Stockholm University

Pollution

Cynthia de Wit

Department of Environmental Science and Analytical Chemistry

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Persistent organic pollutants (POPs)

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- **PCBS were discovered to be widespread in the Arctic in the late 1980s**
  - **High concentrations in Inuit living far from sources**
  - **Understanding that POPs could travel long distances in air**

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Arctic Monitoring and Assessment Programme (AMAP)

- WG - Saw the immediate need for a scientific assessment of the state of the Arctic environment
- Called scientists together to begin process

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AMAP POPs Expert Group

Stockholm University

- **Expert groups led by countries**
  - **POPs – Canada and Sweden as leads**
    - **Derek Muir, Cynthia de Wit – co-leads**
    - **Recent addition of Denmark – Katrin Vorkamp**
- **Synthesis of all scientific literature on POPs in the Arctic**
- **1994-1998**

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AMAP Arctic Monitoring and Assessment Programme

The first AMAP report

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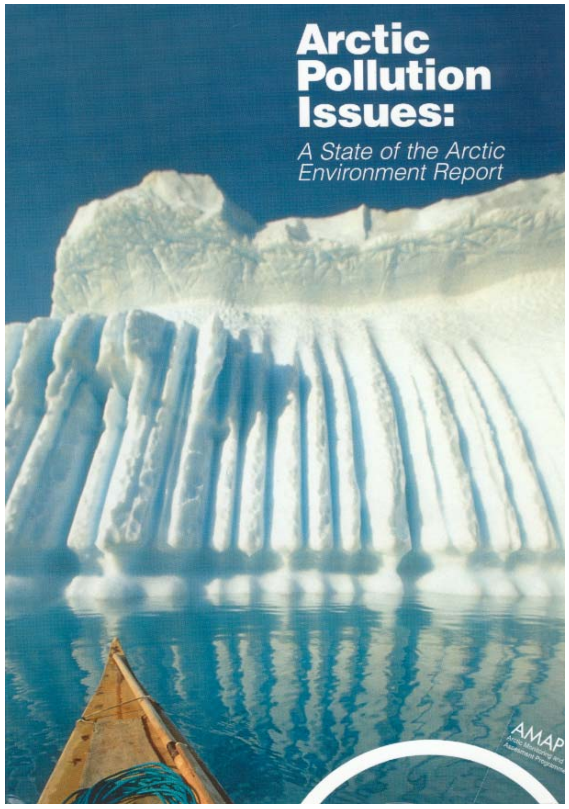
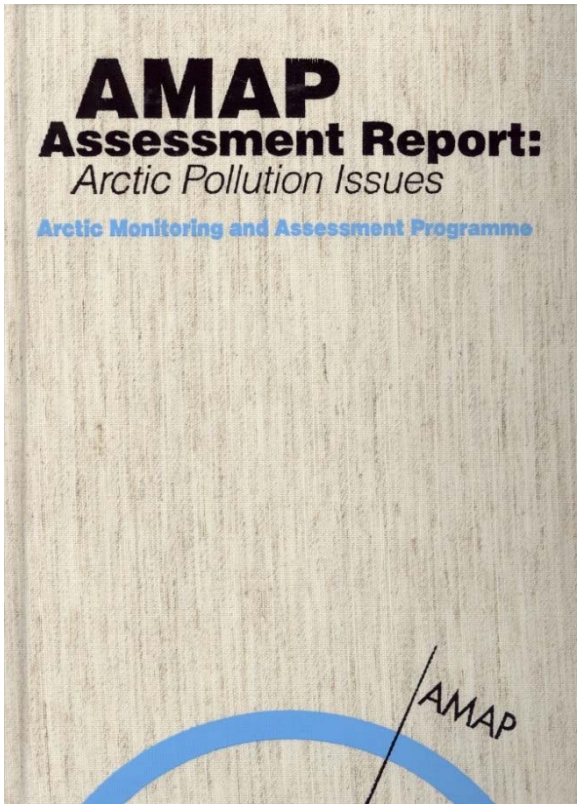
1997 Popular science version



1998 Scientific version



”The Brick”

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

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AMAP Arctic Monitoring and Assessment Programme

Results for POPs in the first AMAP report

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- **AMAP's first report had major impact**
  - Showed high POP concentrations in top predators, higher than southern latitudes
  - Long range atmospheric transport important
  - Long food webs
  - Fat an important nutritional source
  - Leads to high bioaccumulation/biomagnification

