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ArcRisk Newsletter – Fall 2010

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ArcRisk

Arctic Health Risks: Impacts on health in the Arctic and Europe owing to climate-induced changes in contaminant cycling

ArcRisk Newsletter

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ArcRisk is a project supported under the Seventh Framework Programme of the European Community for research, technological development and demonstration activities.

Introducing ArcRisk

ArcRisk is a research project funded under the EU's Seventh Framework Programme. ArcRisk is short for Arctic Health Risks: Impacts on health in the Arctic and Europe owing to climate induced changes in contaminant cycling. The project officially started in June 2009 with the ArcRisk consortium partners.

With 21 partners from twelve countries, coordination of this multi-disciplinary project is a major undertaking in itself; the responsibility of the Secretariat of the Arctic Monitoring and Assessment Programme (AMAP), together with the Work Package leads.

ArcRisk is investigating the influence of climate change on contaminant transport, fate and exposure, and resulting risks to human populations in the Arctic and selected areas of Europe.

Main components of the project include:

- Using models to investigate ways in which climate change will affect long-range transport and fate of representative groups of contaminants, and its implications for their re-distribution - geographically and between relevant environmental media.
- Process studies, and targeted analytical work to validate modelling and support research into the effects that changing pathways and climatic conditions will have on contaminant uptake and transfer within food webs – and thus on human dietary exposure.
- Compiling data on relationships between contaminant exposure and human health outcomes – in order to project how climate-mediated changes in environmental fate of selected contaminants may influence exposure of human populations in the Arctic and selected areas of Europe – and what the implications of this exposure may be for future incidence of health effects.

Partners in ArcRisk

List of partner institutes with abbreviations and countries

1. Arctic Monitoring and Assessment Programme Secretariat, Norway (AMAP)
2. Stockholm University, Sweden (SU)
3. Aarhus University, Denmark (AU)
4. Alfred Wegener Institute for Polar and Marine Resarch, Germany (AWI)
5. Lancaster University, United Kingdom (ULANC)
6. University Centre of Svalbard, Norway (UNIS)
7. Institute of Chemical and Environmental Research, Spain (CSIC)
8. IVL - Swedish Environmental Research Institute, Ltd, Sweden (IVL)
9. University of Oulu, Finland (UOULU)
10. Norwegian Institute for Air Research, Norway (NILU)
11. Institut Jozef Stefan, Slovenia (JSI)
12. O.A.Sys – Ocean Atmosphere Systems GmbH, Germany (OASys)
13. Max Planck Institute for Chemistry, Germany (MPG)
14. Swiss Federal Institute of Technology, Zurich (ETH Zurich)
15. Masaryk University, Czech Republic (MUNI)
16. Norwegian Institute of Public Health, Norway (NIPH)
17. Northwest Public Health Research Centre, Russia (SZNC)
18. Environment Canada (EC-GC)
19. Department of Fisheries and Oceans, Canada (DFO)
20. Health Canada (HC-SC)
21. University of Tromsø, Norway (UiT)

Contents

Air and deposition sampling.

Organizing the work

ArcRisk is organized around six Work Packages:

- WP1: Project Management (led by AMAP)
- WP2: Modelling the impacts of climate change on pollutant transport and fate (led by SU)
- WP3: Contaminant transfer in the Arctic—process studies (led by ULANC)
- WP4: Effects of contaminants on human health and the influence of climate change (led by UOULU)
- WP5: Synthesis and policy implications (led by IVL)
- WP6: Dissemination and communication (led by AMAP)

Work Packages 2-4 comprise the core of the research effort. Ensuring linkages between them is a key to success of the project.

More detailed information on ArcRisk is available from the project website: www.arcrisk.eu – including a project flyer (in several languages).

Progress to date

This first project newsletter features the two environmental Work Packages (WP2 and WP3) where much of the initial project work is concentrated. A little over a year into the project significant progress has already been made, and the first 10 deliverables completed and publications of results already appearing in the scientific literature.

