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Overview of AMAP emerging contaminants

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Arctic Monitoring and Assessment Programme (AMAP)

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- 8 Arctic countries
- Working Group under the Arctic Council
- Environmental monitoring
  - Builds on the different Arctic country's national programs, as well as research
- POPs expert group

AMAP Arctic Monitoring and Assessment Programme

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AMAP POPs Expert Group

- **Expert groups led by countries**
  - POPs – Canada, Sweden, Denmark as lead countries
    - Derek Muir, Cynthia de Wit, Katrin Vorkamp – co-leads
- **Syntheses of all scientific literature on POPs in the Arctic**
  - Assessment reports
- **Other expert groups for heavy metals, human health, acidifying compounds, climate change etc.**

The first AMAP report

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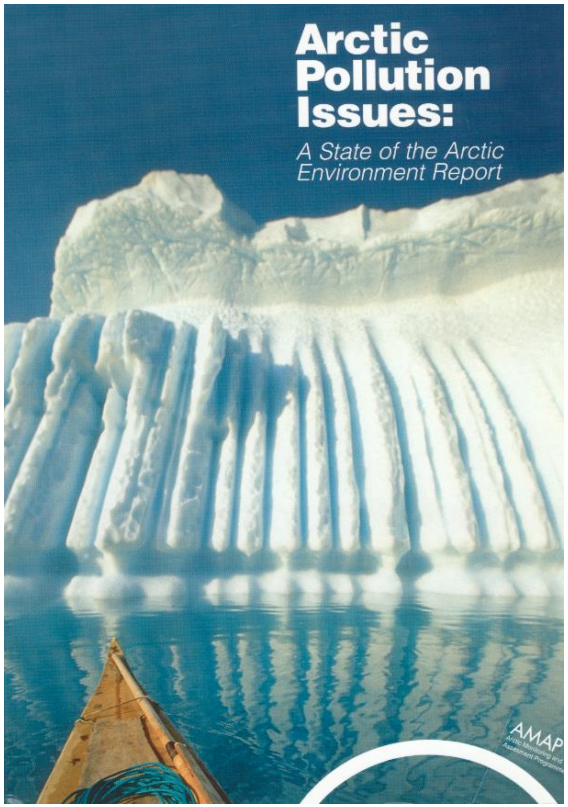
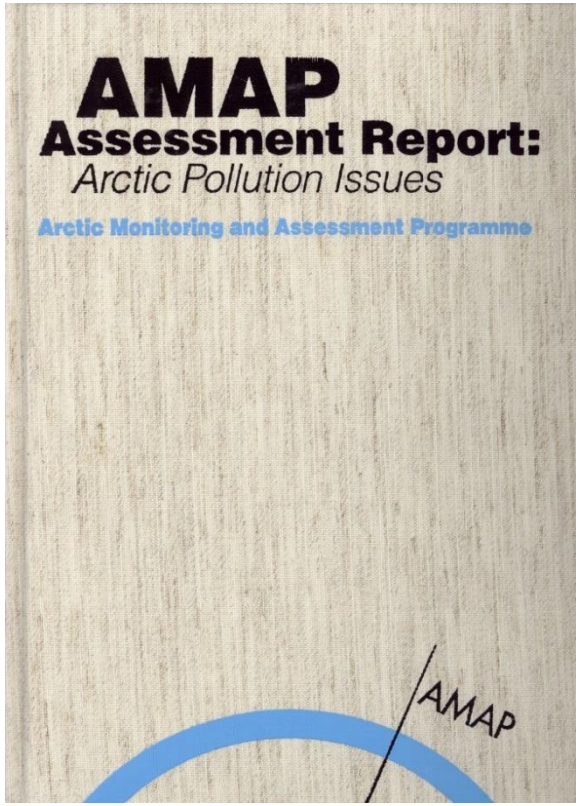
1997 Popular science version



1998 Scientific version



"The Brick"

- POPs
- Heavy metals
- Radioactivity
- Acidifying substances
- PAHs
- Climate change, ozone, UV
- Human health

Stockholm Convention on Persistent Organic Pollutants

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- **Stockholm Convention signed in 2001 - <u>global</u>**
- **Ratified in 2004**
- **Bans or restricts 12 POPs ("dirty dozen")**
  - **Dioxins, PCB, DDT, various organochlorine pesticides**

Criteria for listing new POPs under the Stockholm Convention

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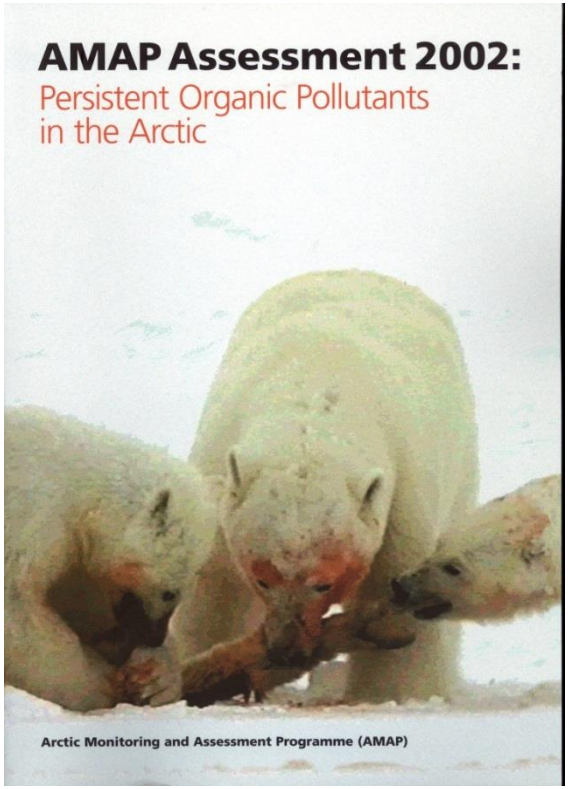
- **Persistence, bioaccumulation, toxicity (PBT)**
- **Found in the Arctic**
  - **“distant from sources”**
  - **“monitoring data showing that long-range environmental transport of the chemical….may have occurred”**

The second and third AMAP reports included ”new” POPs



Special issue
Science of the Total Environment
Vol. 408, 2010

- **Brominated flame retardants**
  - PBDEs, HBCDD, HxBB
- **Perfluorinated compounds**
  - PFOS
- **New pesticides**
  - Endosulfan

