

# Contaminants in Arctic human populations

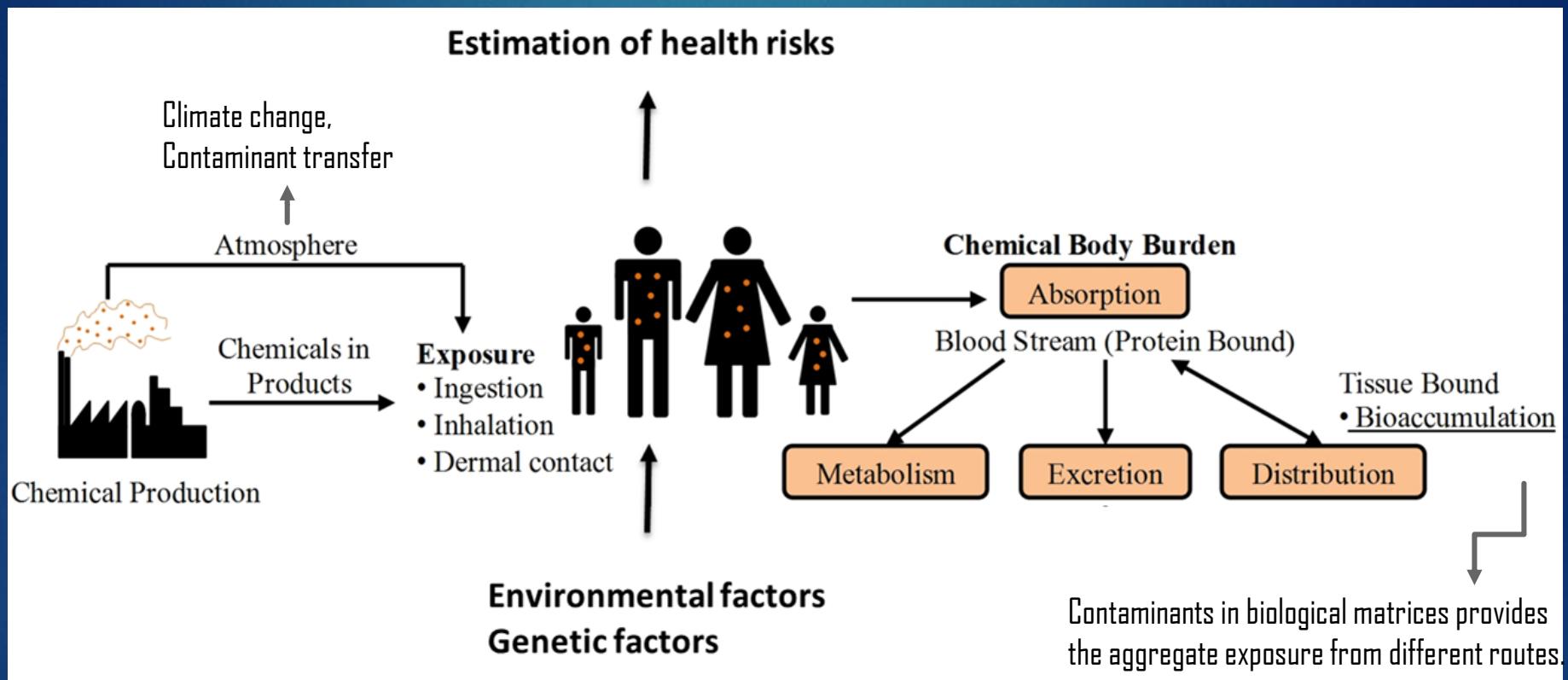
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# Outline

- Exposure and risks
- Contaminants in Arctic human populations
- Chemicals of emerging Arctic concern
- Contaminants and infectious diseases

# Contaminants - Exposure and risks



# Health outcomes reported in published Arctic cohort studies associated with exposure to contaminants

Health endpoint	Findings	Cohort
Cardiovascular system effects	Hg in cord blood associated with decreased heart rate variability in children at ages 7 and 14 years old	Faroe Islands
	Hg in child blood correlated with reduction of heart rate variability	Nunavik
	Hg was associated with elevated blood pressure among adults	Faroe Islands and Nunavik
Endocrine system effects	Prenatal exposure to high levels of PCBs associated with lower serum testosterone in boys	Faroe Islands
	Exposure to PCBs interferes with thyroid hormone homeostasis in adults	Hudson River (USA)
	The serum POPs have hormone disruptive potentials to ER, AR, and AhR	Greenland
Immune system effects	Serum PCB conc. at 7 years of age positively associated with total immunoglobulin E. conc.	Faroe Islands
	Parental exposure to OCs increases the susceptibility to infectious diseases	Nunavik
	OCs strongly, negatively affected serum antibody concentrations during developmental and perinatal exposure	Faroe Islands

# Health outcomes reported in published Arctic cohort studies associated with exposure to contaminants

<b>Health endpoint</b>	<b>Findings</b>	<b>Cohort</b>
<b>Nervous system effects</b>	Postnatal PCB exposure affects information processing at later stages.	Arctic Québec
	Parental MeHg exposure, up to the age of 22, decreased motor function, verbal ability, memory, and defects in general mental ability	Faroe Islands
	Parental exposure to Hg linked to, up to the age of 11, several neuro-developmental outcomes in children i.e. lower estimated IQ, poorer memory functions, increased risk of attention problems &ADHD behavior.	Nunavik
<b>Reproductive effects</b>	PCB153 strongly correlated with the level of SHB globulin.	Norway
	High PCB levels associated with low semen quality in men	Faroe Islands
	High levels of PFCs in blood were adversely associated with longer menstrual cycles	Greenland
<b>Skeletal system effects</b>	Prenatal exposure to OCs was associated with reduced gestation duration	Arctic Quebec
	Serum PFC levels were associated significantly with breast cancer risk	Greenland
<b>Skeletal system effects</b>	PCB105 and PCB118 inversely associated with the bone stiffness index	Eastern James Bay (Canada)

# BIOLOGICAL EFFECTS OF CONTAMINANTS ON ARCTIC WILDLIFE & FISH

Contaminant-mediated biological effects reported in Arctic wildlife and fish

- Hormone levels
- Immune function
- Oxidative stress
- Blood biochemistry
- Bone density
- Reproduction
- Vitamin status
- Enzyme activity
- DNA damage
- Tissue pathology
- Neurological and behavioral effects

Legacy chemicals and mercury continue to pose a significant concern for Arctic biota.

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## Temporal trends of contaminants in Arctic human populations

Khaled Abass<sup>1,2</sup> · Anastasia Emelyanova<sup>3</sup> · Arja Rautio<sup>1,3</sup>

