

Project information

Keywords

Emerging contaminants, freshwater ecosystems, long-range transport, modeling

Project title

Atmospheric inputs of organic contaminants of emerging concern to the Arctic and possible implications for ecosystem exposures

Year

2018

Project leader

Ingjerd S. Krogseth (NILU)

Geographical localization of the research project in decimal degrees (max 5 per project, ex. 70,662°N and 23,707°E)

Takvatn (~69°N,19°E) in Troms county, in addition to air samples at 45 locations all across Norway.

Participants

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Flagship

Hazardous Substances

Funding Source

Fram Centre flagship for Hazardous Substances

Summary of Results

The two initial years of this project have focused on (i) extraction and analysis of selected contaminants of emerging concern (CECs) in air samples collected across Norway, (ii) collection, extraction, and analysis of samples from the subarctic lake Takvatn (Troms) for evaluation of the deposition and bioaccumulation potential of the same CECs, and (iii) publication of a new benthopelagic bioaccumulation model and presentation of preliminary results at international conferences.

- (i) All air samples have now been analyzed for both legacy POPs (including polychlorinated biphenyls (PCBs), polybrominated diphenylethers (PBDEs), organochlorine pesticides (OCPs)) and selected CECs (including short- and medium chain chlorinated paraffins (SCCPs, MCCPs), Dechlorane Plus and analogues, and new brominated flame retardants (NBFRs)). Preliminary results indicate low concentrations of these CECs in Norwegian background air. Unfortunately, purchase of the flow-through samplers was not possible as planned due to challenges with the Chinese supplier. Instead, passive air samplers have been deployed at Takvatnet in October 2018, and collection and analysis of these samples will be carried out through synergies with SERA.
- (ii) Fieldwork in Takvatnet was carried out in October 2017, sampling the whole lake system and food web. This included passive water samples, sediment, plankton, benthos (molluscs and *Gammarus lacustris*), and fish (three-spined sticklebacks (*Gasterosteus aculeatus*), brown trout (*Salmo trutta*) and Arctic char (*Salvelinus alpinus*)). In addition, a sediment core was collected in April 2018. The length and weight of the fish was recorded, samples of muscle and liver were retrieved, and morphometric data (sex, age, maturity) will be obtained in cooperation with the University in Tromsø, which will utilize the same samples. Samples of muscle and liver of char and trout (the two top predators) were extracted and analyzed first, to look for the same POPs and CECs as in the air samples.

Preliminary results indicate very low levels of the selected CECs in the fish from Takvatnet. This implies that it will be hard to study bioaccumulation processes of CECs in Takvatnet, as many concentrations will likely be below detection limits. As a result, we have changed the plans of the SERA project to include an urban and contaminated lake (Storvatnet, Hammerfest) as (i) concentrations of CECs in this lake are suspected to be higher and hence make it easier to study bioaccumulation processes and (ii) environmental fate and bioaccumulation models for this lake are already available (see (iii)). However, Takvatnet will also be included in the SERA project to provide information on the link between LRAT and ecosystem exposure. Fieldwork for SERA was carried out in Takvatnet and Storvatnet in October 2018, and results from SERA and the project described herein will be combined to maximize the output of both projects.

- (iii) This project has helped finalize a scientific publication describing model development, parameterization, evaluation, and application of a benthopelagic bioaccumulation model for organic contaminants in Storvatnet. This model, as well as a related model for contaminant fate and behavior in the physical environment of Storvatnet, will in 2019 be adapted and

applied to Takvatnet. These models have already proved very useful to increase our understanding of the environmental fate and bioaccumulation behavior of cyclic volatile methyl siloxanes. Besides parameterization of the model for Takvatnet, this project will provide the possibility to parameterize the models for CECs analysed for in this project (and SERA). A key objective is to identify and prioritize key knowledge gaps critical for understanding the link between the atmospheric burden attributed to long-range atmospheric transport and ecosystem exposures for the selected airborne CECs in Arctic areas.

Master and PhD-students involved in the project

Helene Lunder Halvorsen, PhD-student (UiO/NILU)

Lovise Skogeng Pedersen, master student (NMBU/NILU) – successfully completed June 2018.

For the Management

international agencies involved in the regulation of chemicals, particularly as there is currently an ongoing process within the EU proposing to restrict the use of certain cyclic volatile methyl siloxanes. In 2018, the EU decided that the use of certain volatile methyl siloxanes in so-called “wash-off” products will be restricted within the EU to no more than 0.1 % from February 1st 2020. The research on siloxanes in this and earlier flagship projects has contributed significantly to these regulatory processes. In 2018, the results were presented at a siloxane workshop for scientists, industry, and Norwegian environmental authorities.

When finalized, the results for concentrations of organic contaminants of emerging concern in air across Norway as well as in a Norwegian freshwater ecosystem obtained in this project are in the same way believed to be highly relevant for national and international agencies involved in the regulation of chemicals, particularly combined with additional insight from the mechanistic modelling that is to be carried out.

Published Results/Planned Publications

Krogseth, I.S.; Undeman, E.U.; Evenset, A.; Christensen, G.N.; Whelan, M.J.; Breivik, K.; Warner, N.A. Elucidating the behavior of cyclic volatile methylsiloxanes in a subarctic freshwater food web: A modeled and measured approach. *Environmental Science and Technology*, **2017**, 51, 12489-12497.