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Stockholm Convention

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- **2009 – 9 new POPs listed**
  - Penta- and octaBDE
  - PFOS
  - More pesticides
- **2011 – endosulfan**
- **2014 – hexabromcyclododecane (HBCDD)**

Stockholm Convention

- **2015 – 3 new POPs listed**
  - PCNs
  - Pentachlorophenol
  - Hexachlorobutadiene

- **Under review**
  - DecaBDE
  - PFOA
  - Dicofol
  - SCCPs

Fourth AMAP report - Chemicals of emerging Arctic concern

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- Chapter 1 – Introduction
- Chapter 2 – Contaminants of emerging concern (CECs)
- Chapter 3 – Biological and toxicological effects of CECs
- Chapter 4 - Further contaminants of potential Arctic concern
- Chapter 5 – Policy options and implications
- Appendix – searchable database of chemicals included in report

Fourth AMAP report - Chemicals of emerging Arctic concern

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- **Includes (among others):**
  - Per-/polyfluorinated alkyl substances (PFAS)
  - New brominated, chlorinated and phosphorous based flame retardants
  - Phthalates
  - Chlorinated paraffins, PCNs
  - Pharmaceuticals, personal care products, siloxanes
  - Hexachlorobutadiene
  - Current use pesticides, pentachlorophenol
  - PAHs
  - Organotins
  - Macro- and microplastics

Methods

- **Literature searches**
  - Peer reviewed articles
  - Government or other reports
- **Data for atmospheric, terrestrial and marine environments**
- **Levels**
- **Spatial and temporal trends**

Results

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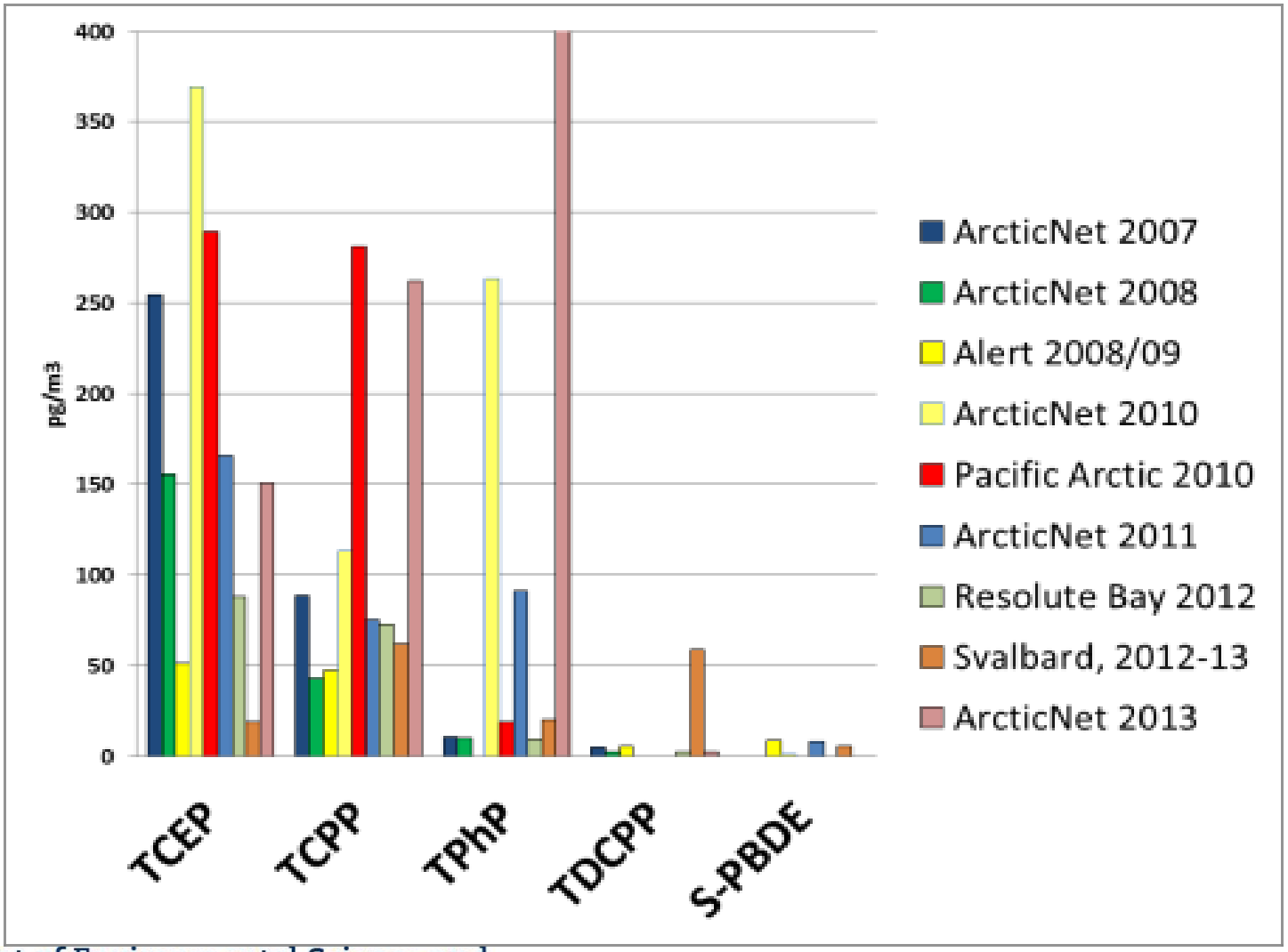
- **Air monitoring**
  - Most data
  - Many CECs undergo long range atmospheric transport
  - Includes PFAS, BFRs, CFRs, PFRs, SCCPs, phthalates, siloxanes, PCNs, HCBD, several CUPs, PAHs