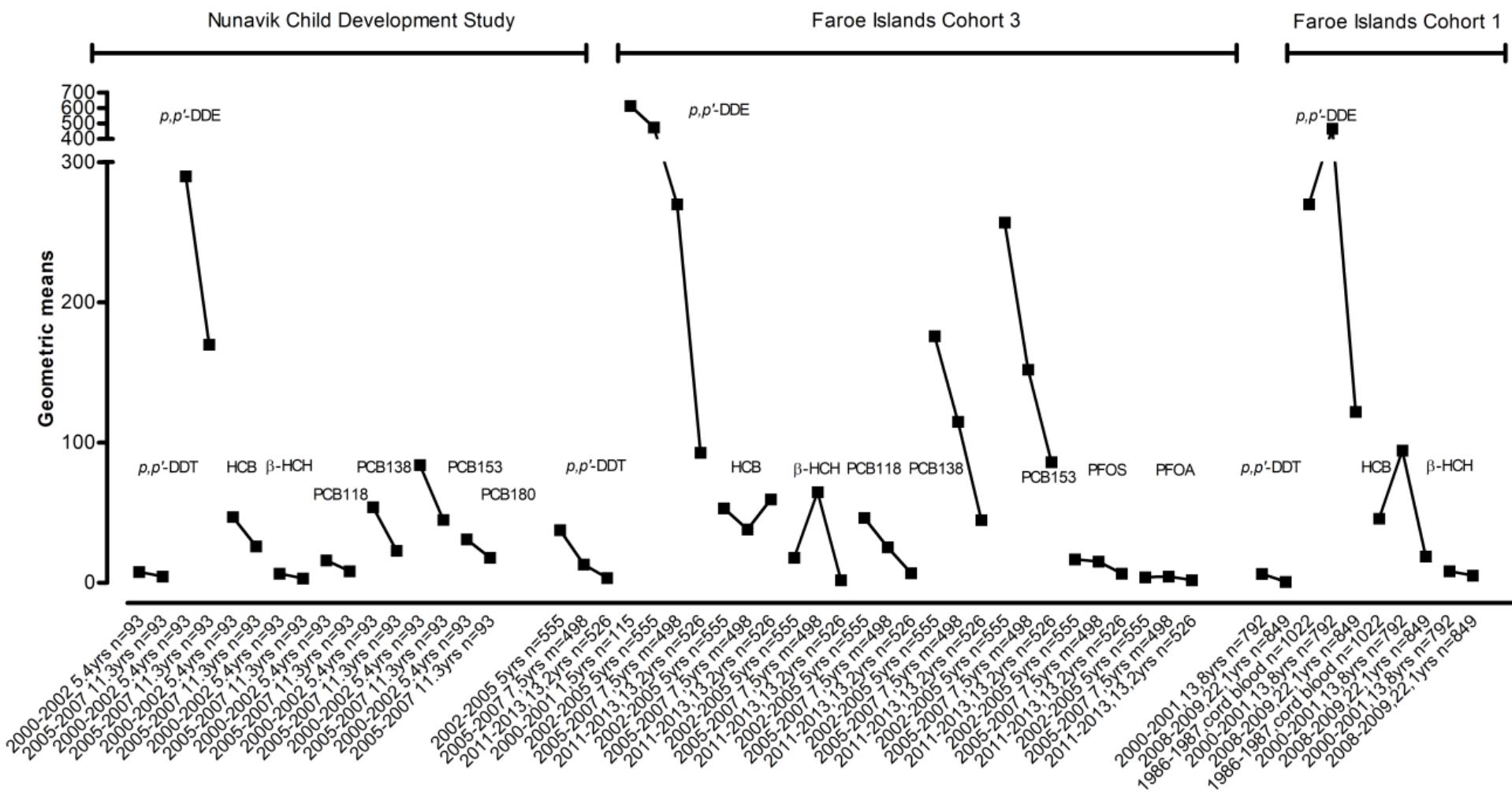
Received: 10 April 2018 / Accepted: 6 August 2018  
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### Abstract

The first Arctic Monitoring and Assessment Programme (AMAP) report was published in 1998 and followed by three assessment reports of human health (AMAP 2003, 2009 and 2015). The focus area of the AMAP reports was to monitor levels of environmental contaminants in the Arctic and to assess the health effects connected with detected levels in Arctic countries. This review gives an overview of temporal trends of contaminants and their health effects in humans of the Arctic based on data available in the AMAP reports. Previous significant literature contributions in the field of environmental health of the Arctic from

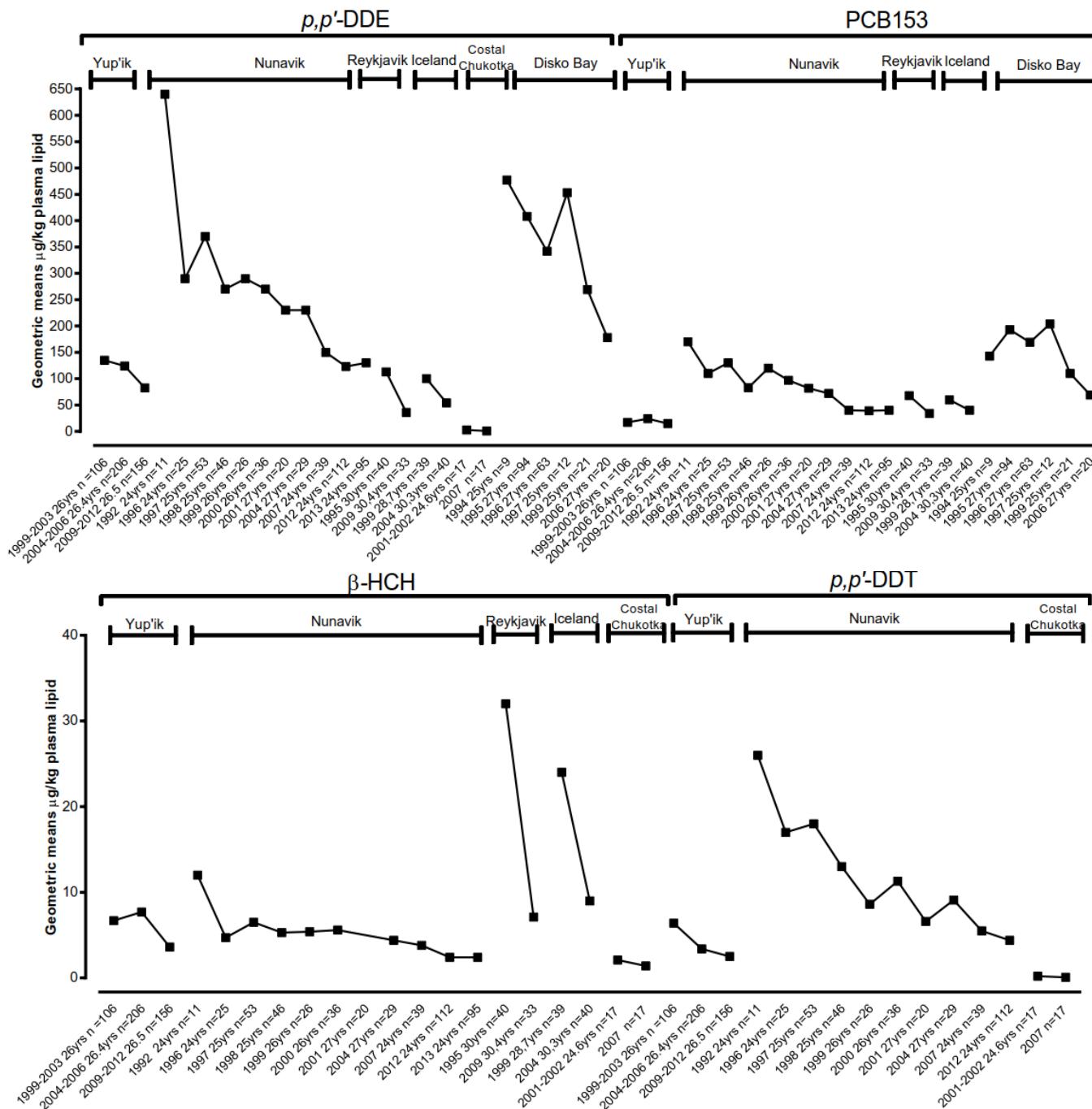
- To assess the stability
- To examine the impact of regulations
- To provide a firm basis for future levels of pollutants in Arctic human populations under climate and environmental changes

