephen Platt
Budget 2016:	1,35 MNOK	**NILU-project:**	B-116005
Total budget:	5,4 MNOK		

Background and objectives

The purpose of “Signals from the Ocean in the Arctic (SOCA)” is to characterise sources of atmospheric trace constituents in the Arctic and study the effects of climate change thereon, with a particular emphasis on oceanic sources. The project aims to strengthen NILU’s expertise in the area of sea-atmosphere interaction and the positive matrix factorization (PMF) statistical analysis technique. The project is divided into the following work-packages: data collection (WP1), data analysis (WP2), data interpretation (WP3), development of methodology for analysis of dissolved constituents (WP4), and management and interaction with stakeholders (WP5). In 2016, we have made considerable progress in WP1 and WP2; we have collated data on gaseous atmospheric components from between 1989-2015. The period of data with the highest overall coverage is 2010-2015. For this period, we have produced input matrices and calculated measurement errors as required for PMF and have been able to perform preliminary source apportionment.

In 2017, the related “Methane from the ocean in the Arctic (MOCA)”-project expires. The SOCA-project therefore provides an opportunity to facilitate the continuation of MOCA and the collaborations established thereunder (e.g. with the CAGE centre of excellence at the University of Tromsø). During 2017, we will expand upon the MOCA-remit by investigating Ocean emissions of e.g. light hydrocarbons such as ethane.

7 SIM-CITY-3D - Simulating the city air for new greener neighbourhoods

Annual Report 2016

Duration:	2016 - 2019	**Project leader:**	Nuria Castell
Budget 2016:	1,35 MNOK	**NILU-project:**	B-116007
Total budget:	5,4 MNOK		

Background and objectives

The main goal of SIM-CITY-3D is to update the air quality dispersion model EPISODE by integrating it with a micro-scale model that considers the fine-spatial structure of the city. EPISODE-3D will be able to consider the effect of buildings and obstacles on air dispersion, offering a better comprehension of air quality at the neighbourhood and street level.

During 2016, we have conducted an extensive literature review of the state-of-the-art air quality models, selecting the parametrizations that will be later implemented in EPISODE. In parallel we have compared the performance of EPISODE against the EMEP model. The EMEP model is an Eulerian dispersion model with full chemistry, but does not have any micro-scale parametrizations (e.g. line emissions), while EPISODE does not have a full chemistry, but has micro-scale parametrizations. This work will continue in 2017.

8 NyFOM - Nye målemetoder for Fremtidens Organiske Miljøgifter

Annual Report 2016

Duration:	2016 - 2019	**Project leader:**	Martin Schlabach
Budget 2016:	1,35 MNOK	**NILU-project:**	B-116037
Total budget:	5,4 MNOK		

Background and objectives

The strategic development project «NyFOM» has four pillars: (1) further development of air sampling methods used for emerging compounds, (2) further development of suspect and non-target screening methods of sample types relevant for NILU, (3) development of target analysis methods for high priority emerging pollutants, and (4) establish effect directed analysis (EDA) methods together with MILK's effect section.

With regard to air sampling, NyFOM has been part of the funding of a PhD-study related to "Monitoring of Persistent Organic Pollutants in northern Europe" with a special focus on expanding sampling and clean-up to emerging pollutants. This sub-project has a good progress and has resulted in a completely new analytical method, which is highly relevant for air monitoring projects.

The "Network of reference laboratories, research centers and related organizations for monitoring of emerging environmental substances (NORMAN)" is the main driving force for the development of suspect and non-target screening methods and NILU, with NyFOM, is a major contributor to several NORMAN-activities and NILU is a member of the NORMAN Steering Committee. The most important activity in 2016 was the organization and participation in the non-target screening collaborative trial on indoor dust. This activity is also related to NILU's "ChemInAir" Strategic program.

NILU – Norwegian Institute for Air Research

NILU – Norwegian Institute for Air Research is an independent, nonprofit institution established in 1969. 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 analyzing, monitoring and consulting. NILU is concerned with increasing public awareness about climate change and environmental pollution.

NILU's values: *Integrity - Competence - Benefit to society*
NILU's vision: *Research for a clean atmosphere*

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