PFRs in Arctic air



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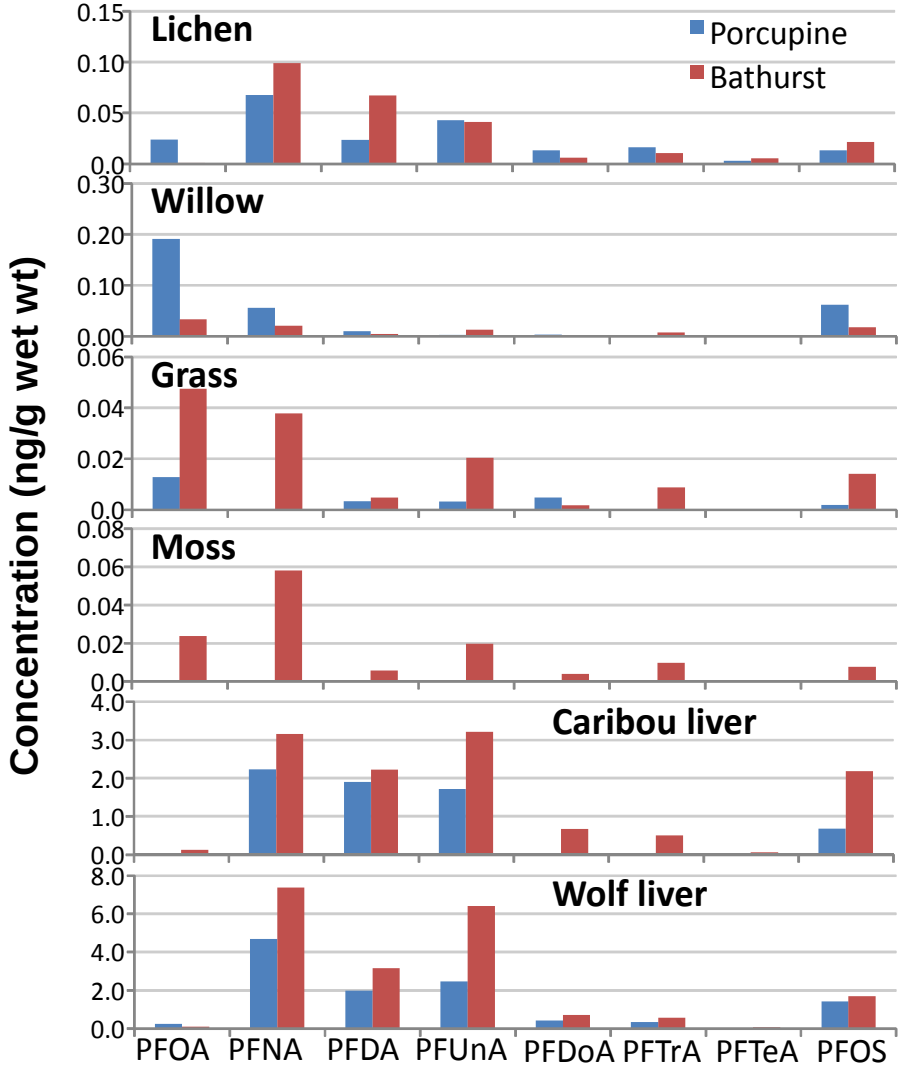
Möller et al. 2012, Salamova et al. 2014, Xiao et al. 2012

Results

- **Terrestrial environment**
  - **Few data**

PFCA concentrations - Canadian food web



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Müller et al. 2011

Results

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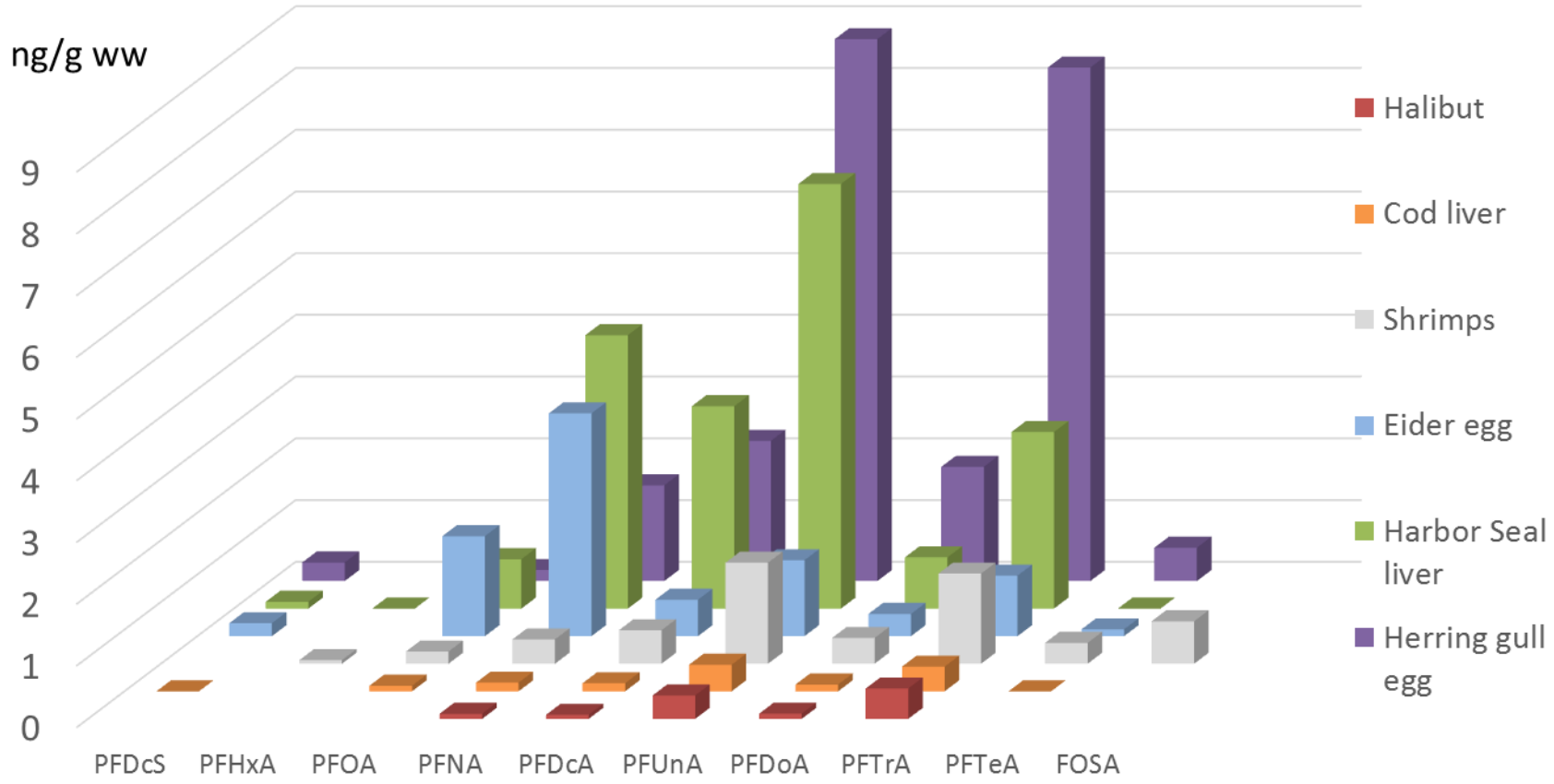
- **Marine environment**
  - Some data
  - Present in biota:
    - Long chain PFCAs, some new BFRs, CFRs, PFRs, SCCPs, phthalates, siloxanes, some PPCPs, PCNs, HCBD, several CUPs, organotins, some HNPs
    - Indicates bioaccumulation potential