# Trends of POPs in children blood



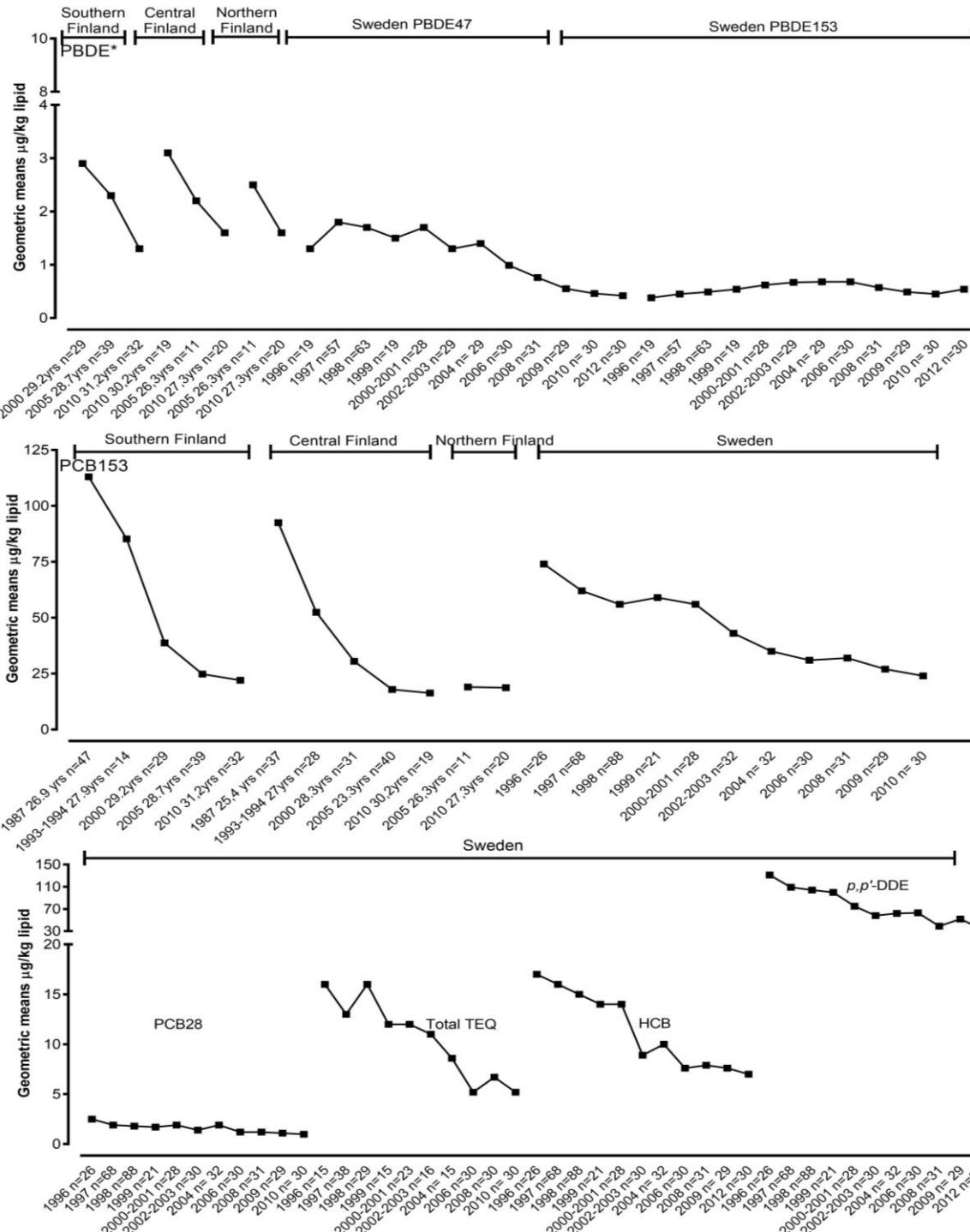
Trends of blood POPs concentrations from same children. Data presented as geometric means.  
POPs and OCs are in  $\mu\text{g}/\text{kg}$  plasma lipid.

# Trends of POPs in maternal blood



Data represented as geometric means ( $\mu\text{g}/\text{kg}$  plasma lipid) for specific locations and periods of time.