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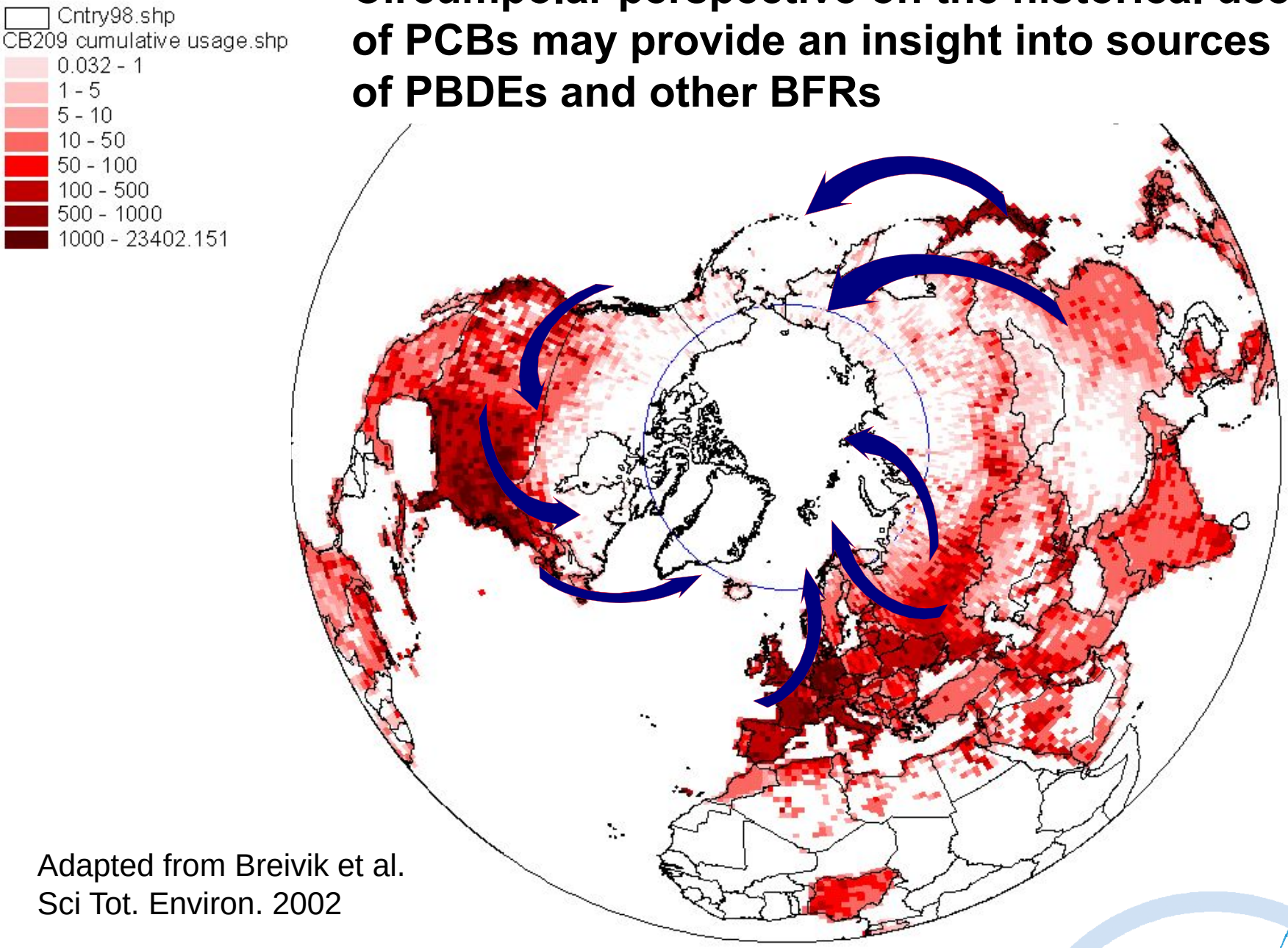
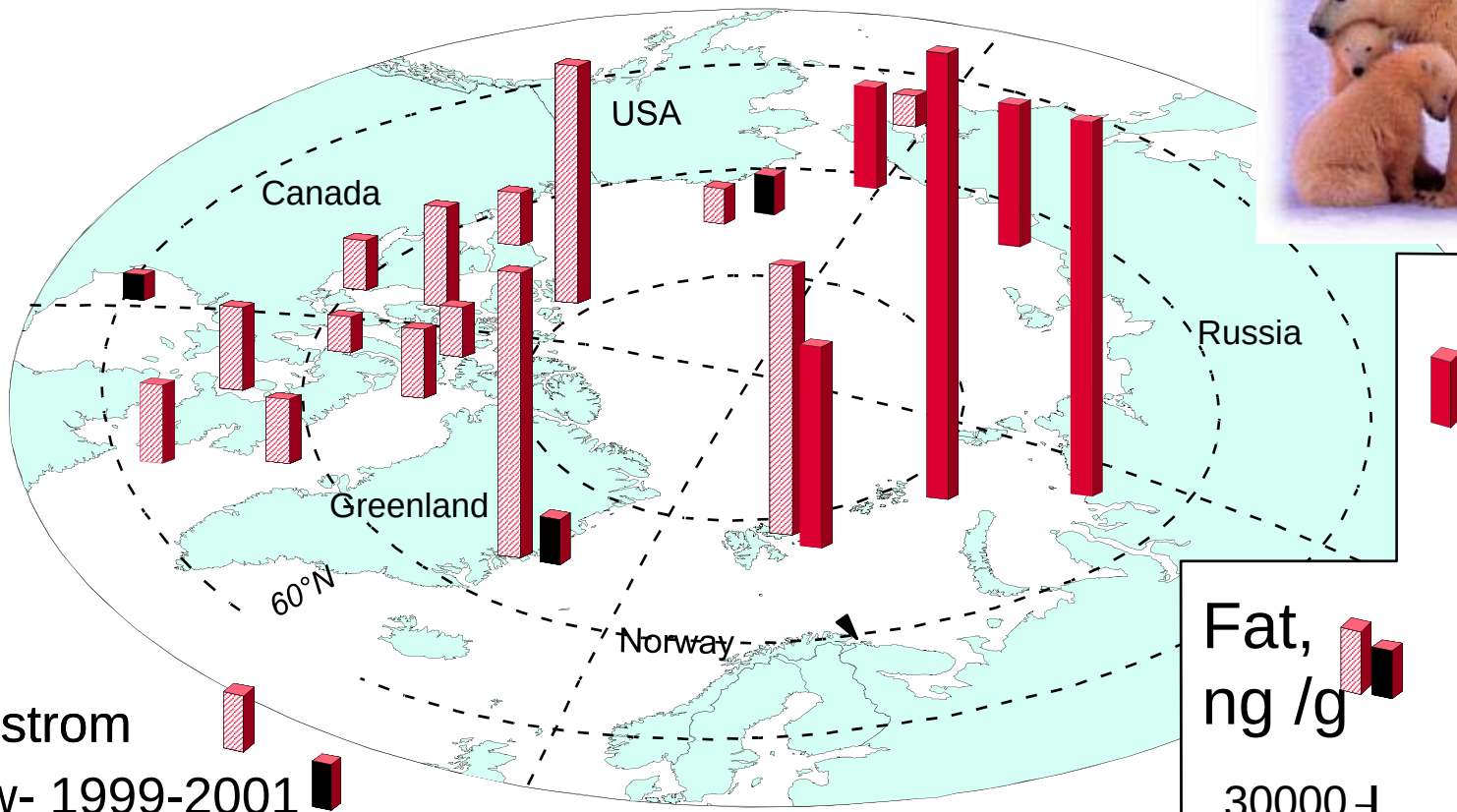
Circumpolar perspective on the historical use of PCBs may provide an insight into sources of PBDEs and other BFRs