PFAS in biota from N. Norway



Norwegian Environment Agency 2013

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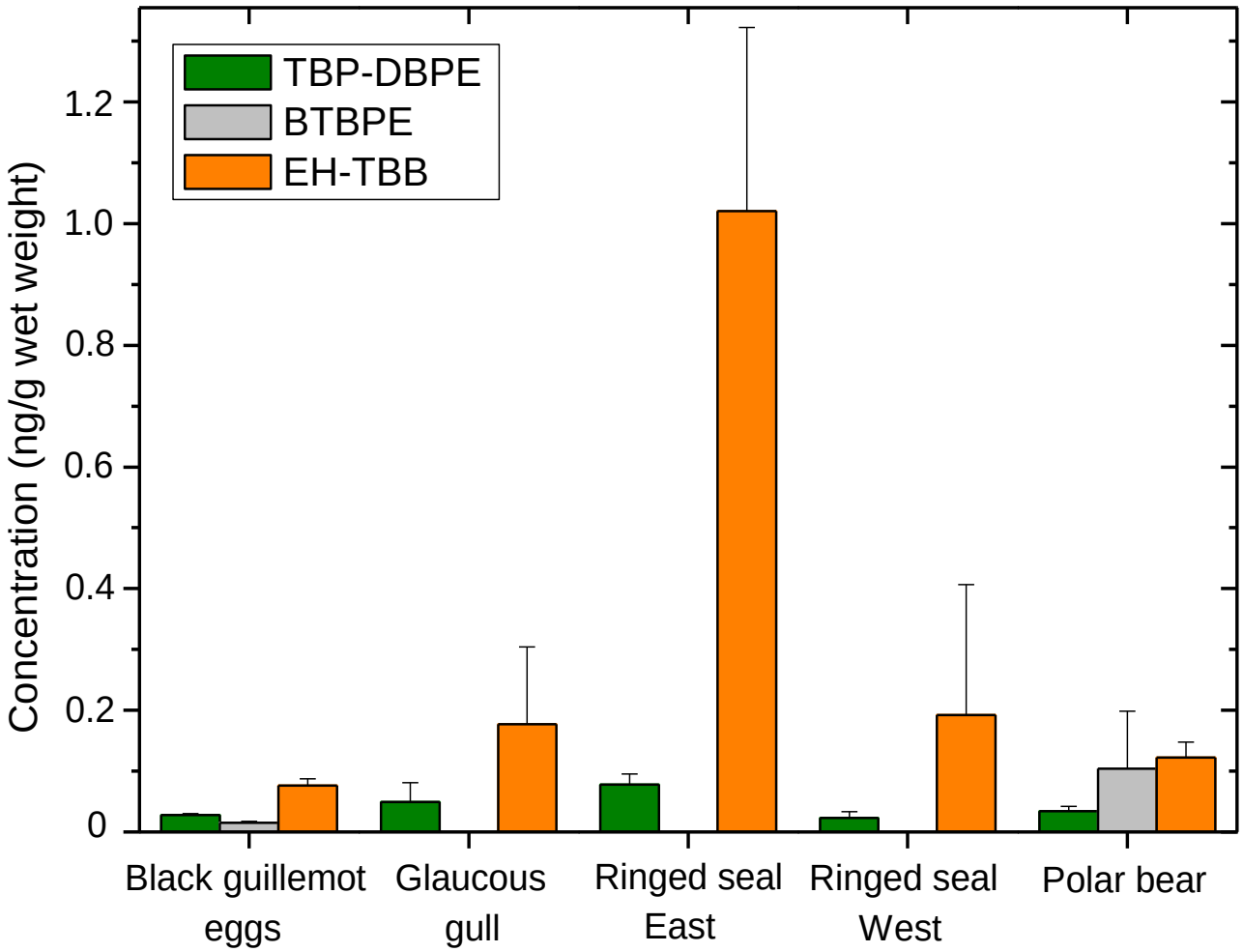
New BFRs in Greenland biota