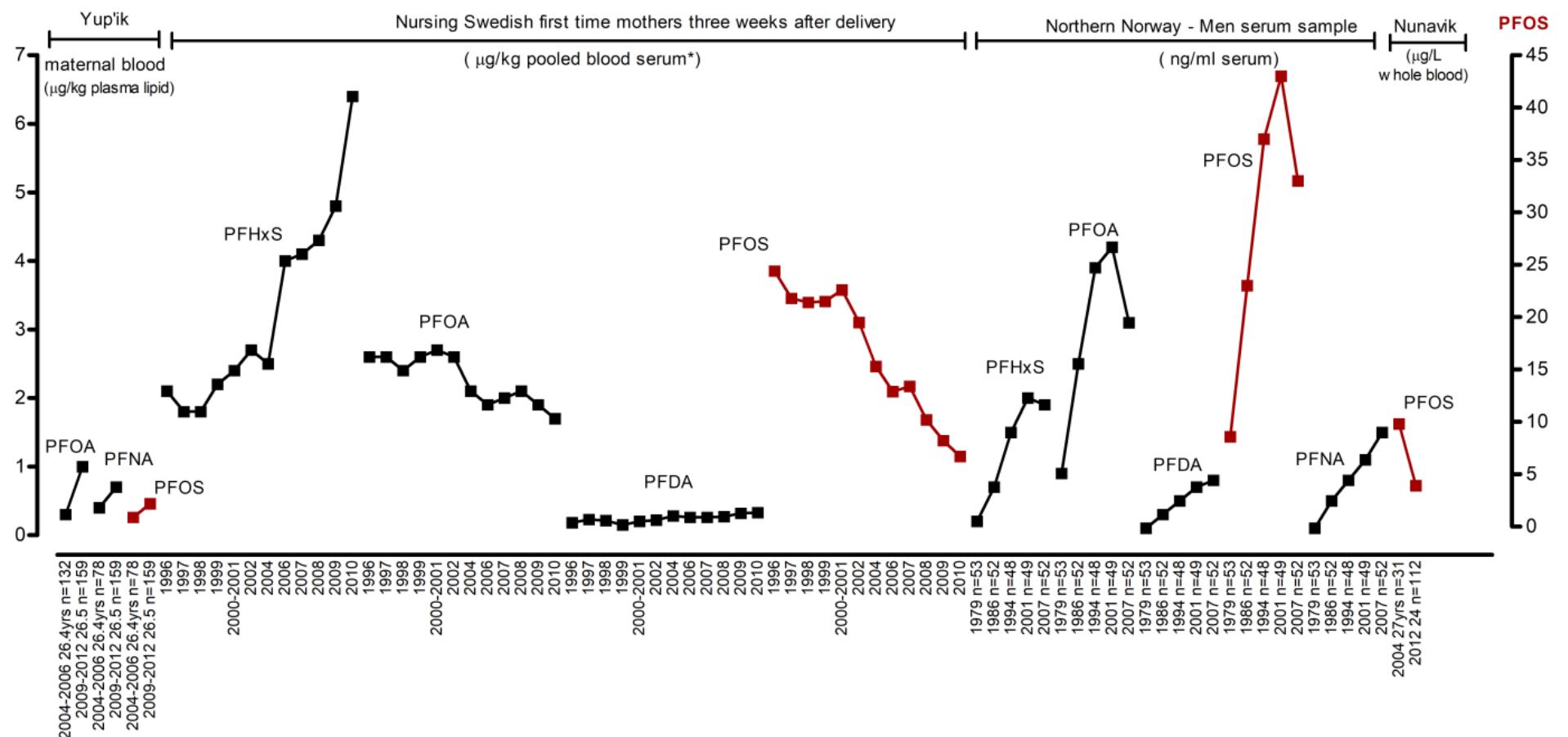
# Trends of POPs in breast milk samples



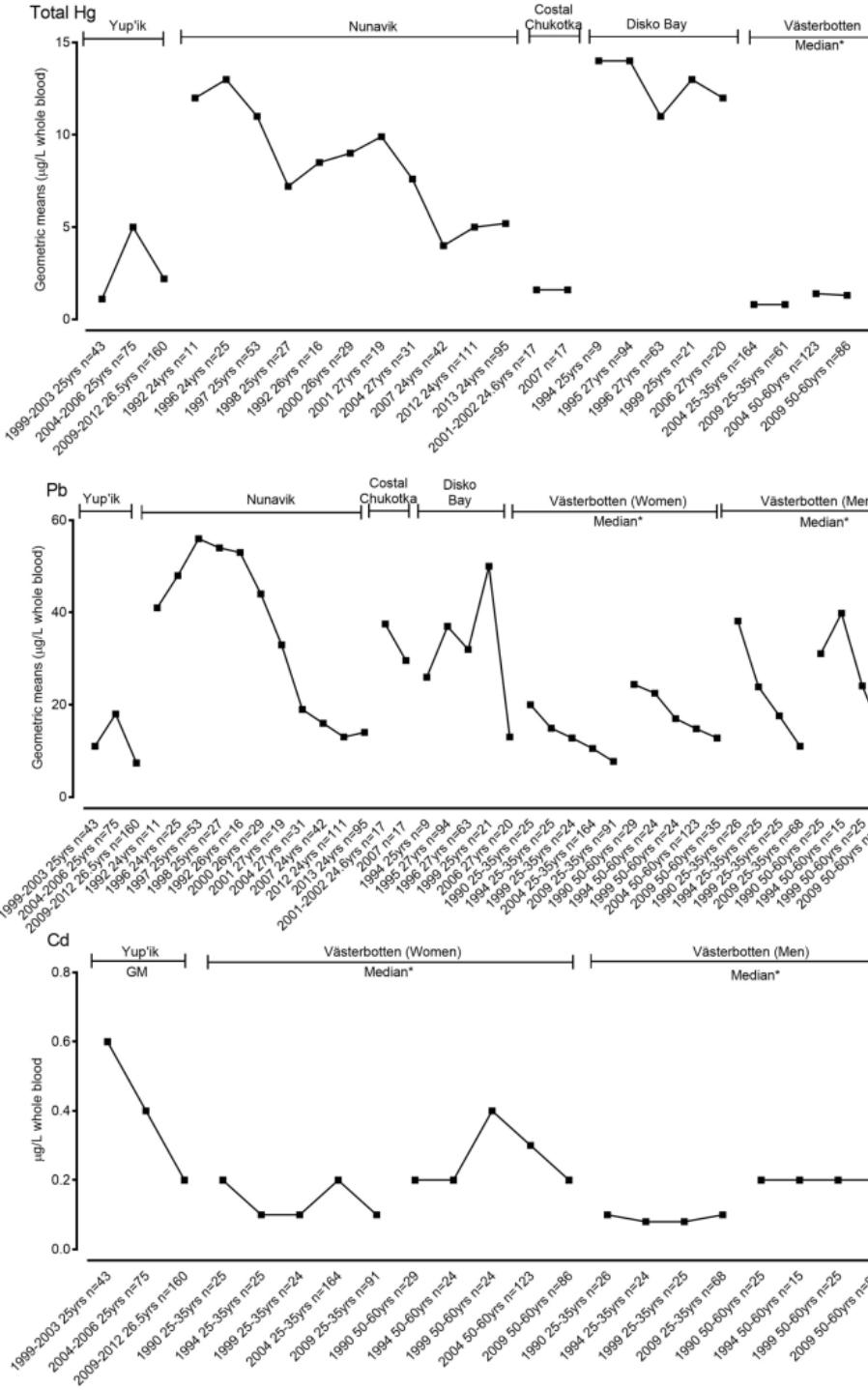
Data are represented for the specific period of sampling

PBDE in Finnish breast milk represented  
PBDE47+PBDE99+PBDE100+PBDE153+PBDE209. TEQ: dioxin toxic equivalents

# Trends of PFCs in human biological matrices



Trends of PFCs geometric means ( $\mu\text{g}/\text{kg}$  plasma lipid) in Yup'ik maternal blood; ( $\mu\text{g}/\text{kg}$  pooled blood serum) Swedish first-time mothers and ( $\mu\text{g}/\text{L}$  whole blood) in Nunavik maternal blood, and median ( $\text{ng}/\text{ml}$  serum) in men serum sample from Northern Norway.  
 PFOS perfluorooctane sulfonic acid; PFOA perfluooctanoic acid; PFDA Nonadecafluorodecanoic acid



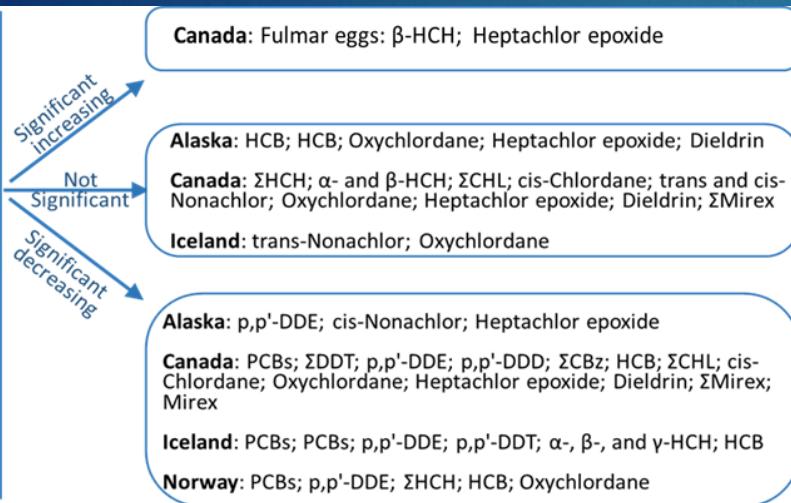
# Trends of THg, Pb, and Cd in Arctic human biological matrices

Geometric means ( $\mu\text{g/L}$  whole blood) in Yup'ik, Nunavik, coastal Chukotka and Disko Bay maternal blood and \*median ( $\mu\text{g/L}$  whole blood) in women and men from Västerbotten, Sweden.

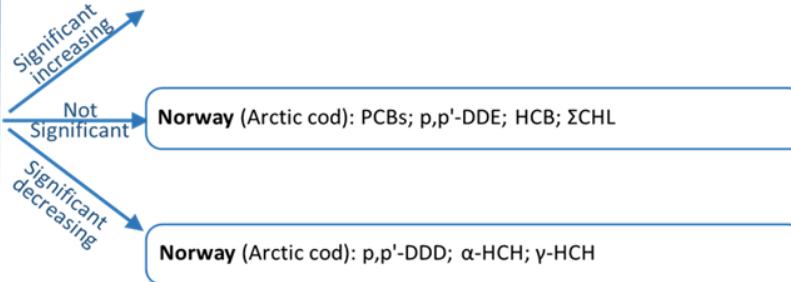
Data represented for the specific period of sampling

