Highlights from the new AMAP Assessment report on Chemicals of Emerging Arctic Concern

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Introduction

Three previous persistent organic pollutants (POPs) assessments have been compiled by the Arctic Monitoring and Assessment Programme (AMAP) [1-3]. A new fourth update assessment [4] addresses 'chemicals of emerging Arctic concern'. Under the Stockholm Convention on POPs, one of the criteria for establishing that chemicals are persistent in the environment is if they are found at locations "distant from sources" or "where monitoring data show that long-range environmental transport of the chemical…may have occurred" [5]. The new AMAP assessment addresses some chemicals of emerging Arctic concern with POP-like characteristics and also some chemicals and groups of substances that may not meet the classical definition of POPs. It also identifies Arctic contaminants that may originate from point sources rather than long-range transport. The new assessment compiles available Arctic data for per- and polyfluorinated substances (PFAS), brominated, chlorinated and organophosphorus-based flame retardants and plasticisers (BFRs, CFRs, PFRs), phthalates, short chain chlorinated paraffins (SCCPs), siloxanes, pharmaceuticals and personal care products (PPCPs), polychlorinated naphthalenes (PCNs), hexachlorobutadiene, current use pesticides (CUPs), pentachlorophenol/ pentachloroanisole, non-Aroclor and byproduct PCBs, halogenated natural products (HNPs), mono- and dibutyltins, polycyclic aromatic hydrocarbons (PAHs), and microplastics.

Methods

The assessment was based on a review of both the recent peer reviewed and grey literature for existing data on a wide range of chemicals of emerging concern (CECs) that had recently been detected in Arctic environmental compartments. The emphasis was on environmental levels and trends.

Results and discussion

Results from air monitoring at Arctic sites (including Alert, Canada; Pallas, Finland; Zeppelin station, Svalbard; Storhofdi, Iceland; Villum Research Station, Greenland and shipboard measurements on Arctic expeditions) confirm that, like 'legacy' POPs (e.g. PCBs and DDT), many CECs also undergo long-range atmospheric transport from source regions to the Arctic. These include PFAS, BFRs, CFRs, PFRs, SCCPs, phthalates, siloxanes, PCNs, HCBD, several CUPs, and PAHs. Results for several PFRs in air showed surprisingly high concentrations compared to PBDEs. At least seven new pesticides were measured in Arctic media: MCPA, metribuzin, pendimethalin, phosalone, quizalofop-ethyl, tefluthrin and triallate.

Studies of biota in the Arctic terrestrial environment are few, but show that some CECs bioaccumulate. For example, PFAS were found in reindeer/caribou, wolf, moose, muskox and ptarmigan. In Arctic freshwater and marine environments, a number of CECs (long chain PFCAs, several new BFRs, dechloranes, PFRs, phthalates, SCCPs, siloxanes, some PPCPs, PCNs, HCBD, several CUPs, organotins, some HNPs) have been found in fish, seabirds and marine mammals, indicating bioaccumulation potential for these. For some of these, (long chain PFCAs, a few BFRs (α-HBCDD, DBDPE), SCCPs, and PCNs) biomagnification was also indicated. Figure 1 illustrates the trophic magnification of SCCPs in an Arctic food web from Svalbard.

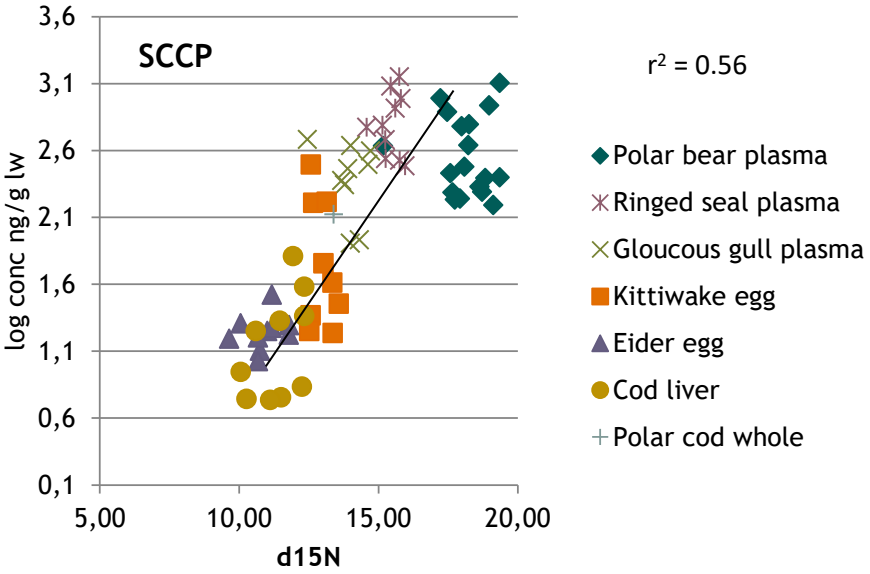

Figure 1. Relationship between SCCP concentrations (log ng/g lw) and $\delta^{15}N$ in a food web from Svalbard. Figure reproduced from NILU [6].