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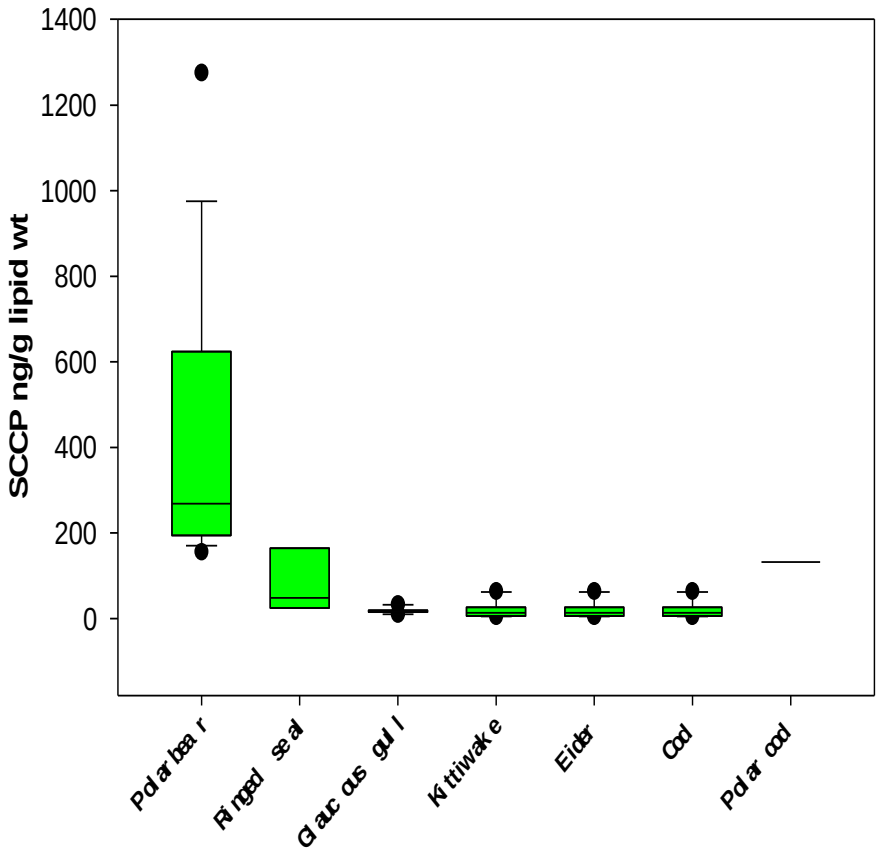
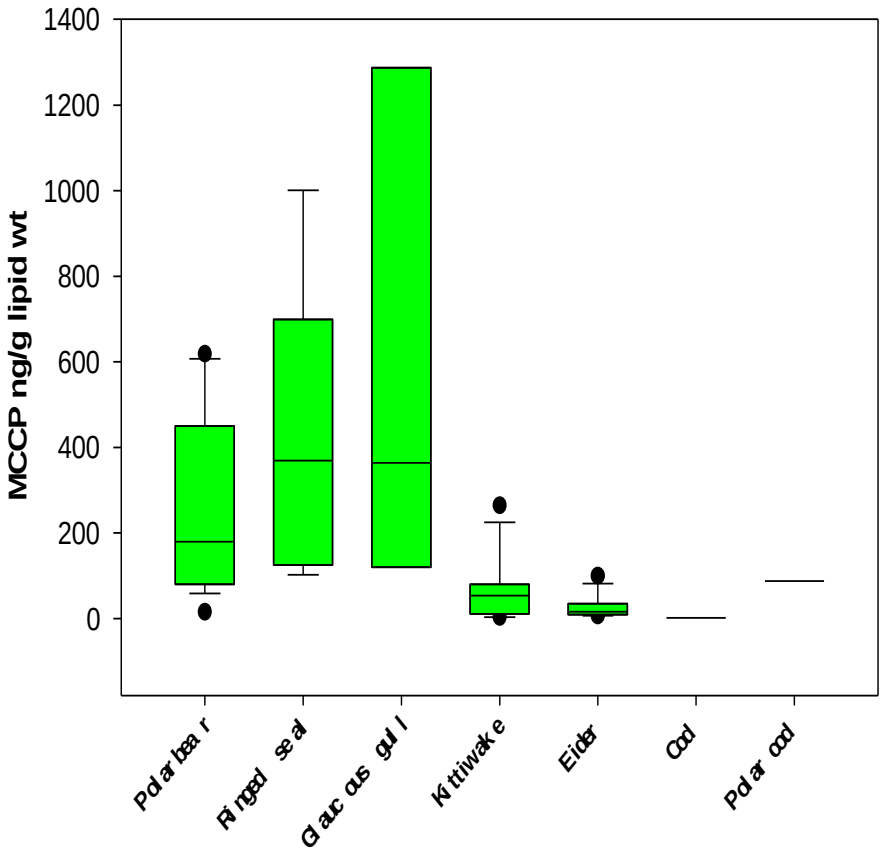
Vorkamp et al. 2015

Chlorinated paraffins in Svalbard biota





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NILU 2013

Results

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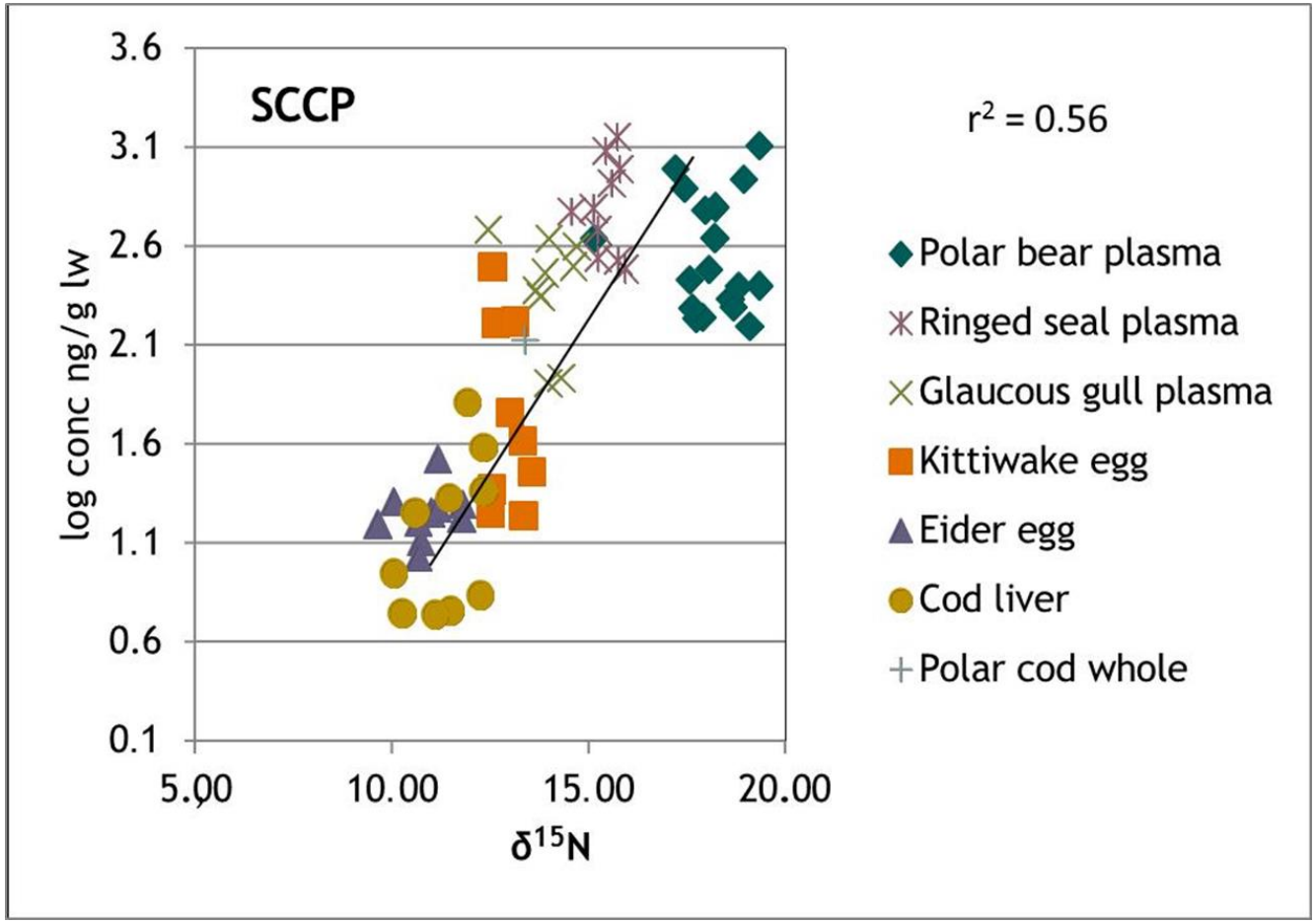
- **Biomagnification indicated for:**
  - Long chain PFCAs
  - A few BFRs (α-HBCDD, DBDPE)
  - SCCPs
  - PCNs