Adapted from Breivik et al.
Sci Tot. Environ. 2002

PCBs (ng/g lipid weight) in polar bear



Norstrom

**New- 1999-2001

Andersen

Blood lipid, ng /g

12000
10000
8000
6000
4000
2000
0

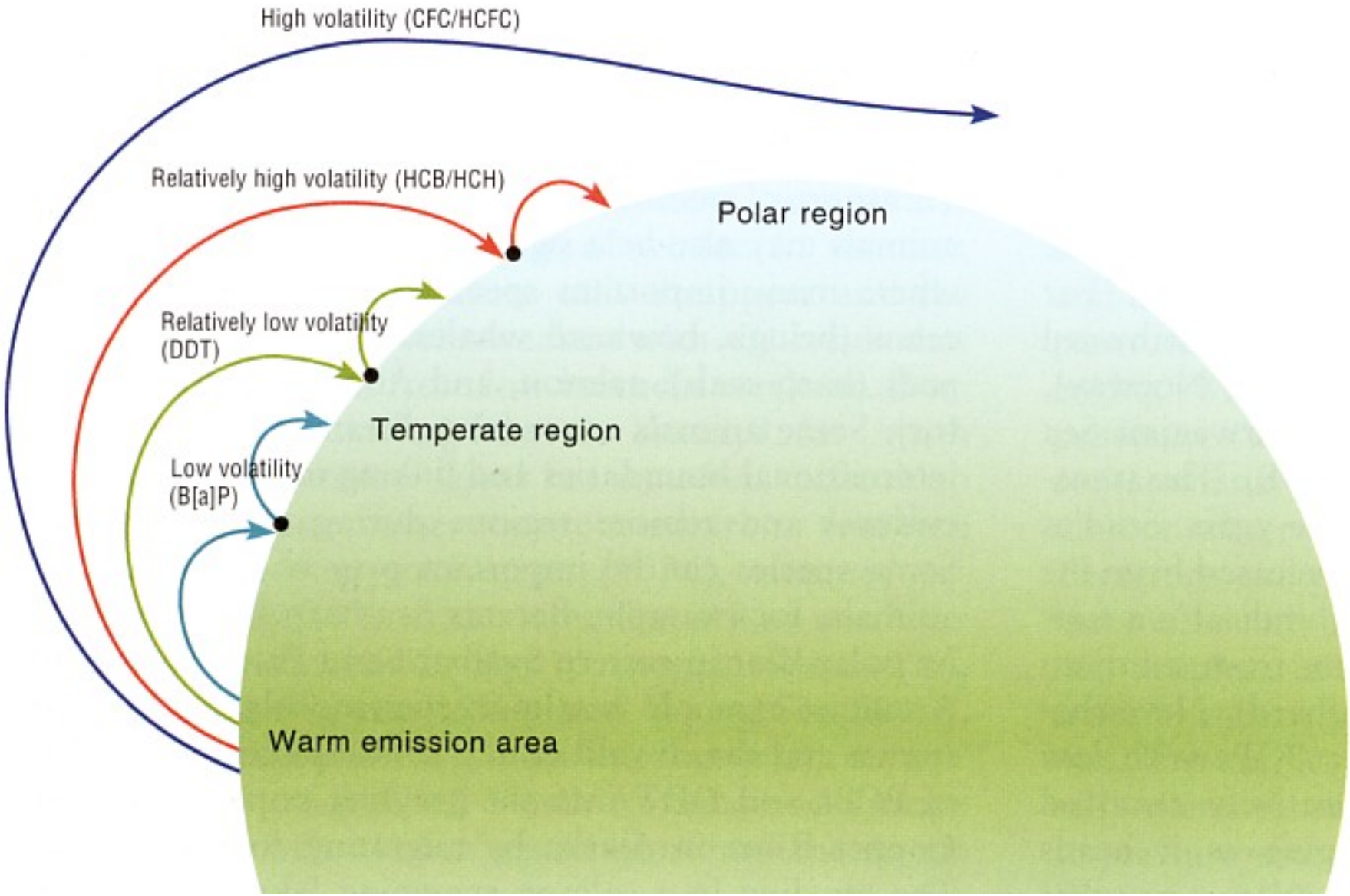
Fat, ng /g

30000
20000
10000
0

* scaled to equivalent concentrations at Svalbard

** Norstrom 2000; Krahn et al. 2002; Letcher et al. 2003

Global condensation / fractionation



Alpha-HCH concentrations in seawater

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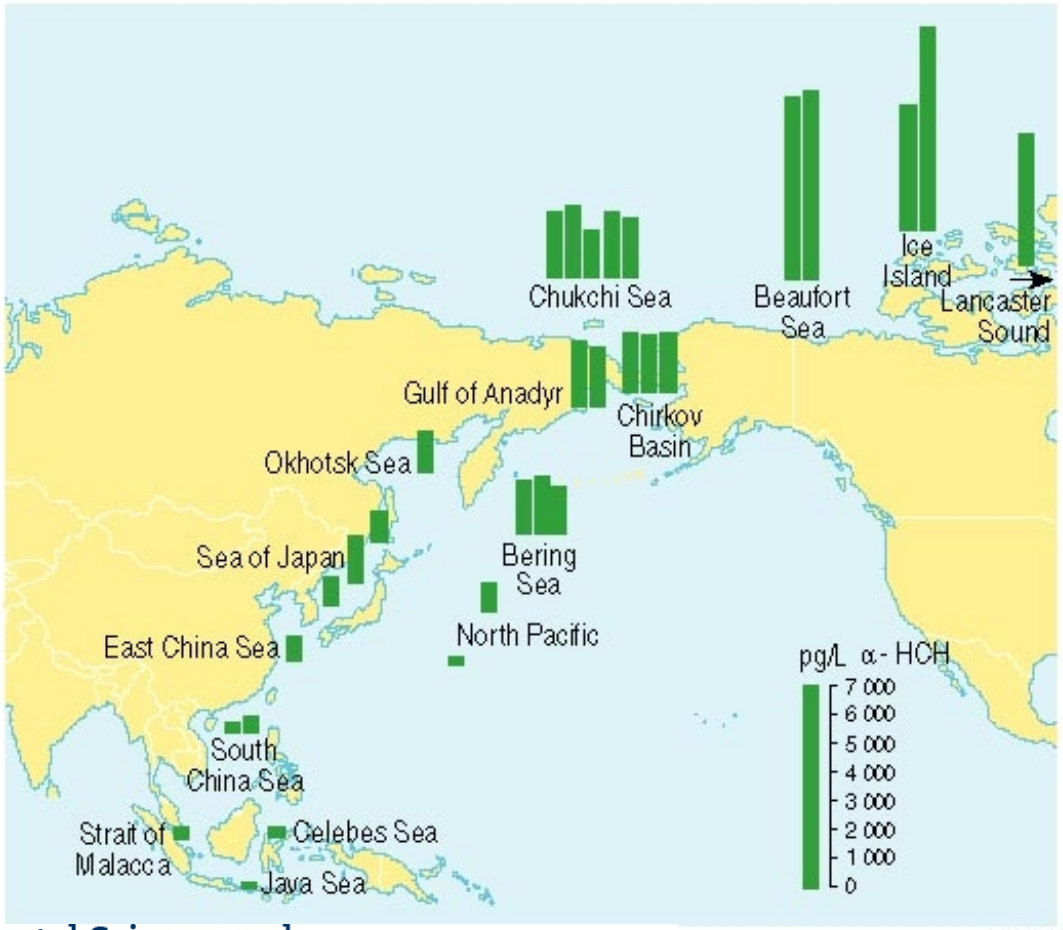
Arctic Monitoring and Assessment Programme
AMAP Assessment Report: Arctic Pollution Issues, Figure 6-21