# Legacy POPs in Arctic Biota

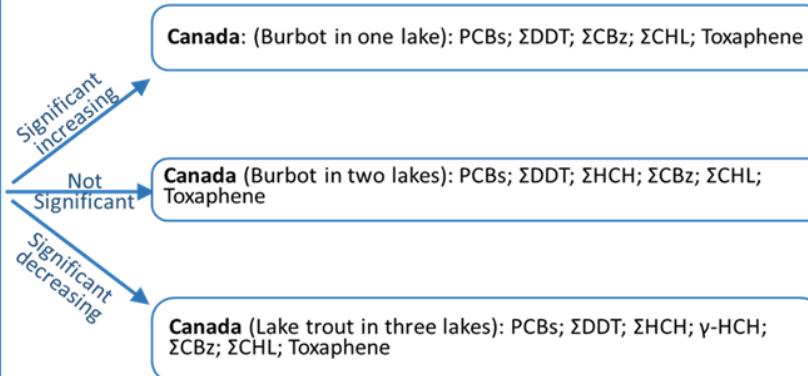
## MARINE BIRDS



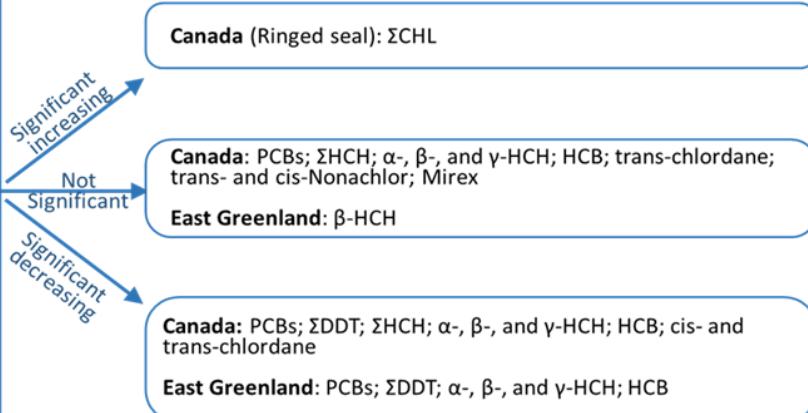
## MARINE FISH



## FRESH WATER FISH



## MARINE MAMMALS



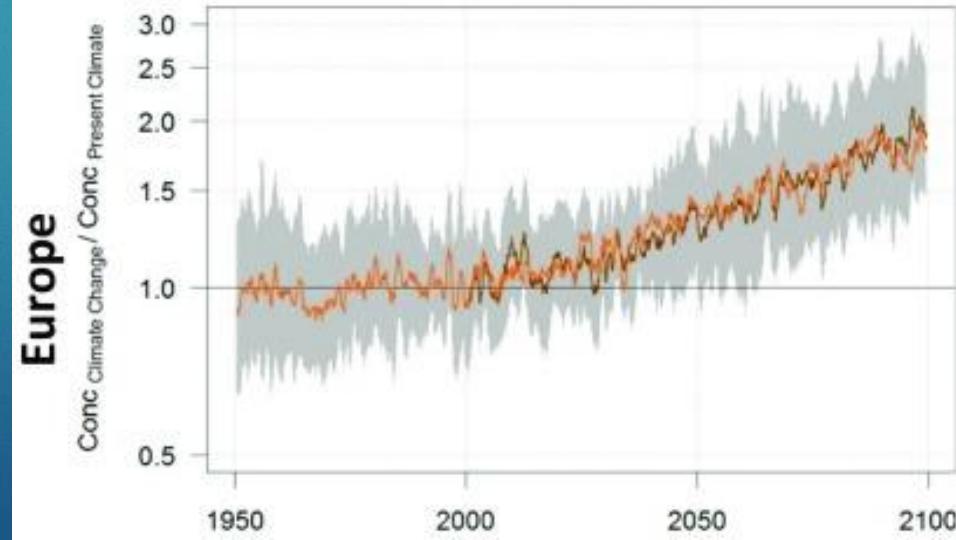
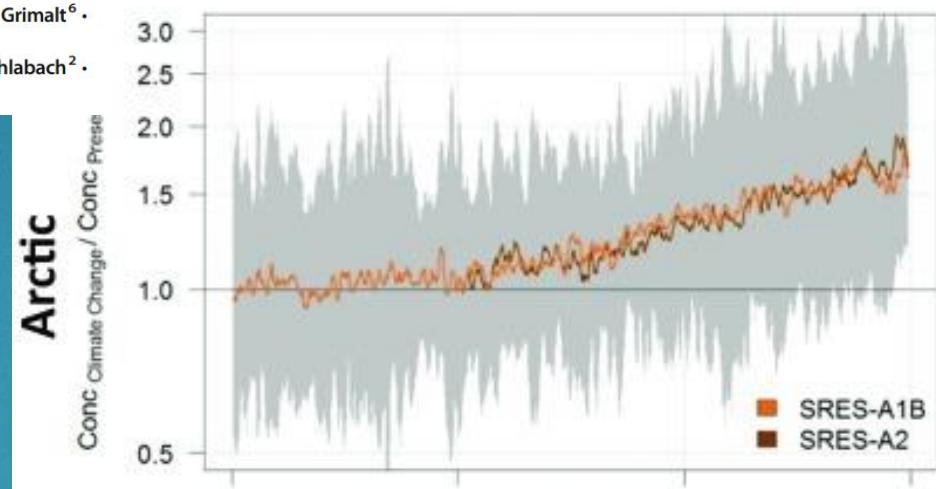
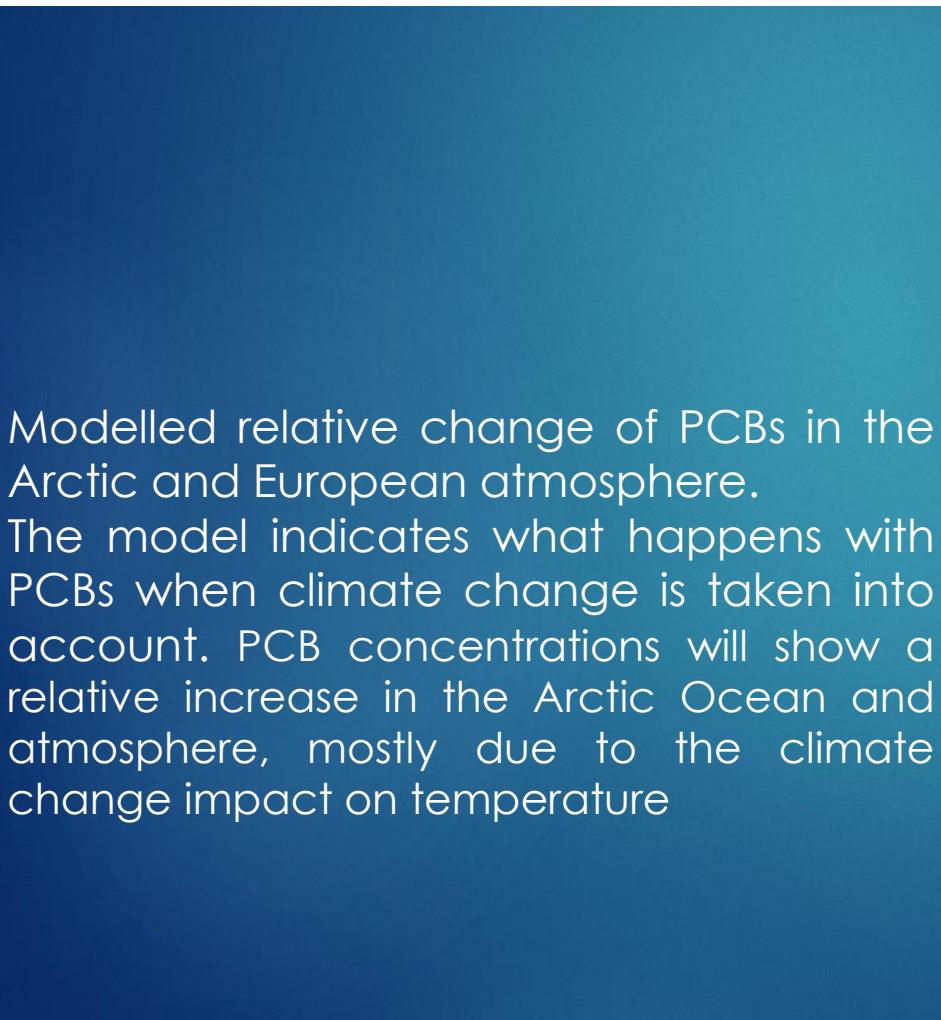
Different significances on trend data based on biota, location and contaminants.