SCCP biomagnification - Svalbard



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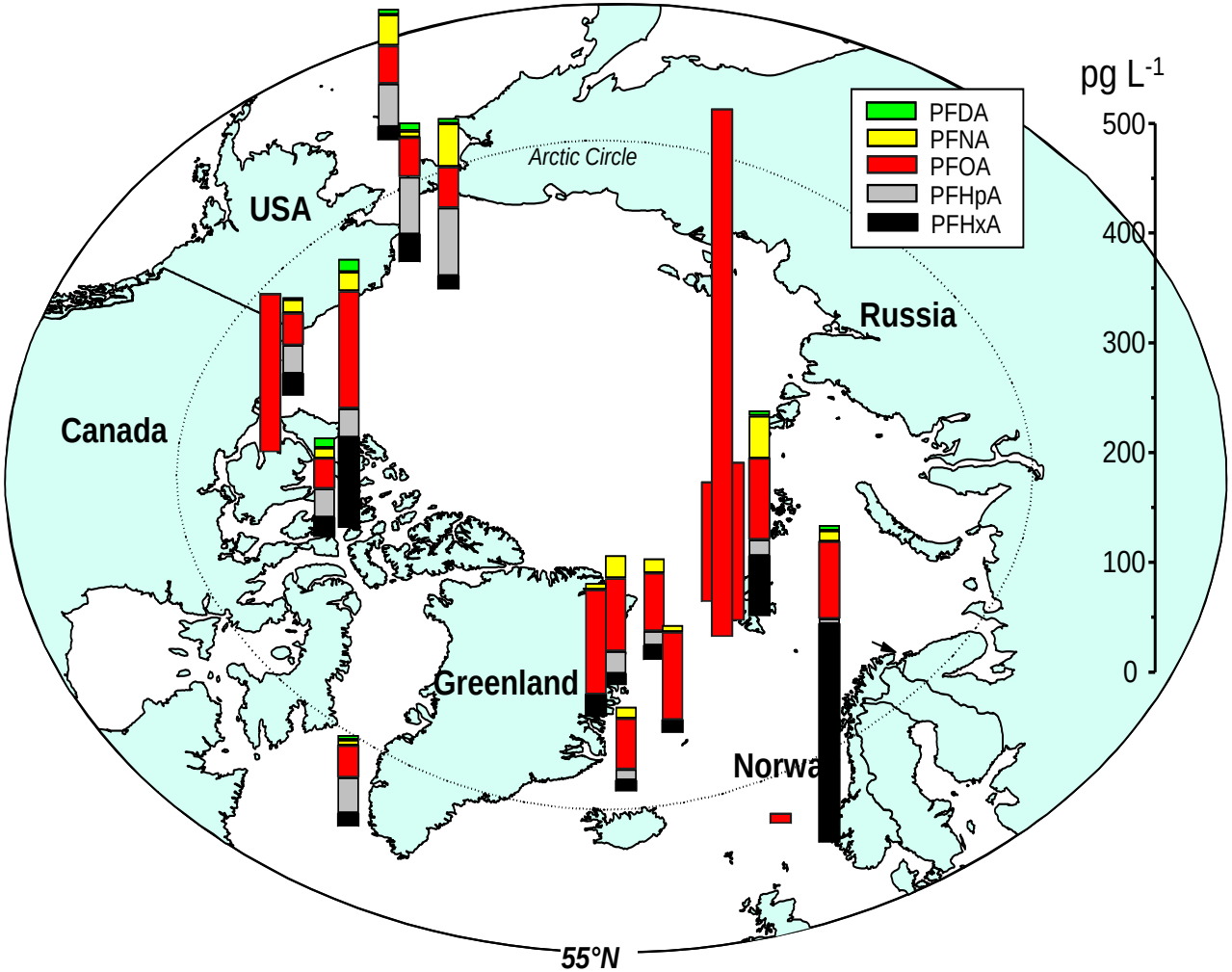
Results

- **Marine environment**
  - For siloxanes and PPCPs
    - Higher concentrations in receiving waters near settlements (sewage outflows)
    - Persistence of these enhanced due to cold, periods of no light

Results

- **Spatial trends**
  - Very few available
  - Lack of data from Russia
  - Little data from Alaska, Finland, Iceland, Sweden