Work Package 2: Modelling impacts of climate change on pollutant transport and fate

Work Package 2 produced three main deliverables during the initial phase of the project – all of which help establish a common basis for the project work – essential for activities under the various ArcRisk work packages to be integrated and connected in a meaningful way.

The first of these key elements is a report on the selection of chemicals for study in the project, prepared by Matthew MacLeod (ETH-Zurich) together with the leads of WP2, WP3 and WP4. Selection criteria included the availability of good quality environmental data for use in modelling studies, analytical capability of partner laboratories to analyse them in environmental samples, and the availability of data to characterize their health impacts. The outcome is a core set of substances including PCBs, HCHs, DDTs, mercury, and perfluorinated compounds that will be the focus for study in all work packages. Other substances will also receive attention under one or more parts of the project.

A second WP2 deliverable, prepared by Rüdiger Gerdes (AWI), involved the selection of the climate scenario and climate models to be used in the project. Based on a review of model results for emissions scenarios and an evaluation of the performance of global climate models in the Arctic region, the A1B emissions scenario and the ECHAM5/MPI-OM and CCSM3 models were recommended for use in the ArcRisk project.

The third deliverable was a database containing a list of the physical and chemical properties of the chemicals that are being studied in the project, to promote the use of a common set of properties in the work of all partners – compiled by Ian Cousins (SU); and data on historical emissions and estimates of future emissions of selected chemicals under study in the project, for use in modelling – prepared by Jozef Pacyna and Kyrre Sundseth (NILU).

WP2 Partner Profiles

Seven partners contribute to WP2:

Stockholm University (SU): Ian Cousins is supervising PhD student Deguo Kong on the development of an Arctic human food-web model that can be applied to data being collected in WP3, with particular interest in applying the model to perfluorinated compounds. A database of levels of perfluorinated compounds in the environment has been compiled as part of the preparation of a critical review of the global sources of this class of compounds. As part of the work to compare Arctic model results with results for some European regions, a modelling study has been undertaken to determine the effects of climate change on the fate and exposure of PCBs in the Baltic Sea region using the POPCYCLING-Baltic modelling tool.

Aarhus University (AU): Kaj Mantzius Hansen and Jesper Christensen, at AU's National Environmental Research Institute, have prepared the DEHM model for simulations with climate data from the ECHAM5/MPI-OM model. POPs included in this version of the model are alpha-HCH, gamma- HCH, PCB28, PCB52, PCB101, and PCB180. They have also conducted four simulations with DEHM. The model system has been run with meteorology obtained from ECHAM5/MPI-OM (A1B scenario) for three different decades: 1990–1999, 2090–2099, and 2190–2199. Preparations are being made for the inclusion of additional chemicals in the DEHM model.

Alfred Wegener Institute for Polar and Marine Research (AWI): In addition to the work in relation to the preparation of the report on the selection of a climate scenario and climate models mentioned above, Rüdiger Gerdes at AWI has begun to simulate oceanic tracers within a high-resolution coupled ocean-sea ice model. Under realistic atmospheric forcing for the past 20 years, he has investigated the spreading of Atlantic Water entering the Arctic Ocean and its impact on the sea ice distribution. Further tracers have been used to follow river water and sea ice melt water.

Norwegian Institute for Air Research (NILU): As noted above, a database on physical-chemical properties (in collaboration with SU and ETH Zurich) and historical/future emission estimates was prepared by Jozef Pacyna and Kyrre Sundseth for the selected chemicals. Using the best available data in the literature and in various databases, historical emissions and scenarios of future emissions for selected chemicals were also generated. This included estimates of global DDT emissions by county, global mercury emissions by emission source sectors, country, and region, and emissions of heavy metals (As, Cd, Pb, Hg, Ni), PCBs and dioxins.