PCB153

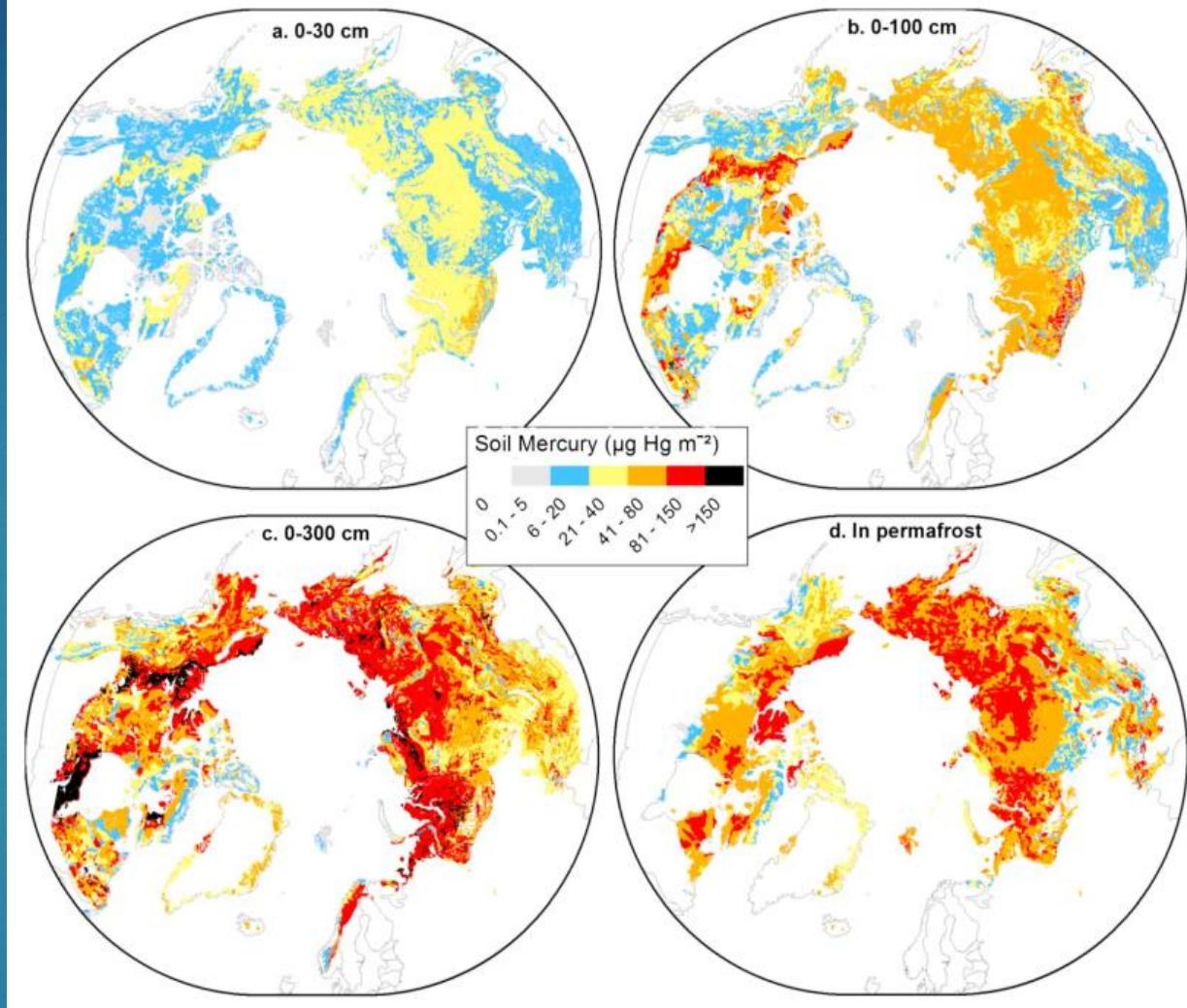
## Polychlorinated biphenyls (PCBs) as sentinels for the elucidation of Arctic environmental change processes: a comprehensive review combined with ArcRisk project results

Pernilla Carlsson<sup>1</sup> · Knut Breivik<sup>2</sup> · Eva Brorström-Lundén<sup>3</sup> · Ian Cousins<sup>4</sup> · Jesper Christensen<sup>5</sup> · Joan O. Grimalt<sup>6</sup> · Crispin Halsall<sup>7</sup> · Roland Kallenborn<sup>8,9</sup> · Khaled Abass<sup>10,11</sup> · Gerhard Lammel<sup>12,13</sup> · John Munthe<sup>3</sup> · Matthew MacLeod<sup>4</sup> · Jon Øyvind Odland<sup>14</sup> · Janet Pawlak<sup>15</sup> · Arja Rautio<sup>11</sup> · Lars-Otto Reiersen<sup>15</sup> · Martin Schlabach<sup>2</sup> · Irene Stemmler<sup>12,16</sup> · Simon Wilson<sup>15</sup> · Henry Wöhrnschimmel<sup>17,18</sup>



Maps of Hg ( $\mu\text{g Hg m}^{-2}$ ) in Northern Hemisphere permafrost zones for four soil layers and permafrost derived by multiplying maps of carbon from Hugelius et al. (2014) by the median RHgC (Hg to carbon ratio). The relative uncertainty is 57% for all pixels.

(Schuster et al. 2018 Geophysical Research Letter)



Permafrost thaw has major implications for the global mercury cycle. The results of the recent study finds that more than 15 million gallons of mercury is frozen in permafrost in the Northern hemisphere—it is roughly 10 times the amount of global mercury emissions over the last 30 years



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- Contaminants and infectious diseases

# Chemicals of emerging Arctic concern

## AMAP Assessment 2016: Chemicals of Emerging Arctic Concern

Arctic Monitoring and Assessment Programme (AMAP)

- Current-use pesticides
- Per- and polyfluoroalkyl substances
- Brominated flame retardants
- Chlorinated flame retardants
- Organophosphate-based flame retardants and plasticizers
- Siloxanes
- Pharmaceuticals and personal care products
- Polychlorinated naphthalenes
- Hexachlorobutadiene
- Pentachlorophenol (PCP) and pentachloroanisole
- Organotins
- Polycyclic aromatic hydrocarbons
- ‘New’ unintentionally generated PCBs
- Halogenated natural products
- Marine plastics and microplastics

# Chemicals of emerging Arctic concern

## AMAP Assessment 2016: Chemicals of Emerging Arctic Concern

### 2.11 Current-use pesticides (CUPs)

AUTHORS: JENNIFER BALMER, ADAM MORRIS, DEREK MUIR

CONTRIBUTORS: HAYLEY HUNG, LIISA JANTUNEN, FRANK RIGÉT, KATRIN VORKAMP

Still approved to use in USA, Canada and Europe

Table 2.63 Summary of Arctic media for which CUP data have been previously (+) and newly (x) reported.

Common name	Air		Terrestrial		Freshwater			Marine		
	Air	Snow	Soil	Biota	Water	Sediment	Biota	Water	Sediment	Biota
Chlorothalonil	+,x	+		x	+				+,x	
Chlorpyrifos	+,x	+		x	+		+	+,x		+
Dacthal	+,x	+		+,x	+	+	+	+,x		+,x
Diazinon		+			+					
Dicofol		+,x						+,x		
Endosulfan	+,x	+		+,x	+		+	+,x	x	+,x
MCPA		x								
Methoxychlor	+	+		+	+		+	x		+
Metribuzin		x								
Pendimethalin		x								
Pentachloro-nitrobenzene (PCNB)	x	+,x		x	+			x		x
Phosalone		x								
Quizalofop ethyl		x								
Tefluthrin		x								
Triallate		x								
Trifluralin	+,x	+			+	+	+,x	x		

CUPs are only licensed for use if they do not persist in the environment and have low bioaccumulation and short range transport potential