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Arctic food web

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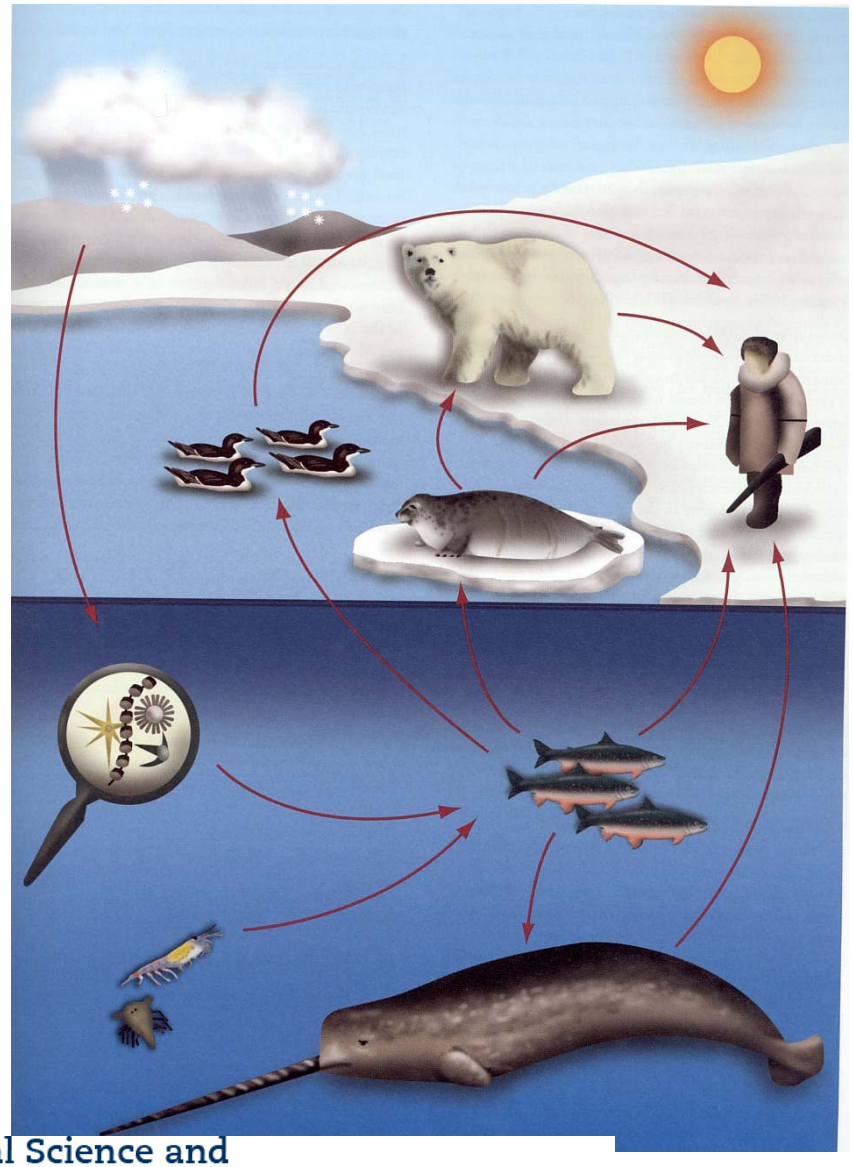
”Fat is king”



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Biomagnification of PCB

Sea water	0.00000128 ng/g
Zooplankton	30 ng/g fat
Polar cod	180 ng/g fat
Ringed seal	2800 ng/g fat
Polar bear	20 000 ng/g fat

Concentration increase of 16 000 000 000 from water to polar bear

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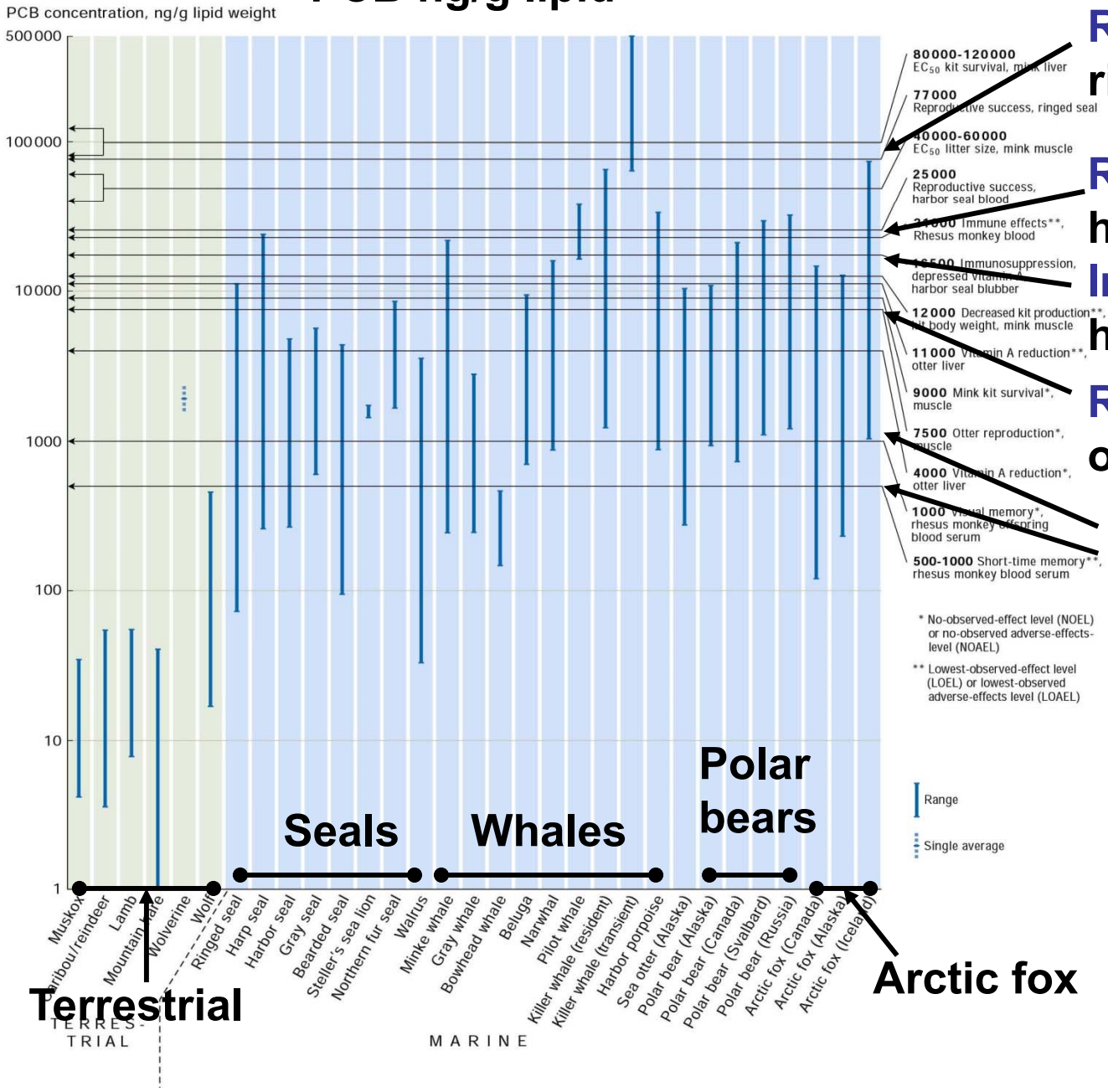
PCB ng/g lipid