O.A.Sys – Ocean Atmosphere Systems GmbH (OASys): Michael Karcher is conducting a basic evaluation of processes regarding the implementation of a simple suspended matter module into the OGCM NAOSIM, and conducting experiments with conservative tracers in the Arctic Ocean. For the latter, the anthropogenic radionuclide iodine-129 was released at the European reprocessing facilities in La Hague and Sellafield to simulate the invasion of an anthropogenic pollutant from European waters into the Arctic Ocean. Preparations for release experiments of PFOA have been undertaken, in cooperation with I. Stemmler from MPG.

Max Planck Institute for Chemistry (MPG): Gerhard Lammel and postdoctoral fellow Irene Stemmler have updated the MPI-MCTM (which is based on an AOGCM, a coupled climate model) to a new version of the AOGCM. They have also extrapolated and formatted globally gridded emissions data on HCH, DDT, and PCBs for simulations covering the years 1950–2000 and performed global model experiments using the MPI-MCTM simulating the cycling of four selected PCB congeners, two selected HCH isomers, DDT and DDE during 1950–1990 under climate change.

The results of a study of the long-range transport of PFOA into the Arctic by means of the MPI-MCTM (in the version with coupled atmosphere and ocean general circulation models and sea ice) showed that oceanic transport constituted the dominant source of PFOA to the Arctic. The total atmospheric deposition of PFOA in the Arctic in the 1990s was much higher than previously estimated.

Swiss Federal Institute of Technology, Zurich (ETH Zurich): Matthew MacLeod was the lead author of the report on the selection of chemicals for the project. He and Henry Wöhrnshimmel, PhD student at ETH Zurich, have focused on developing global-scale modelling scenarios for the emissions, fate, and transport pathways of the alpha- and beta-isomers of hexachlorocyclohexane (HCH) using the BETR Global multimedia contaminant fate model.

Work Package 3: Contaminant transfer in the Arctic - Process studies

Work Package 3 also prepared three deliverables during the first phase of the project.

The first, coordinated by Work Package 3 lead Crispin Halsall (ULANC), with the assistance of other partners, outlined the field sampling strategy for the process studies, covering the types and locations of abiotic and biota samples that would be collected for study in the project with the aim of obtaining a better understanding of specific processes involved in the transfer and fate of contaminants between and within Arctic compartments and their uptake into marine and terrestrial food chains. The abiotic collections include samples of air and atmospheric deposition, seawater and sea ice, snowpack, and snow and glacier meltwater runoff. Lower food-web organisms and fish are being sampled in the marine environment, while terrestrial biota sampled comprise 'country foods' including some freshwater fish species, wildfowl, and reindeer. Samples will be analysed for the core contaminants in the project and some others, as appropriate.

As a second deliverable, a meta-database of contemporary contaminant concentrations measured in the Arctic has also been compiled by ULANC. This was further extended in a third deliverable that included more detailed geographical coordinates and quality control criteria for the data, when available. The data cover the major compartments of air, snow, ice, seawater, and lake water obtained for the main geographical regions of the Arctic. The database will be updated as new data become available.

WP3 Partner Profiles

Eight partners contribute to WP3:

Lancaster University (ULANC): Crispin Halsall and PhD student Olivier Bertrand created the above-mentioned database deliverables of chemical contaminant data from a variety of contemporary Arctic fieldwork campaigns including recent campaigns under the International Polar Year.

Snow samples collected on sea ice on the Barents Sea, Greenland Sea, and in Greenland by partners at UNIS/NILU have been analysed for POPs (OC pesticides) at Lancaster. In addition, POPs data from snowmelt studies conducted in sub-Arctic Sweden have been analysed to examine chemical fate during the melt period. Large snow 'lysimeters' will be deployed during the winter of 2010/2011 either near Tromsø or near Longyearbyen, Svalbard. Similarly, deposition collectors have been ordered in partnership with MUNI, UNIS/NILU, and IVL to form a deposition sampling transect from central Europe to the European High Arctic.