# Chemicals of emerging Arctic concern

## Current Use Pesticides

Toxicology 294 (2012) 17–26

Contents lists available at SciVerse ScienceDirect



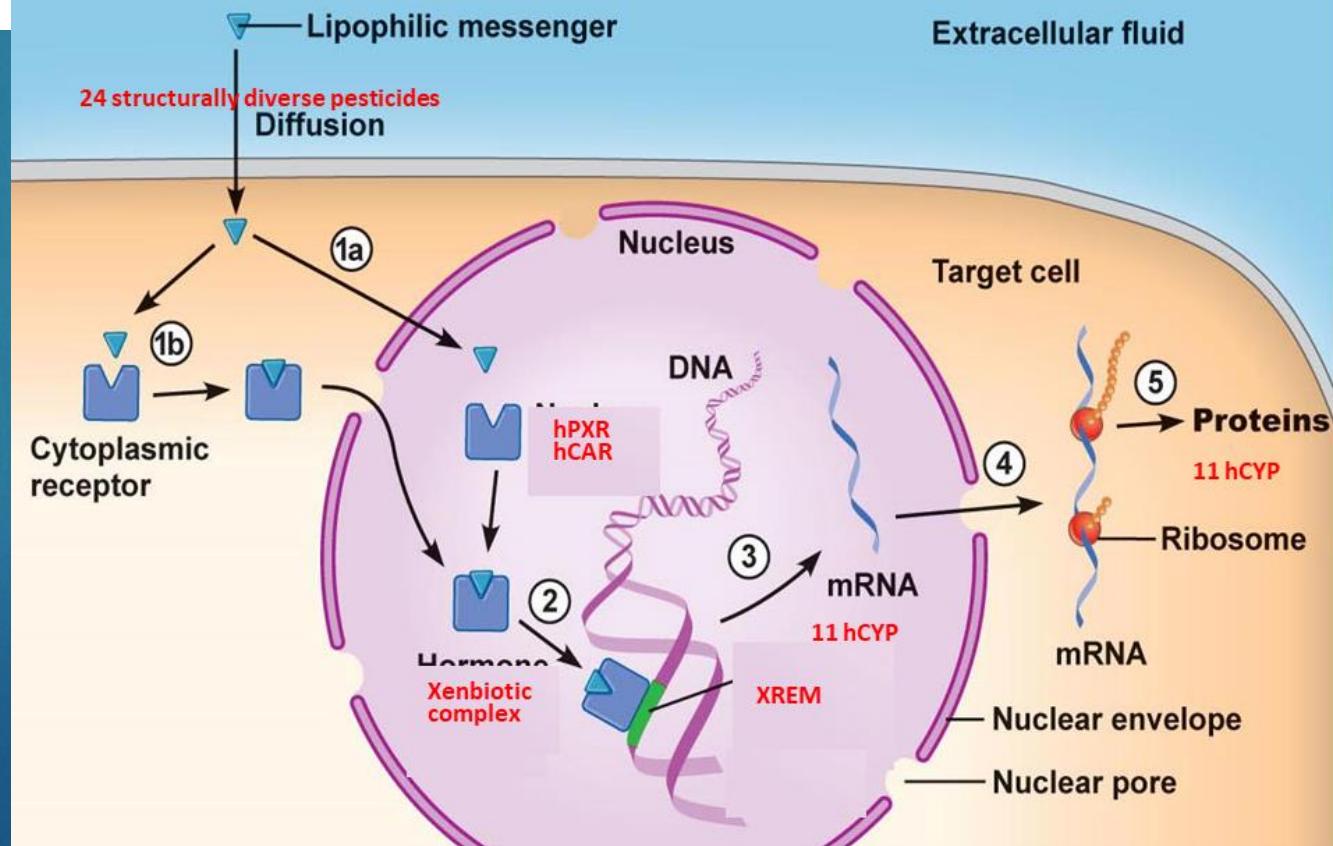
Toxicology

journal homepage: [www.elsevier.com/locate/toxcol](http://www.elsevier.com/locate/toxcol)



### Characterization of human cytochrome P450 induction by pesticides

Khaled Abass<sup>a,b,1</sup>, Virpi Lämsä<sup>a</sup>, Petri Reponen<sup>a,c</sup>, Jenni Kühlbeck<sup>d</sup>, Paavo Honkakoski<sup>d</sup>, Sampo Mattila<sup>c</sup>, Olavi Pelkonen<sup>a</sup>, Jukka Hakkola<sup>a,\*</sup>



CYPs are important in the metabolism of wide range of endogenous substrates as well as a wide range of xenobiotics.

# Chemicals of emerging Arctic concern

## Current Use Pesticides

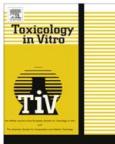
Toxicology in Vitro 27 (2013) 1584–1588

Contents lists available at SciVerse ScienceDirect

Toxicology in Vitro

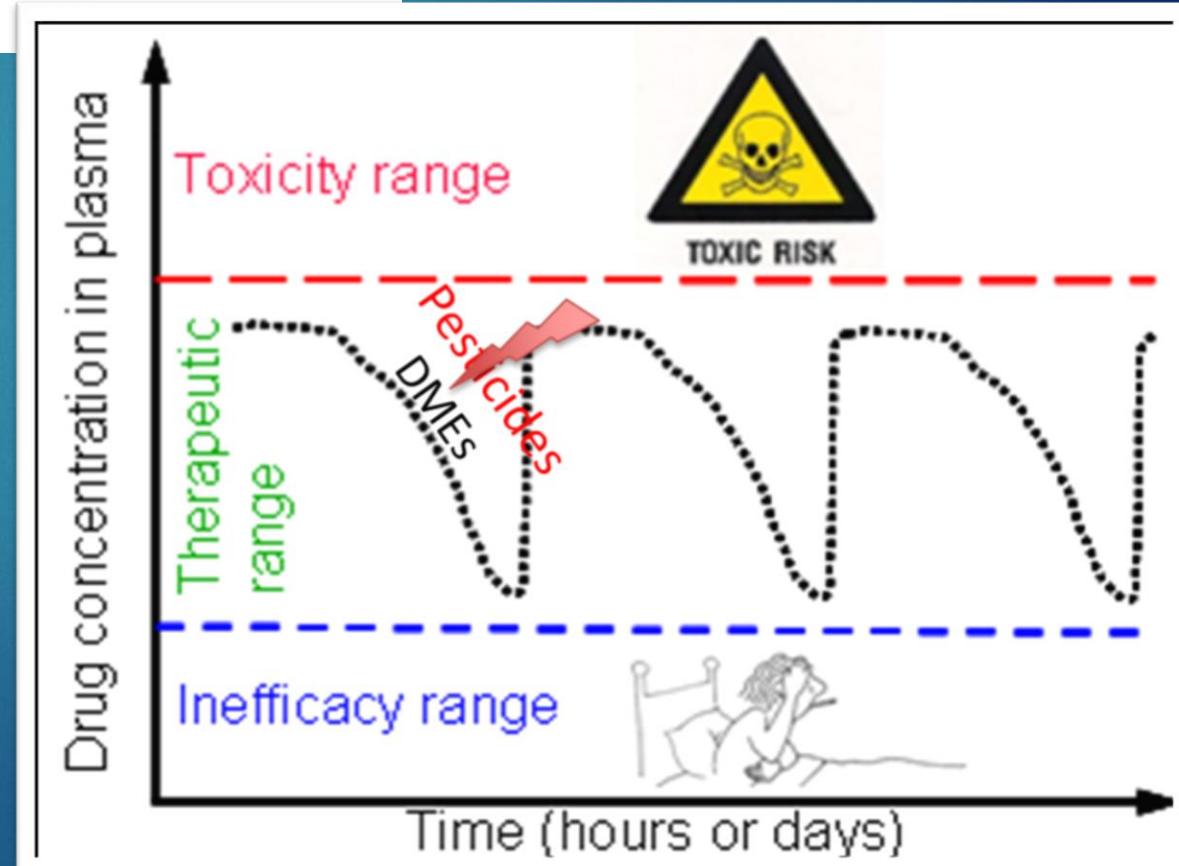


journal homepage: [www.elsevier.com/locate/toxinvit](http://www.elsevier.com/locate/toxinvit)



The inhibition of major human hepatic cytochrome P450 enzymes by 18 pesticides:  
Comparison of the N-in-one and single substrate approaches

Khaled Abass <sup>a,b,\*1</sup>, Olavi Pelkonen <sup>a</sup>



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# Is there a link between pollutant exposure and emerging infectious disease?

A scoping literature review found evidence supporting the hypothesis that a population's pollution status could help refine classification of emerging infectious disease hotspots

(Hodges and Tomcej Can Vet J v.57(5); 2016)

Health endpoint	Findings	Cohort
Immune system effects	Serum PCB conc. at 7 years of age positively associated with total immunoglobulin E. conc.	Faroe Islands
	Parental exposure to OCs weaken the immune system and increases the susceptibility to infectious diseases	Nunavik
	OCs strongly, negatively affected serum antibody concentrations during developmental and perinatal exposure	Faroe Islands