Concentrations of PFCAs in Arctic seawater



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Results

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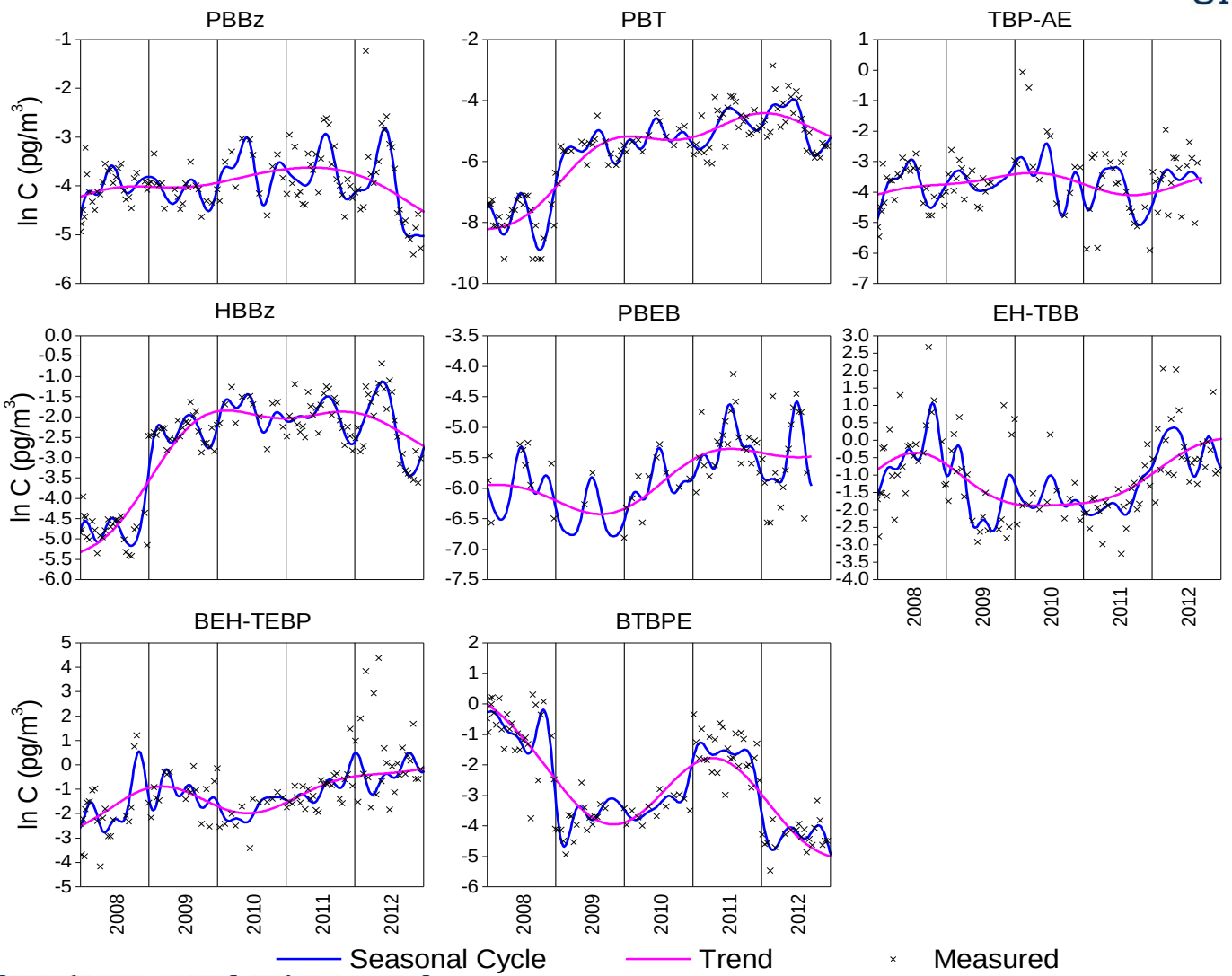
- **Temporal trends**
  - Mostly available for air
  - Some for biota
  - Indicate stable or increasing concentrations of some PFCAs, some new BFRs and siloxanes
  - Decreasing trends of BDE209, PCNs, some CUPs

Trends for new BFRs – air from Alert, Canada



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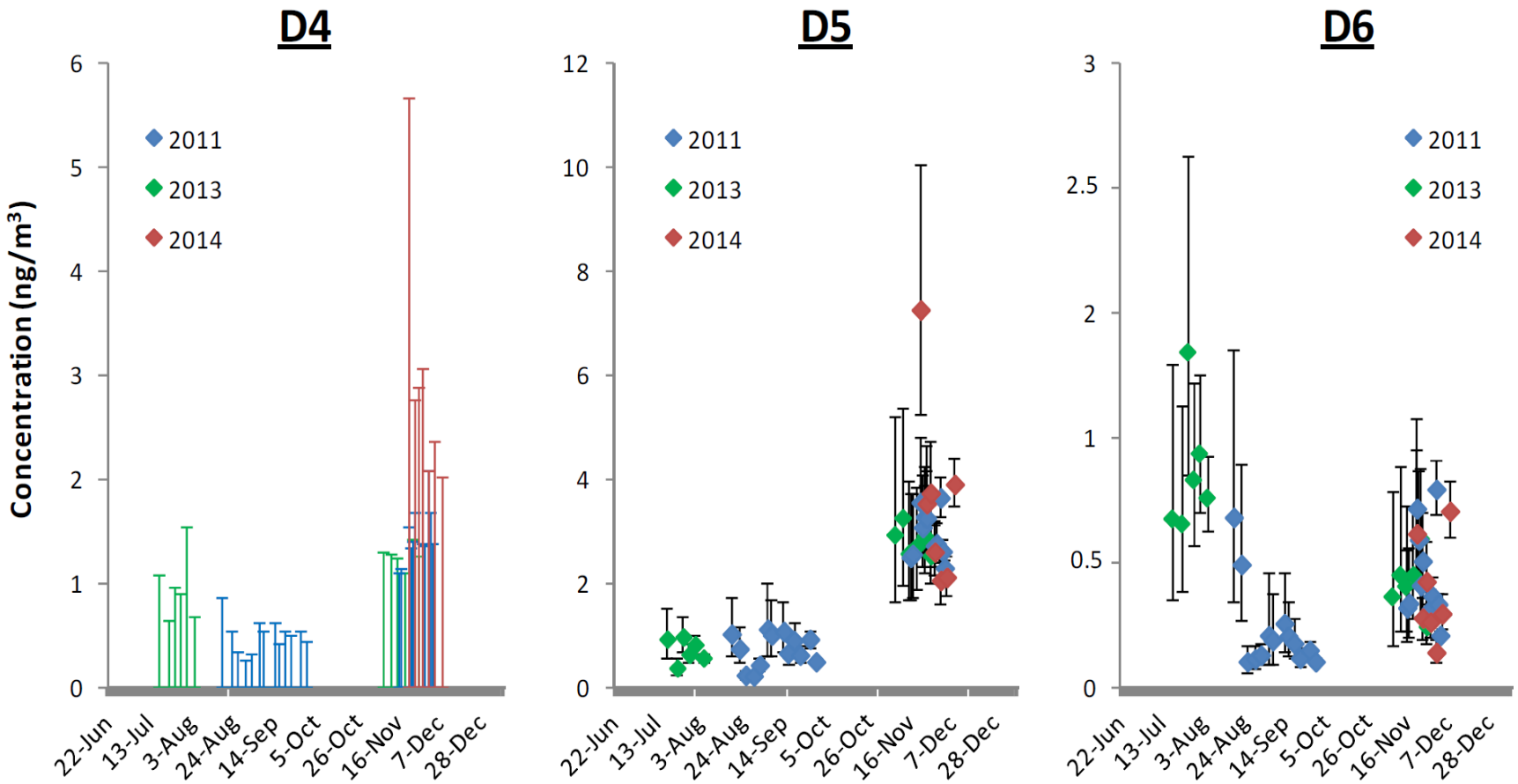
Hung et al. In prep