Reproduction – ringed seal

Reproduction – harbor seal

Immune effects – harbor seal

Reproduction – otter, mink

Neurobeh. effects – rhesus monkey

Stockholm Convention on Persistent Organic Pollutants

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- **Stockholm Convention signed in 2001 - global**
- **Ratified in 2004**
- **Banned or restricted 12 POPs ("dirty dozen")**
  - **Dioxins, PCB, DDT, various organochlorine pesticides**

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Criteria for listing new POPs under the Stockholm Convention

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

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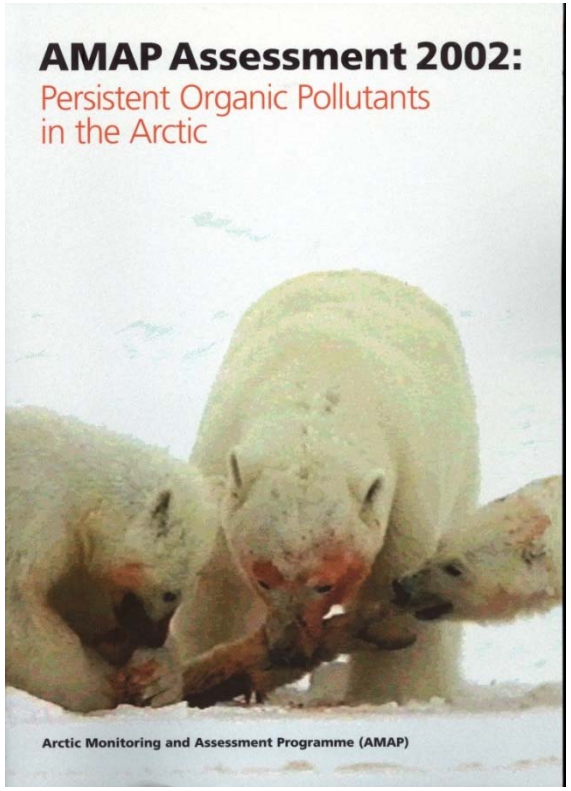
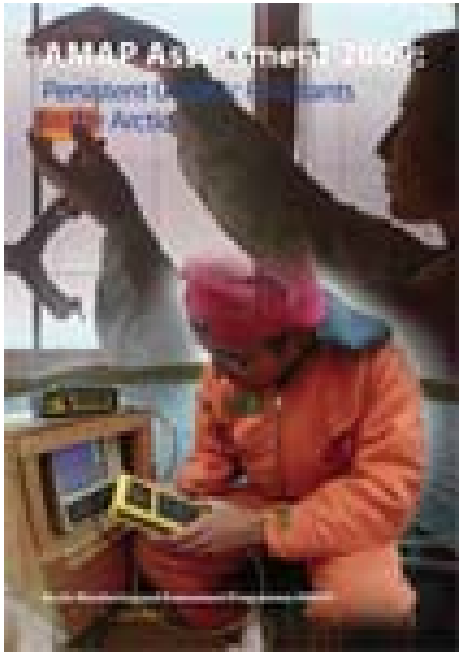
Second and third AMAP reports included ”new” POPs



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



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

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Stockholm Convention

- **2009 – 9 new POPs listed**
  - Penta- and octaBDE
  - PFOS
  - More pesticides
- **2011 – endosulfan**
- **2014 – hexabromcyclododecane (HBCD)**
- **2015 – 3 new POPs listed**
  - PCNs
  - Pentachlorophenol
  - Hexachlorobutadiene
- **Approved by POPRC in 2016 (to COP 2017)**
  - DecaBDE
  - SCCPs
- **Under review**
  - PFOA
  - Dicofol