University Centre of Svalbard (UNIS): Roland Kallenborn together with PhD students Pernilla Carlsson and Monika Trümper are involved in ArcRisk work. A ten-day field expedition in combination with a UNIS graduate course was conducted in May 2010. A series of snow and ice samples from the west coast of Spitsbergen was collected to complete a data set from the 2009 expedition with respect to possible spatial trends. In June 2010, a final one-week field expedition was conducted in the Godthåb fjord system near Nuuk (Eastern Greenland) as a cooperative effort with the FreshLink project. A set of passive sampling devices was deployed in surface water along the fjord system in order to identify chemical markers for water mass characterization. This sam-

Students taking snow and ice samples during the UNIS expedition in May to the Van Mijen fjord in Svalbard.

ple set will be collected in autumn 2010 and will supplement the active high volume samples collected during earlier field campaigns. During the Greenland expedition, characteristic food products associated with traditional food habits of the Eastern Greenland indigenous population were purchased and will be analysed for priority contaminants as part of the process study on selective uptake processes of contaminants into the human food web.

From July to November 2010, David Huegas from the group of Prof. Joan Grimalt (CSIC Barcelona) was stationed at UNIS for ArcRisk-related field and laboratory work. He was involved in the development and adaptation of a new high-volume water sampling device provided from the Institute of Marine Research, University of Kiel, Germany.

Institute of Chemical and Environmental Research (CSIC): Under the direction of Joan O. Grimalt, several studies were performed to increase understanding of the toxicity potential in remote cold areas as a consequence of the load of persistent organic compounds. A study using sediment quality guidelines and toxic equivalent factors for assessment of the toxicity of sedimentary long-range atmospherically transported polycyclic aromatic hydrocarbons to the organisms living in high mountain European lakes was performed. The results of this study have been published.

Stockholm University (SU): Daniel Carrizo and Örjan Gustafsson from SU are involved in this part of the project. Water samples collected during the IPY expedition the International Siberian Shelf Study 2008 (ISSS-08) were analysed for PCBs. PCBs were also quantified in surface seawater samples collected previously on the Beringia 2005 expedition, with samples from Baffin Bay, Beaufort Sea, the Bering and Chukchi Seas as well as in the interior Canadian Basin. These two data sets, combined with a previous partially unpublished data set from the Arctic Ocean 2001 (AO-01) expedition (Barents Sea and the interior Nansen, Amundsen and Makarov Basins), have been interpreted and a paper is under preparation. The objective is to provide a pan-Arctic view on the distribution and inventories of PCBs in the upper water column based on these three basin-scale expeditions. The PCB concentrations in the surface floc of the estuaries of the seven largest pan- Arctic rivers have also been analysed. Using associated biogeochemical and hydrological information, it is planned to construct an observation-based estimate of the PCB input to the Arctic Ocean from its main rivers.

Masaryk University (MUNI): Under Jana Klánová, work at MUNI RECETOX has involved organizing relevant equipment for atmospheric sampling; these samplers have been installed at selected sites in the Czech Republic and air and deposition sampling has now commenced. Deployment of high-volume air samplers fitted with 'Digital' Cascade Impactors to fractionate airborne particles of different sizes and determine the associated contaminant levels has also been undertaken and will complement sampling planned for sites at higher latitudes with UNIS, IVL, and ULANC. Specialized bulk deposition samplers are under construction for deployment at sites along the 'central Europe to High Arctic' transect. In addition, a freezer room facility has been modified and made available for studies of contaminants in snow. It will be utilized for artificial snow and particle interaction studies. Analytical development work will continue using high-resolution GC-MS for work on higher-brominated flame retardants (e.g., deca-BDE) and LC-MS/MS for development of a reproducible analytical method for trace per/poly-fluorinated substances.

