Organophosphate Ester Flame Retardants and Plasticizers in the Canadian Arctic

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Introduction

Persistent Organic Pollutants are transported to the Arctic by air and ocean currents.

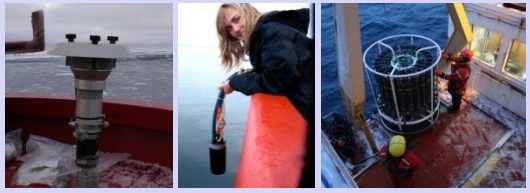
Sampling in the Canadian Archipelago has been done at land based stations and on cruises aboard Canadian Coast Guard ships (Louis S. St. Laurent and Amundsen). These studies have been conducted by the same team since 2007.

Compounds of interest are organophosphate ester flame retardants and plasticizers (OPEs).

Rationale

This work supports the Canadian Chemical Management Plan, Northern Contaminants Program, and Canadian Environmental Protection Act (CEPA) 1999.

Sampling Techniques



air sampler

submersible water sampler

rosette water sampler

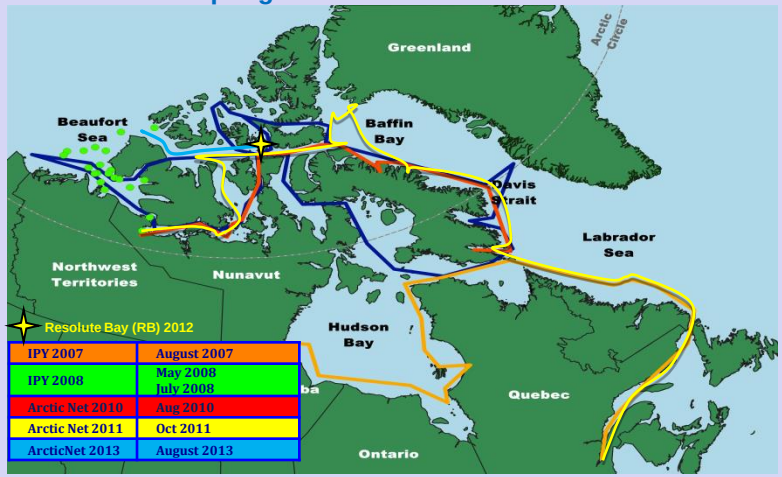
Target OPEs

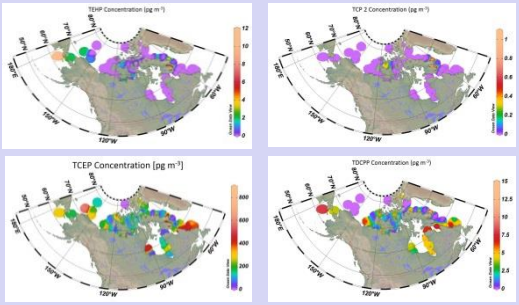
- Tris(chloro-isopropyl) phosphate (TCiPP)
- Tri-phenyl phosphate (TPhP)
- Tris(chloro-ethyl) phosphate (TCEP)
- Tris(dichloro-propyl) phosphate (TDCPP)
- ethyl hexyl di-phenyl Phosphate (EHDPP)
- tri-cresly phosphate (TCP2/3)
- Tris(butyloxy ethyl) phosphate (TBEP)
- tri-n-butyl Phosphate (TBP)

Materials and Methods

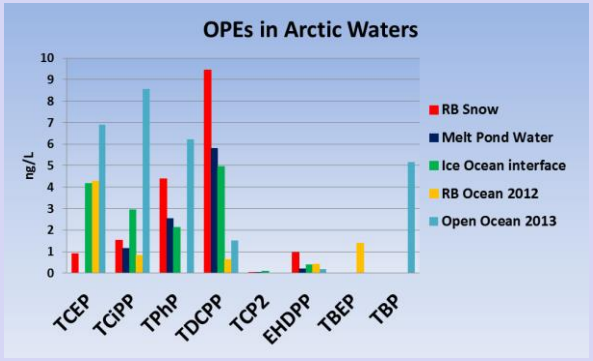
- Water: 40-100 L were processed through a glass-fiber filter followed by XAD-2 resin, OPEs are mainly in the dissolved phase.
- Air: 400–1500 m^3 were sampled with a glass fiber filter – PUF/XAD cartridge, OPEs are in the particulate phase.
- OPEs were determined by capillary GC using a DB-5 column, with detection by ECNI-MS and EI-MS modes.
- Labelled surrogates (^{13}C and deuterated) were added to each sample to monitor recoveries (range from 67-109%).

Sampling Locations and Cruise Tracks

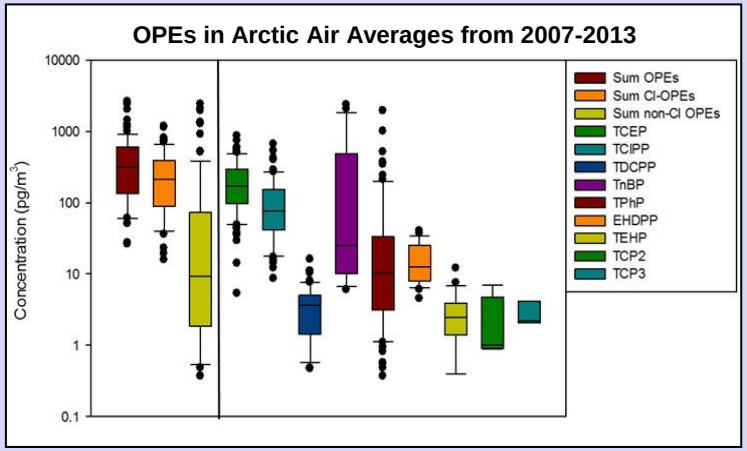




Spatial Distribution of OPEs to Arctic Air, 2007-2013.



Concentration of OPEs in Canadian Archipelago water from Resolute Bay and Barrow Strait, note: TBP was only sought in 2013 samples.



Concentrations (pg m^{-3}) of OPEs in the atmospheric particle phase from the Canadian Arctic (2007 – 2013). The black horizontal line inside each box represents the median. The boxes represent the 25th and 75th percentiles.

Trend in Canadian Arctic Air: 2007-2013

- **TCEP significant declined between 2007-2013, probably in response to Europe's ban, TCEP is also slated to be banned in Canada**
- **Generally the levels of sum-OPEs is increasing, this trend is being driven by declines in alkylated OPEs, where the Sum-Cl-OPEs are remaining constant.**

Results and Discussion

- Most are Canadian Chemical Management Plan priority compounds, TCEP has been phased out in Europe and is being phased out in Canada due to toxicity.
- OPEs were found on air particles, not in the gas phase.
- Northern communities are local sources of OPE to arctic air and rivers inflows are also sources of OPEs.
- The levels of OPEs are orders of magnitude higher than other flame retardants ie PBDEs and novel BFRs.
- OPEs in snow and melt pond water are very well correlated (r2 = 0.991) indicating snow is a delivery pathway of OPEs to surface waters.

Acknowledgements:
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