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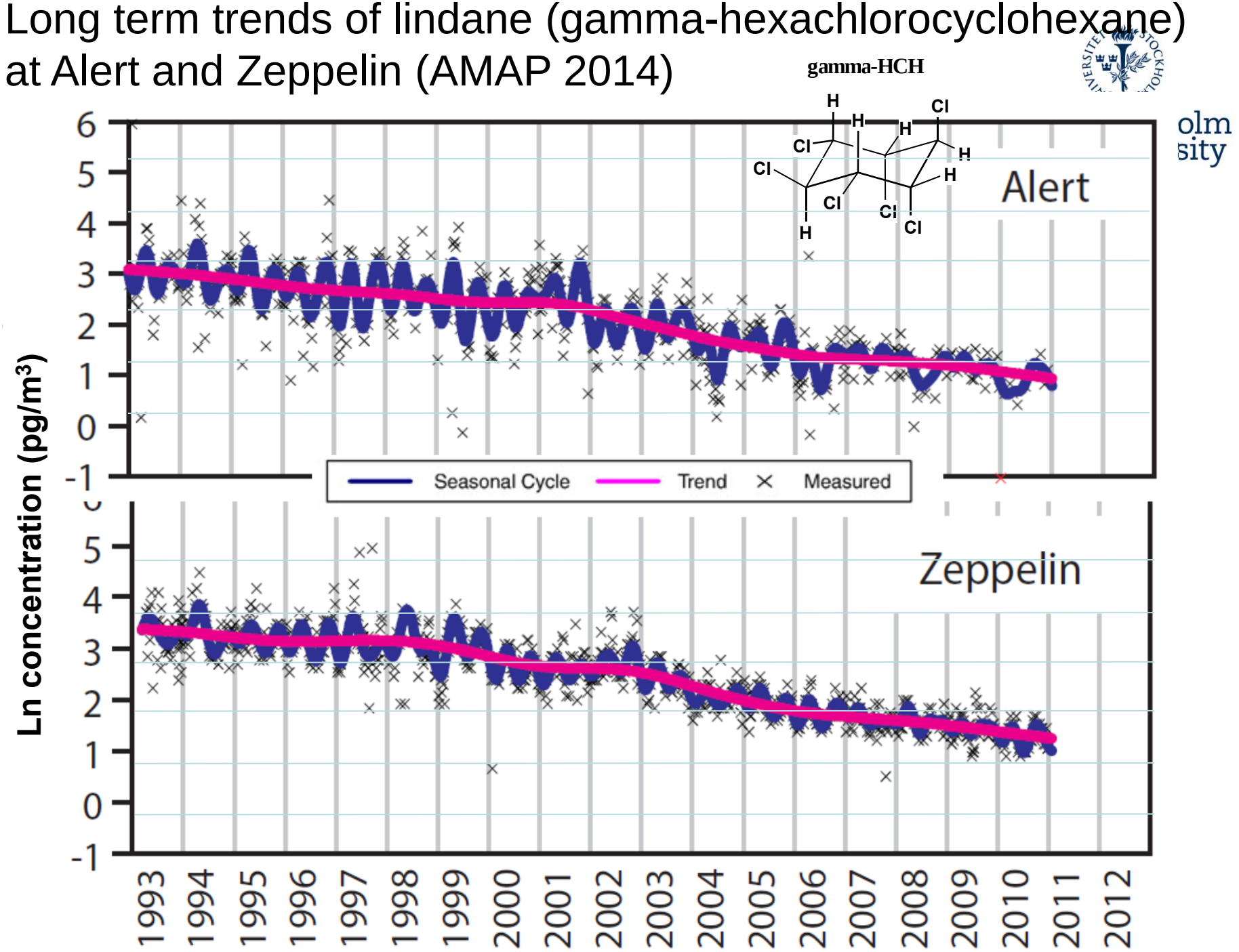
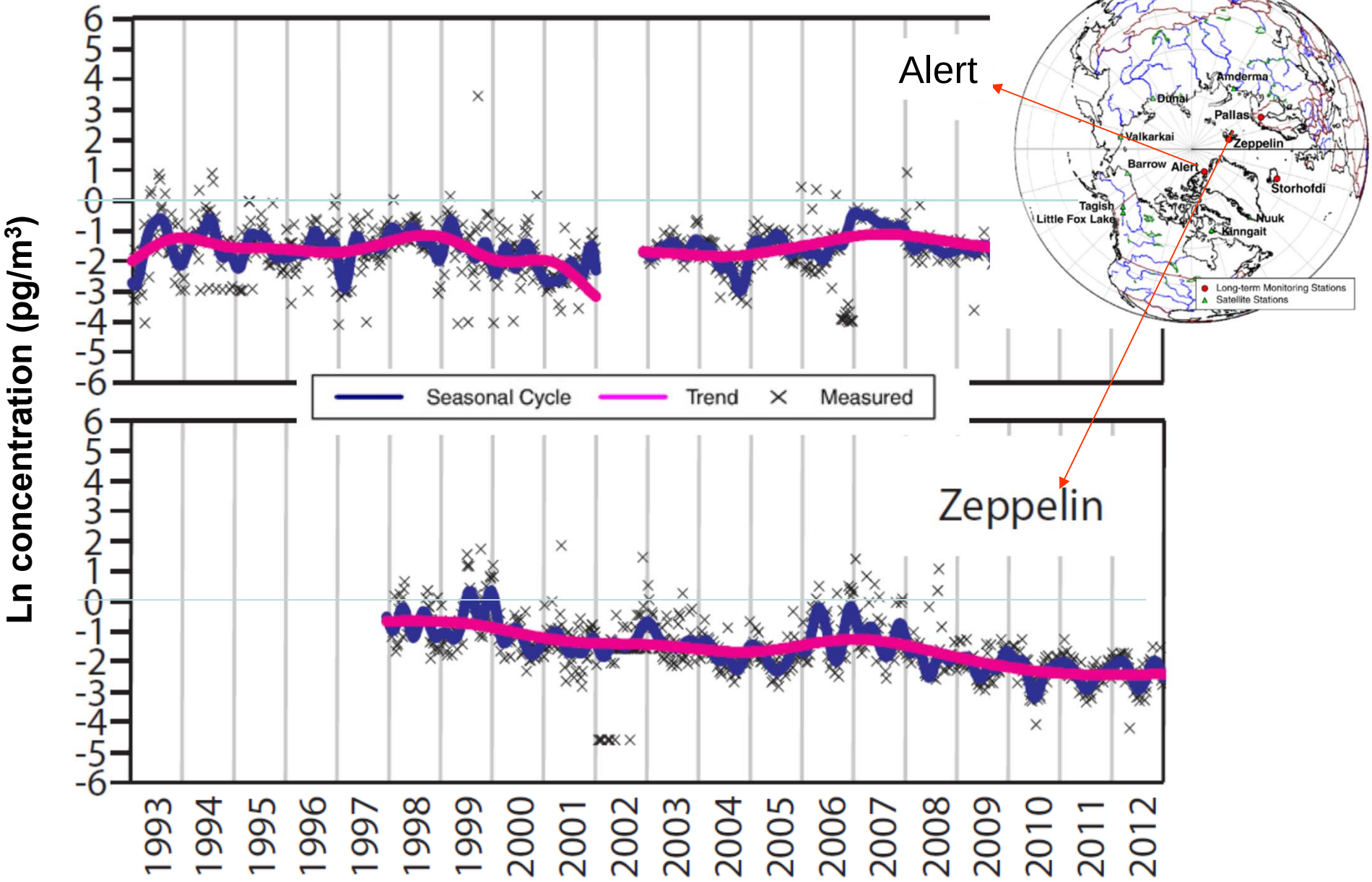
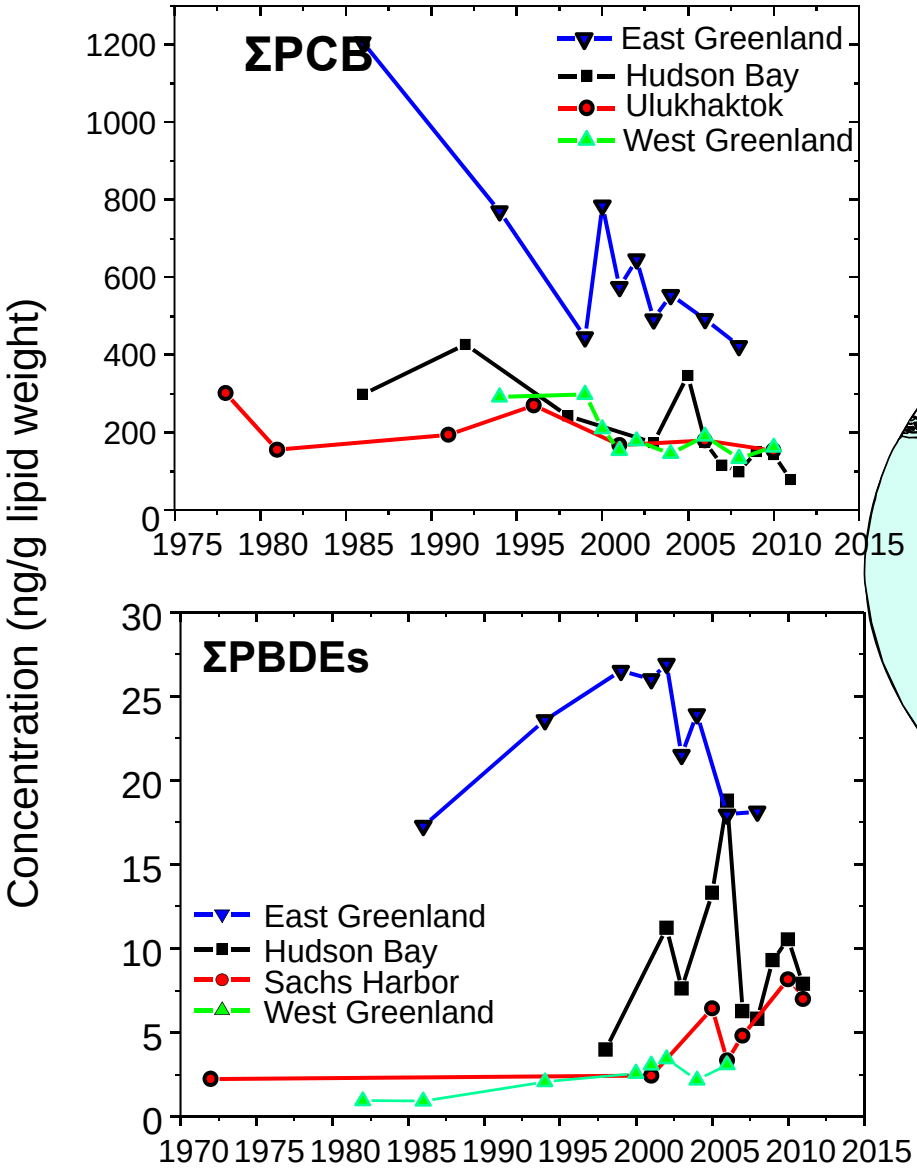
Long term trends of lindane (gamma-hexachlorocyclohexane) at Alert and Zeppelin (AMAP 2014)