Swedish Environmental Research Institute, Ltd (IVL): Eva Brorström-Lundén has made available established national sampling sites for ArcRisk work. Monitoring of organic contaminants in air and deposition is carried out at the air monitoring station at Pallas located close to the Arctic Circle (in cooperation with the Swedish monitoring programme for air pollutants and with the Finnish Meteorological Institute). A new deposition collector is being situated at the Pallas station and measurements are beginning; they will be harmonized with other measurements in the ArcRisk project.

Environment Canada (EC-GC): Derek Muir is providing advice on sampling and data acquisition for emerging chemical contaminants based on his substantial knowledge of contaminant behaviour and impact in the Canadian Arctic and beyond.

Department of Fisheries and Oceans Canada (DFO): Gary Stern was one of the principal scientists on the recent Canadian Flaw-Lead system project as part of the International Polar Year. Through his expertise in mercury and the biogeochemistry of trace organics in the marine system, he is supporting WP3 with advice on mercury.

ArcRisk – the Next Generation

The ArcRisk project framework is the ideal training ground for the next generation of Arctic and European scientists – firstly by providing an opportunity to work with leading scientists in a variety of disciplines – secondly, and perhaps more importantly, providing the opportunity to see how their own field of research can fit into a bigger picture - exploiting the multidisciplinary context of the ArcRisk project.

ArcRisk Young Scientists Profiles (WP2 and WP3)

Deguo Kong was recruited as a doctoral student in the Department of Applied Environmental Science at Stock-

holm University to study modelling fate, transport and bioaccumulation of persistent organic pollutants in the Arctic, and the possible influences of climate variability and change on these for the ArcRisk project. Deguo holds a degree

in Fluid Mechanics, and a Masters degree in Sustainable Technology from the Royal Institute of Technology (KTH) in Stockholm.

Irene Stemmler studied meteorology at the Leibniz Institute of Marine Science at the University of Kiel. In 2009

she obtained her doctoral degree from the Faculty of Mathematics, Informatics and Natural Sciences of the University of Hamburg for her PhD thesis 'The role of the ocean in global cycling of persistent organic pollutants – refinement and application of global multicompartment chemistry-transport model'. Irene Stemmler joined the Max Planck Institute for Chemistry in Mainz, Germany, as a research scientist to work on WP2 in the ArcRisk project. She is using the global multicompartment chemistry-transport model MPI-MCTM to study chemodynamics and climate effects on the transport and fate of pollutants in the Arctic, climate change, and implications for the marine food chain with regard to selected reference regions in Europe.

Olivier Bertrand is studying for his PhD as part of ArcRisk at Lancaster University, UK. The title of his research is Climate change impacts on organic contaminant fate in the High Arctic and will include investigations of the occurrence and behaviour of selected organic contaminants in Arctic air, snow and water in both marine and terrestrial environments to gain greater understanding of key transfer processes so that contaminant

pathways in a 'warmer' Arctic can be accurately predicted.

Pernilla Carlsson is doing her PhD work on ArcRisk WP3 at UNIS. Since the beginning of the project in summer 2009,