A similar scientific publication for Takvatnet in a high-ranked scientific journal is planned for 2019.

Communicated Results

Krogseth, I.S. Models and measurements in concert – Overall approach, future plans and a UFO adventure. Guest lecture in the course “AT-324/824: Techniques for the detection of organo-chemical pollutants in the Arctic environment”, University Centre in Svalbard, January 26th 2017, Barentsburg, Norway.

Solbakken, C.F. Searching for environmental contaminants using UFOs. FRAM forum 2017: pp 34-37; <https://issuu.com/framcentre/docs/framforum-2017-innmat-web>

Solbakken, C.F. På ufojakt etter miljøgifter i Norge. NILU Årsrapport 2016: pp 12-13; https://issuu.com/nilu-luftforskning/docs/aarsrapport_2016_norsk

Krogseth, I.S.; Undeman, E.; Evenset, A.; Christensen, G.N.; Whelan, M.J.; Breivik, K.; Evenset, A.; Warner, N.A. Factors affecting bioaccumulation of cyclic volatile methyl siloxanes in a subarctic benthopelagic food web. SETAC Europe 27th Annual Meeting, 7. - 11. May 2017, Brussels, Belgium.

Krogseth, I.S.; Undeman, E.; Evenset, A.; Christensen, G.N.; Whelan, M.J.; Breivik, K.; Evenset, A.; Warner, N.A. Factors affecting bioaccumulation of cyclic volatile methyl siloxanes in a subarctic benthopelagic food web. 16th International Conference on Chemistry and the Environment, 18. - 22. June 2017, Oslo, Norway.

Krogseth, I.S.; Breivik, K.; Nøst, T.H. Towards an “in-house” Arctic bioaccumulation model for organic contaminants. A platform for cooperation across institutes? Fram Centre seminar for the flagship “Hazardous Substances”, 23. May 2017, Tromsø, Norway

Solbakken, C.F. Sminkegift sprer seg fra kloakken til fisken i Stovvannet. *Forskning.no*, October 24, 2017; <https://forskning.no/2017/10/siloksan-funnet-i-fisk-i-stovvannet/produsert-og-finansiert-av/nilu-norsk-institutt-luftforskning>

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Bruland, W. Hudkrem og balsam kan forgifte fisk. Nrk.no, November 2nd 2017, <https://www.nrk.no/finnmark/hudkrem-og-balsam-kan-forgifte-fisk-1.13757971>.

Hudkrem og balsam kan forgifte fisk. NRK Radio, Distriktsprogram – Troms, Ettermiddagssending fra NRK Troms, November 2nd 2017, <https://radio.nrk.no/serie/distriktsprogram-troms/DKTR02021917/02-11-2017#t=2h26m50s>.

Krogseth, I.S.; Undeman, E.; Evenset, A.; Christensen, G.N.; Whelan, M.J.; Breivik, K.; Evenset, A.; Warner, N.A. Environmental fate and bioaccumulation of cVMS in a subarctic freshwater lake. Workshop in Norway to gain a common understanding of the environmental fate and behavior of the volatile methylsiloxanes, 9 March 2018, Oslo, Norway.

Lunder Halvorsen, H.; Möckel, C.; Pedersen, L.S.; Krogseth, I.S.; Bohlin-Nizzetto, P.; Schlabach, M.; Breivik, K. Passive air sampling of POPs in background air along a European-Arctic transect. DIOXIN 38th International Symposium on Halogenated Persistent Organic Pollutants, 26. – 31. August 2018, Krakow, Poland.

Möckel, C.; Lunder Halvorsen, H.; Pedersen, L.S.; Krogseth, I.S.; Bohlin-Nizzetto, P.; Borgen, A.R.; Schlabach, M.; Breivik, K. Spatial distribution of short- and medium-chain chlorinated paraffins in European background air. Poster no. 157. DIOXIN 38th International Symposium on Halogenated Persistent Organic Pollutants, 26. – 31. August 2018, Krakow, Poland.

Möckel, C.; Lunder Halvorsen, H.; Pedersen, L.S.; Krogseth, I.S.; Bohlin-Nizzetto, P.; Borgen, A.R.; Schlabach, M.; Breivik, K. Spatial distribution of short- and medium-chain chlorinated paraffins in European background air. Poster at Framdagen, 22. August 2018, Tromsø, Norway.

Interdisciplinary Cooperation

This project could not have been carried out without the close cooperation between the biology, ecology and freshwater ecosystem competence at Akvaplan-niva and the atmospheric transport, chemistry and modeling competence at NILU. These disciplines complement each other and are both vital to increase the understanding of atmospheric inputs of organic contaminants of emerging concern to the Arctic and possible implications for freshwater ecosystem exposures. In this context, the models serve as very useful frameworks to integrate and organize the existing knowledge from the two disciplines, and to aid address the research questions in the project with a holistic and interdisciplinary approach.

Budget in accordance to results

The activities carried out in 2017-2018 and summarized above could not have been carried out without funding from the Fram Centre. As the project is ongoing, finalization of results are expected in 2019 provided continuation of funding for this project.

Could results from the project be subject for any commercial utilization

No

Conclusions

Preliminary results indicate low concentrations of selected organic contaminants of emerging concern in Norwegian background air and in a Norwegian freshwater ecosystem. However, as results are still preliminary and need to be further processed, no firm conclusions can be made yet.