Sparse data mean that few spatial trends were discernible, and only for Canada, Greenland, Svalbard and the European Arctic, with highest concentrations of many CECs found on Greenland and Svalbard. Some temporal trends were available in air, indicating stable or increasing concentrations of some new BFRs, SCCPs, some CUPs, and for biota, long chain PFCAs. An example of temporal trends for several CUPs is shown in Figure 2. However, more data for most CECs will be required for a more comprehensive assessment of trends.

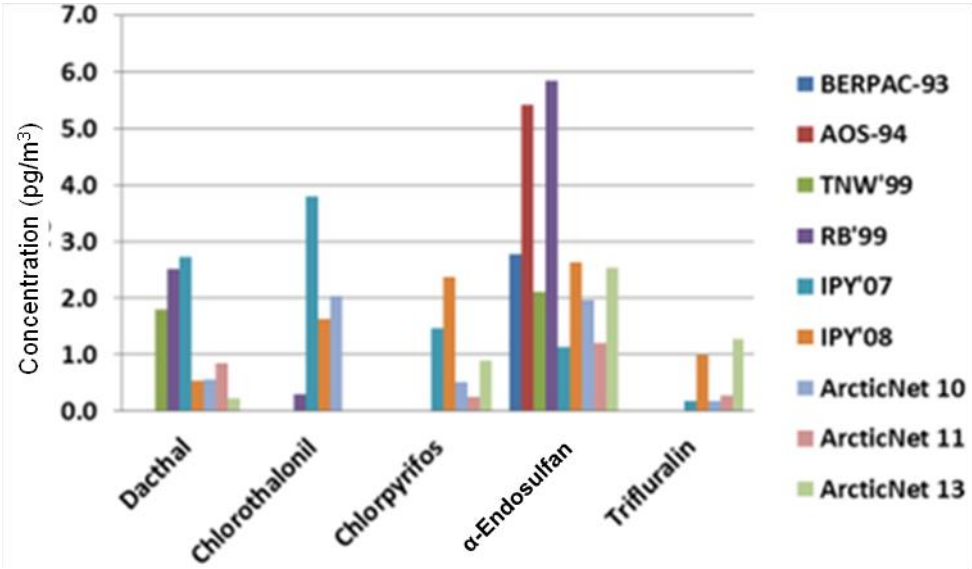

Figure 2. Temporal trends of current use pesticides (CUPs) measured in air of the western Arctic Ocean collected during oceanographic expeditions held between 1999-2013. Arithmetic mean concentrations are given in pg/m^3. Figure from Jantunen [7] ; data listed in Jantunen et al. [8]. Expeditions, listed by year, traversed the Bering-Chukchi Seas (BERPAC-1993), central Canada Basin to the North Pole (AOS-1994) and the Canadian Archipelago (TNW-1999, IPY-2007, IPY-2008, ArcticNet-2010, ArcticNet-2011, ArcticNet-2013).

For some CECs, concentrations were higher in proximity to settlements and urban sites. This was particularly apparent for several CECs that are used in consumer products. In particular, siloxanes and PPCPs were found locally in receiving waters impacted by (often untreated) sewage effluents from Arctic communities. Their persistence is enhanced due to cold conditions and periods of no light, which slow down microbial- and photo-degradation. Thus, several CECs (including PPCPs, siloxanes, phthalates) differ from traditional POPs in that

localized, point sources of pollutants within the Arctic may be important. However, the importance of local sources compared to long-range transport needs to be assessed.

Indications of long-range transport, persistence and bioaccumulation potential suggest that some CECs, such as long chain PFCAs, SCCPs and some BFR/CFRs may be possible POPs as defined by the Stockholm Convention, and confirm the POP classification of PCNs and some BFRs (HBCDD). These compounds constitute an 'emerging concern' with respect to contamination of the Arctic.

Many CECs have been analyzed using previously established methods for other, similar classes of persistent chemicals. For some of the emerging chemicals, cleanup and analytical methods have only recently been developed and these are not yet standardized. QA/QC procedures for new contaminants are not always optimal as pure standards may not be commercially available yet. For most of the CECs, there are no standard reference materials with certified concentrations available to validate methods. Because many emerging chemicals are used in consumer products and building materials, there are also considerable risks with contamination of low level samples. Thus, there is a need for interlaboratory comparison studies, development of best practice for analysis, increase in the number of commercially available standards and certified reference materials for many of the CECs addressed in this assessment.

Results of screening exercises of chemicals in commerce based on physical-chemical properties and long range transport potential indicate that there are many more chemicals with possible POP-like characteristics that may be reaching the Arctic, but that have not been searched for yet. A strategy using targeted and non-targeted chemical analysis, combined with suspect screening based on lists of possible POPs from such *in silico* screening exercises is needed to identify other chemicals of emerging Arctic concern. Asia was identified as an important source region for some CECs.

Findings of the assessment, and associated recommendations were presented to Arctic Council Ministers at their meeting in May 2017 [9].

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