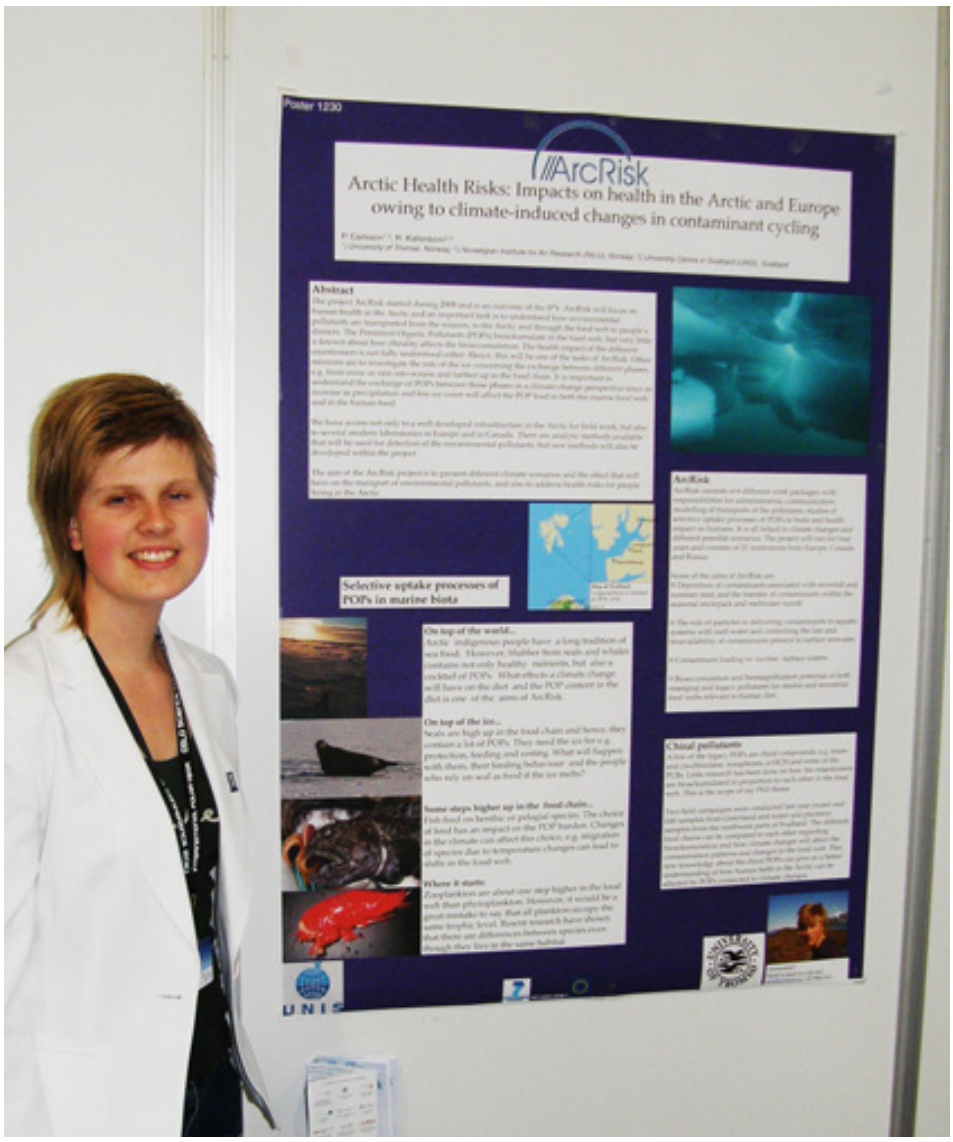
she has participated in several sampling campaigns, with a large portion of sample material collected during the 2010 campaigns. She will begin quantitiative analyses during autumn 2010. Passive water samples were deployed in the Gothhåb fjord close to Nuuk, Greenland; they will be retrieved this autumn and will be analysed for selected organic micro-pollutants. In addition, local traditional food objects (including fish, musk ox, seal products) were obtained in Greenland as well as reindeer meat from Svalbard. These samples will be analysed in association with the work of WP4 to gain important science-based insights into selective processes associated with the exposure of selected Arctic populations.

Monika Trümper has been involved in method development and analyses of water/ice/snow samples from Green-

land and the Fram Strait in the initial phase of ArcRisk. She analysed selected samples from this series at ULANC in the laboratory of Crispin Halsall. Monika has now finished her work at UNIS and is expected to defend her PhD thesis during 2011.