Siloxanes in air – Zeppelin station, Svalbard



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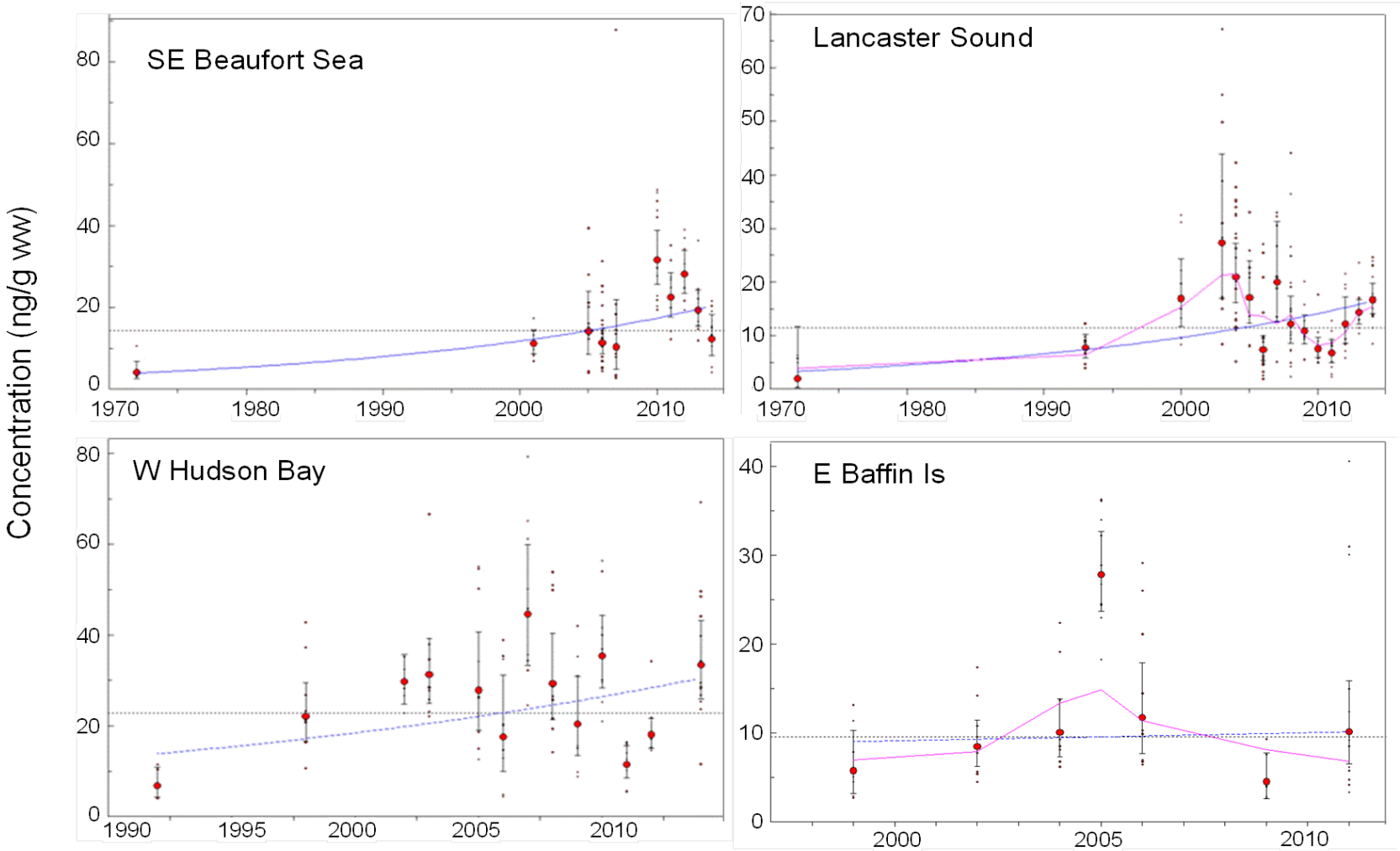
Krogseth et al. 2013, NILU 2015

Total PFCAs in Canadian ringed seal liver



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Muir et al. 2014

Conclusions and recommendations

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- **16 major groups of chemicals of emerging concern and microplastics found in the Arctic**
- **Most data for air**
- **Concentrations generally lower than for legacy POPs**
  - PFRs surprisingly high though
- **Local sources may be important for PPCPs, phthalates, siloxanes**

Conclusions and recommendations

Stockholm University

- **Some CECs may be POPs – P, B and LRT potential**
  - Long chain PFCAs, some BFRs and CFRs
- **Some CECs do not fit definition of POPs**
  - PPCPs, microplastics
- **Few spatial or temporal trend datasets available**
- **More data needed for assessment**

Conclusions and recommendations

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- Best practice for sampling, analysis, QA/QC for many CECs needed
- Numerous chemicals identified having potential to reach the Arctic
- Need combination of target and non-target screening for new chemicals of Arctic concern
- Asia now an important source region
  - E.g. polyfluoroether sulfonates only produced in China

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Additional ongoing AMAP reports

- Temporal trends of POPs - 2016
- Biological effects - 2017
- POPs and climate – start in 2017

Questions?