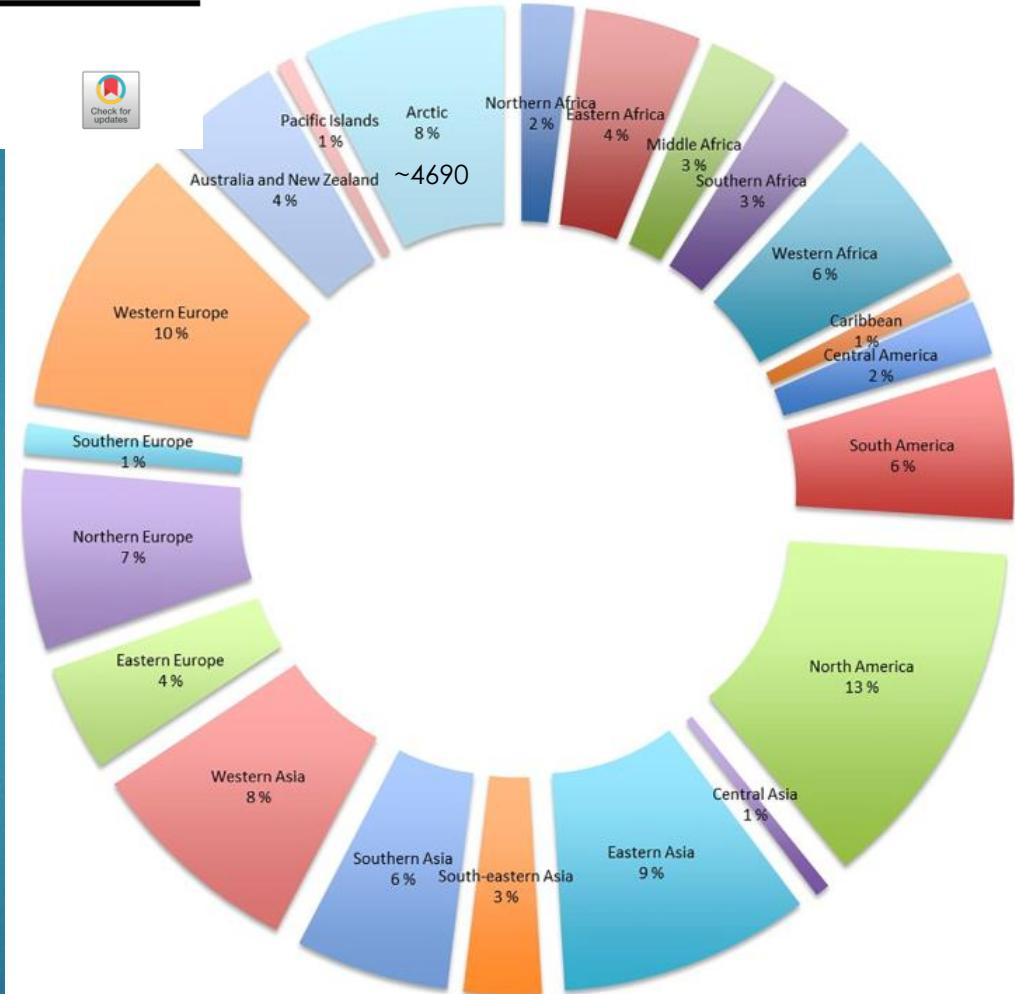


Review article

## Human infectious diseases and the changing climate in the Arctic

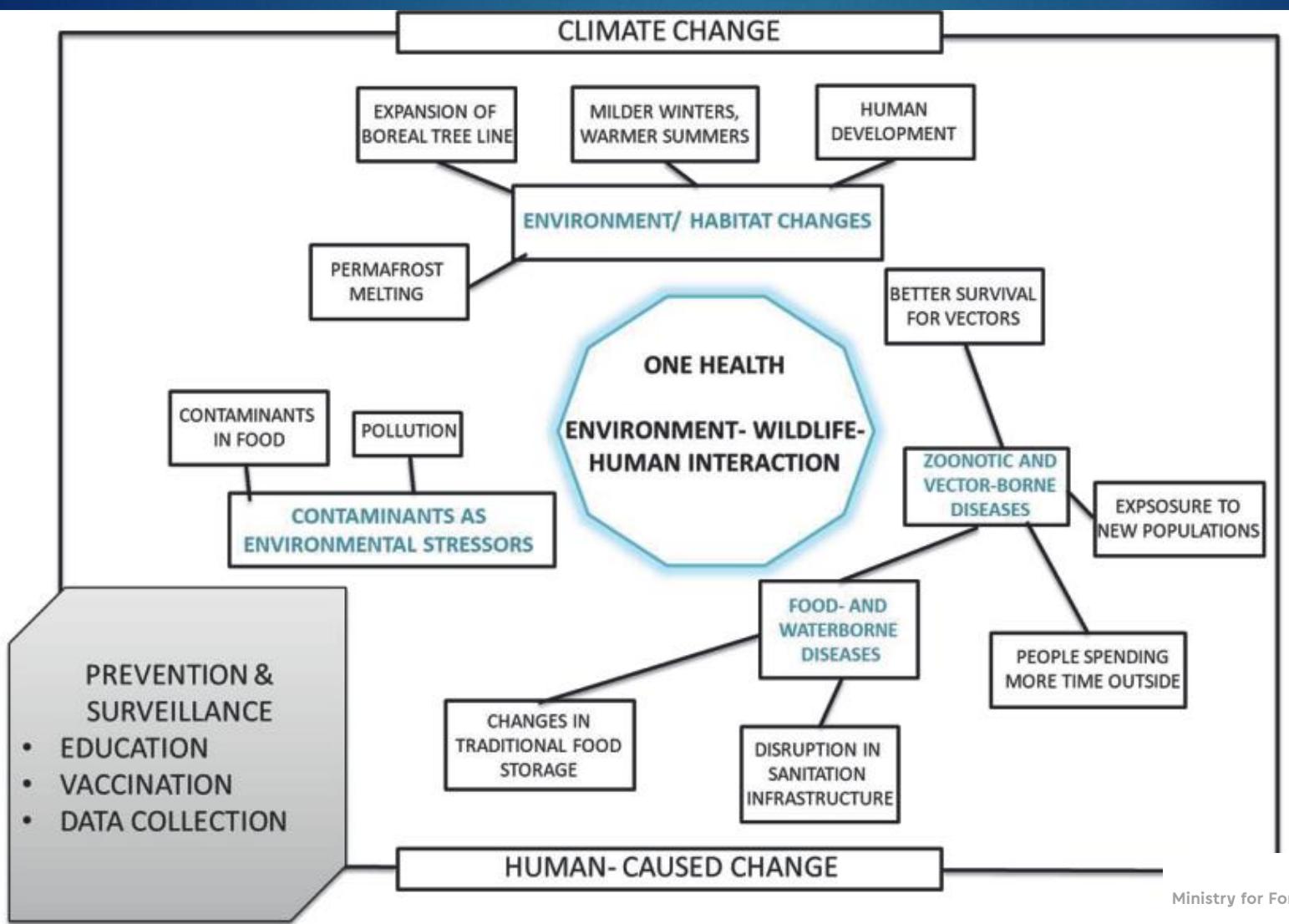
Audrey Waits<sup>a</sup>, Anastasia Emelyanova<sup>b</sup>, Antti Oksanen<sup>c</sup>, Khaled Abass<sup>a,\*</sup>, Arja Rautio<sup>a,b</sup>

Total of 58, 563 PubMed search results



Percentages of PubMed results from searches about climatic factors and infectious diseases by region. 8% of the research done in this field is from the Arctic. The study revealed a positive trend in the number of publications. Tick-borne diseases, tularemia, anthrax, and vibriosis were the most diseases likely to be impacted by climatic factors in the Arctic.

# Holistic integration of human health risks



Ministry for Foreign



Affairs of Finland

# Conclusion

- Contaminants in human biological matrices showed declining trends in most of the monitored Arctic locations, with the exception of oxychlordane, HCB, PBDE153 and PFCs.
- Strengthened collaborations between research scientists, indigenous communities and knowledge holders to facilitate a broader understanding of factors impacting human health in a rapidly changing Arctic.

Arja Rautio, Olavi Pelkonen, Päivi Myllynen, Pentti Nieminen, Antti Huusko, Jukka Hakkola, Audrey Waits, Anastasia Emelyanova, Antti Oksanen, Marjo-Riitta Järvelin...



H2020; Permafrost thaw and the changing Arctic coast (2017-2022)



H2020: Metabolic effects of endocrine disrupting chemicals (2019-2024)



Ympäristöministeriö  
Miljöministeriet  
Ministry of the Environment

Environmental and human exposure to mercury in the Arctic (2019-2021)



Ministry for Foreign



Affairs of Finland

One Arctic – One Health  
(No. HEL7M0674-65) (2017-2019)



FP7; Arctic Health Risk (2009-2013)