Henry Wöhrnschimmel is a PhD student at ETH Zurich. He has a Masters Degree in Environmental Sciences from ETH

Zurich. From 2005 to 2009, Henry was Deputy Director in the department of experimental research on air pollutants, Mexican Environmental Ministry, Mexico City. He apply the multimedia fate model BETR-Global to investigate the climate change dependence of global transport of persistent organic pollutants to the Arctic. Model results will be compared to measurements of ongoing monitoring campaigns, and to results of other transport models applied by collaborators in the ArcRisk project.



Pernilla Carlsson with her poster at the IPY Science Conference in Oslo in June 2010.

ArcRisk Notes:

ArcRisk experts have been actively engaged in a joint AMAP/UNEP Stockholm Convention Secretariat activity to develop a technical report on POPs and climate change linkages. This report will be developed by the Stockholm Convention Secretariat into a report to the Stockholm Convention Conference of Parties and used for awareness-raising in other fora.

In the next issue of the newsletter we will feature Work Package 4 on the effects of contaminants on human health and the influence of climate change, and report from the Second ArcRisk Partner Forum meeting in Barcelona.

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SEVENTH FRAMEWORK PROGRAMME

ArcRisk Publications

AMAP Assessment 2009 - Persistent Organic Pollutants (POPs) in the Arctic. Science of the Total Environment Special Issue. 408:2851-3051. Elsevier, 2010.

Karcher, M., Harms, I., Standring, W., Dowdall, M., Strand, P.(2010).On the Potential for Climate Change Impacts on Marine Anthropogenic Radioactivity in the Arctic Regions, Marine Pollution Bulletin, in press.

Karcher, Smith, Kauker, Dispersion of Iodine- 129 in Arctic Waters (in preparation).

Stemmler I., Lammel G. (2010): Pathways of PFOA to the Arctic: Variabilities and contributions of oceanic currents and atmospheric transport and chemistry sources. Atmos. Chem. Phys. Discuss. 10:9965-9980.

Stemmler I., Lammel G. (2009): Cycling of DDT in the global oceans 1950–2002: World ocean returns the pollutant. Geophys. Res. Lett. 36: L24602, doi:10.1029/2009GL041340.

R. Quiroz, J.O. Grimalt and P. Fernandez. Toxicity assessment of polycyclic aromatic hydrocarbons in sediments from European high mountain lakes. Ecotoxicology and Environmental Safety 73, 559–564 (2010).

Presentations at international scientific conferences:

Woehrnschimmel, H., Tay, P., MacLeod, M., Li, Y-F., and Hungerbuehler, K. Modeling transport pathways for α- and β-HCH from emission sources to the Arctic marine environment. Platform presentation at the 20th SETAC Europe Annual Meeting, 26 May 2010, Seville, Spain.

The ArcRisk project, in particular WP3, was presented by UNIS in poster presentations during the Nordic Environmental Chemistry Conference (NECC 2010) in Longyearbyen (March 2010) and during the IPY Oslo Science Conference (OSC, June 2010).

Results from initial model simulations were presented by AU on a poster at the International Polar Year Oslo Science Conference, Oslo, Norway, 8–12 June 2010.

Stemmler I., Lammel G.: Global contamination by DDT during 1950-2000 – A budget based on multicompartmental modelling, 10th HCH and Pesticides Forum, Brno/Czech Republic, 7.-9.9.2009

Lammel G., Stemmler I., Dvorská A., Holoubek I., Jarkovský J., Klánová J., Stohl A.: Atmospheric lifetime and global distribution and fate of DDT, American Chemical Society Meeting, San Francisco/USA 21.-25.3.2010.

Stemmler I., Lammel G.: Air-sea exchange of semivolatile organic compounds – wind and/or sea surface temperature control of volatilisation studied using a coupled general circulation model, 3rd Symposium The Future Ocean, Kiel/Germany, 13.-16.9.2010.

Lammel G., Stemmler I.: Contamination of the global environment by DDT 1950-2010, Poster contribution, 5th German-Arab Forum for Environmental Studies, Byblos/Lebanon, 20.-21.9.2010.