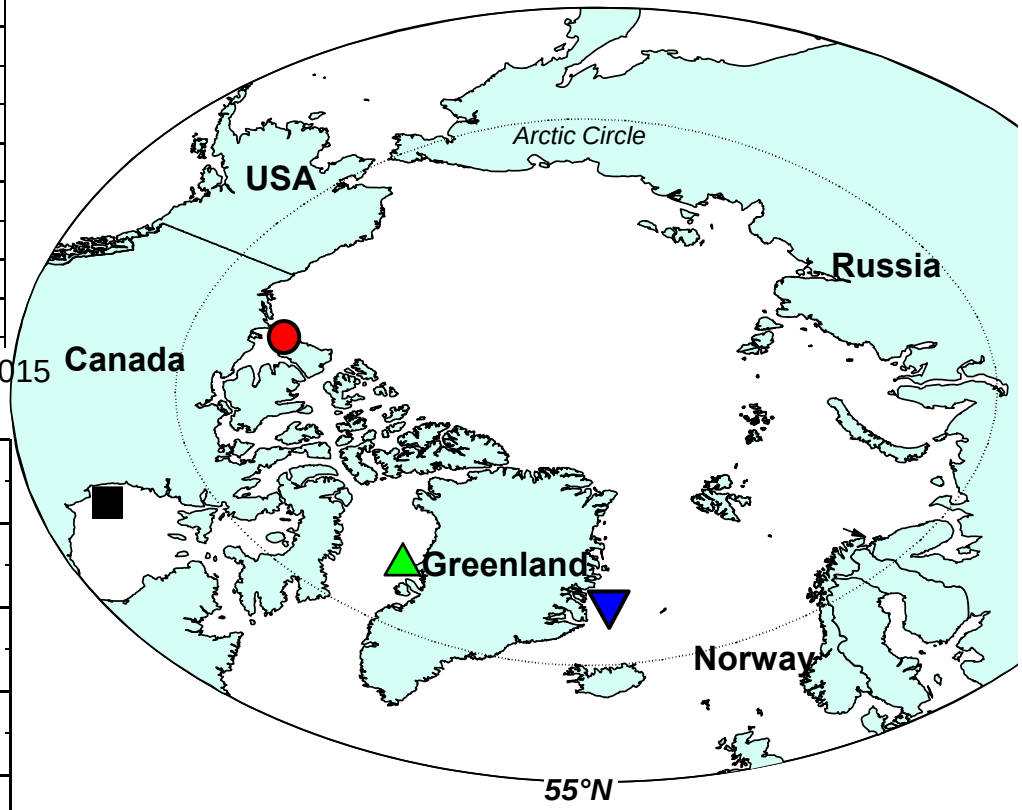


Trends of PCB 153 (hexachlorobiphenyl) at Alert and Zeppelin (AMAP 2014)



Temporal trends of PCBs and PBDEs in ringed seals from the Canadian arctic and Greenland (Vorkamp and Muir 2016)





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Fourth AMAP report - ”Chemicals of emerging concern”

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- **LRT via air and ocean currents**
- **Some have sources in Arctic communities**
  - **E.g. via sewage outfalls**
- **Some contaminants may not be “POPs”**
  - e.g. microplastics, pharmaceuticals
- **Currently in production – out in early 2017**

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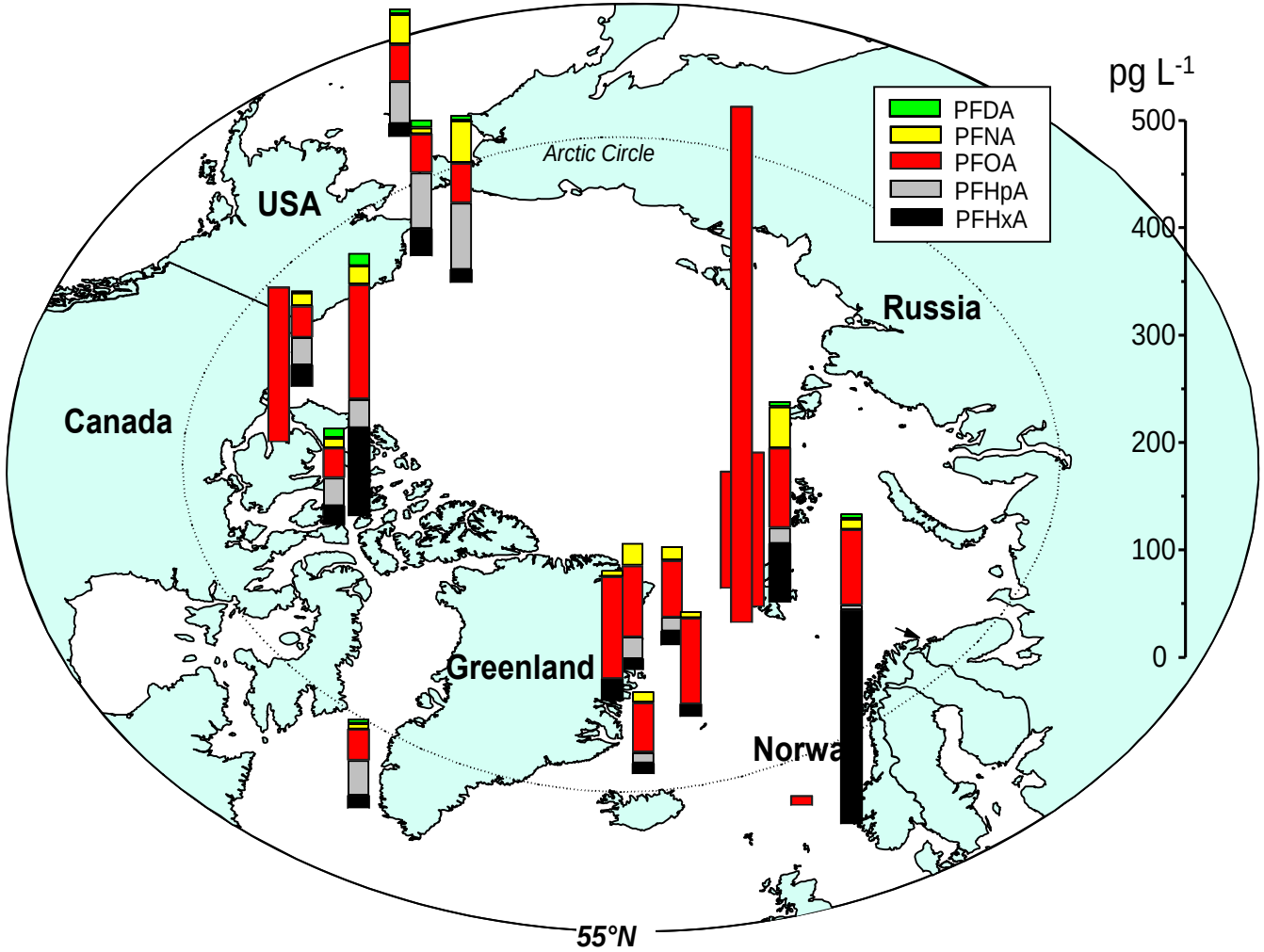
Perfluorinated carboxylic acids



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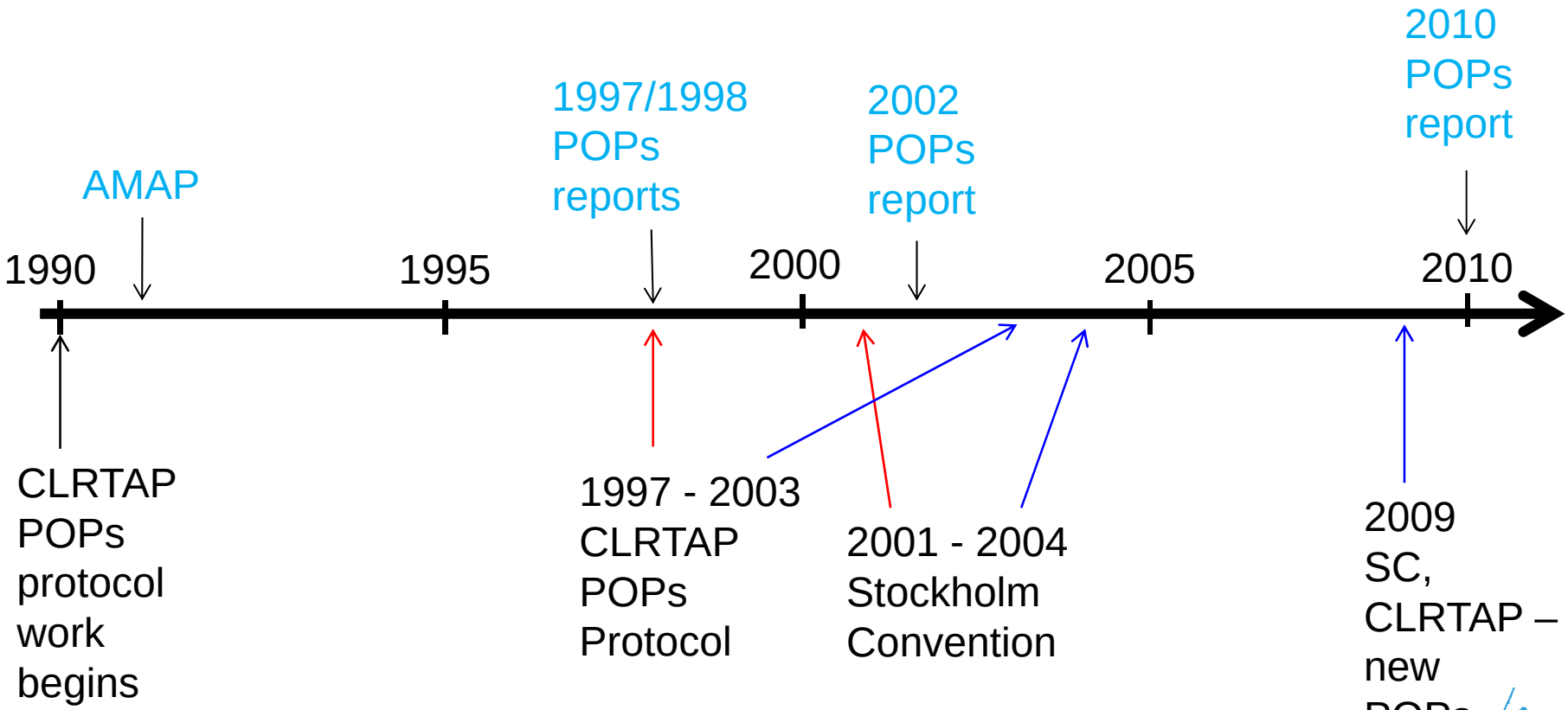
Timeframe for AMAP reports and Conventions



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Major challenges

- Large numbers of new chemicals
- Many have POP-like characteristics and potential to reach the Arctic
- Time lag to listing-regulation-declines in environment is long
- Listing on conventions is reactive
- How to be proactive?

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Questions?

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