

Chemical Substance Monitoring to support the Stockholm and the Minamata Conventions

Yasuyuki SHIBATA

- Global Coordination Group (GCG) and Regional Organization Group (ROG) in Asia / Pacific under the Stockholm Convention
- Vice Director, Environmental Safety Center, Tokyo University of Science
- Visiting Researcher, NIES, Japan



Modern society is supported by a variety of chemicals



PBDE

HBCD

DialkylPhthalates

PFOS, PFOA etc.

UV328

Triclosan

<Additives>

- Flame retardants
- Plasticizers
- Surfactants
- UV absorbers
- Antimicrobials

Pharmaceuticals/
Agrochemicals

Industrial
Chemicals

Plastic wares

Pharmaceuticals
(humans, pets, livestock)
Insecticides/Herbicides
Antimicrobials etc.

PCB

PCN

Carbamazepin

DDT

Chlordane

Neonicotinoids

<Polymers>

PE, PP, PC, PVC

PI, PET, Teflon, etc.

<Monomers>

BPA

VC monomer



Chemical management system is a key to make a safer, more advanced and sustainable society

<Japanese system>

- 1) Chemical Substance Control Law (CSCL: *Kashin-ho* in Japanese)
 - * check risks of newly produced/imported chemicals before use
 - * design - Class
- 2) Law con (PRTR)
* volunt
organiss

Role of Environmental Monitoring

- * ***To identify chemicals of concern***
- * ***To assess risks of selected chemicals***
- * ***To evaluate effectiveness of actions***

Environmental Monitoring (*Kurohon* in Japanese)

- | | |
|----------------------------------|--------------------------------|
| 1) Initial environmental survey | priority pollutants under PRTR |
| 2) Detailed environmental survey | risk assessment under CSCL |
| 3) Environmental monitoring | POPs monitoring |



Selected chemicals / elements of concern

Industrial / commercial *Unintentional* *Agrochemicals / pharmaceuticals*

PCBs CBz

PCNs

PFOS/PFASs

PBDEs, HBCD

Dechlorane plus

OPs

Phthalate esters

BPA

Alkyl phenols

AP ethoxylates

Sun-screens

Musks, LAS

Sweeteners

Organosilicons

Dioxane, TrCE, TeCE, Oils, etc.

Inorganics (metals (Hg, Pb, As, Cd, etc.)

perchlorate, acids/bases, etc.

Nano-materials, microplastics

PCDD/Fs

HCBD

(PCBs)

(CBz)

(PCNs)

PBDD/Fs

(mixed DD/Fs)

PAHs

Nitro-PAHs

Chloro-PAHs

Amino-PAHs

(COD/BOD)

POPs

OCPs

(DDTs, Chlors

Drins, Mirex, PCP

Toxaphene, HCHs

Endosulfans etc)

OPPp

Carbamates

Neonicotinoids

Pyrethroids

DEETs

Triclosan

Pharmaceuticals

*for humans

*for livestock/pets

Pills

Organotins (TBT etc)



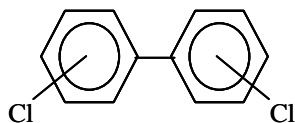
POPs: Persistent Organic Pollutants

(PTS: Persistent Toxic Substances)

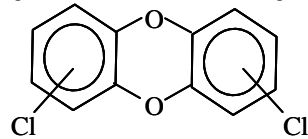
(PBT: Persistent Bioaccumulative Toxicants)

- (1) Chemically / biologically stable
- (2) Accumulated through food web
- (3) Toxicity against humans / ecosystems
- (4) Long range transport potential

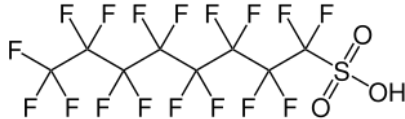
PCB



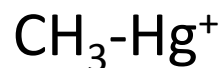
Dioxins



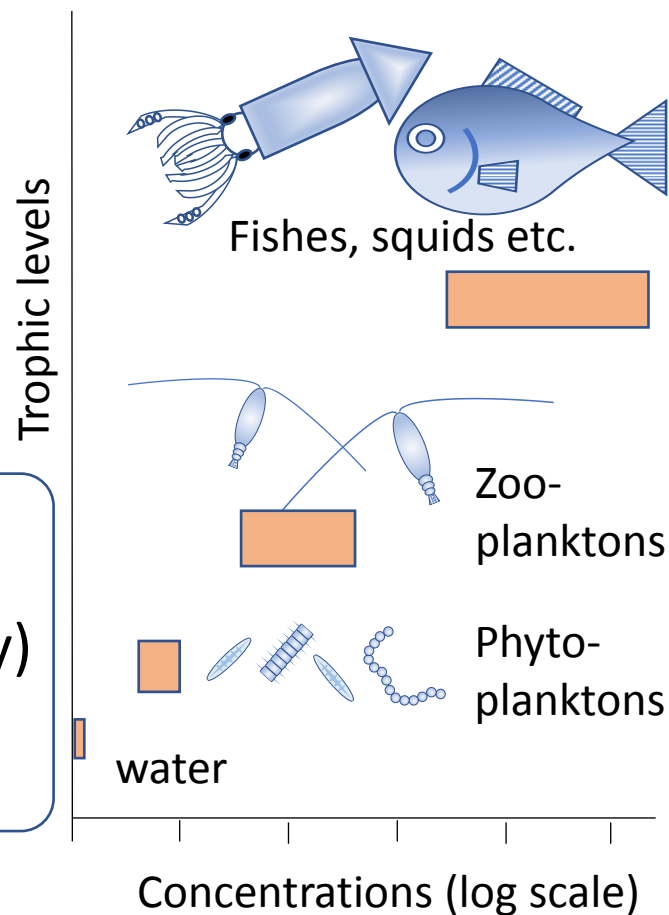
PFOS



Mercury
(Methyl mercury)



*Minamata
Convention*



Stockholm Convention



Stockholm Convention

2001 Ratified

2004 Entry into force

2005 1st COP

POPs (Persistent Organic Pollutants):

12 (2001) => 30 (2020)

Article 16

Effectiveness Evaluation

Minamata Convention

2013 Ratified

2017 Entry into force

2018 1st COP

Mercury and mercury-containing chemicals

Article 22

Effectiveness Evaluation

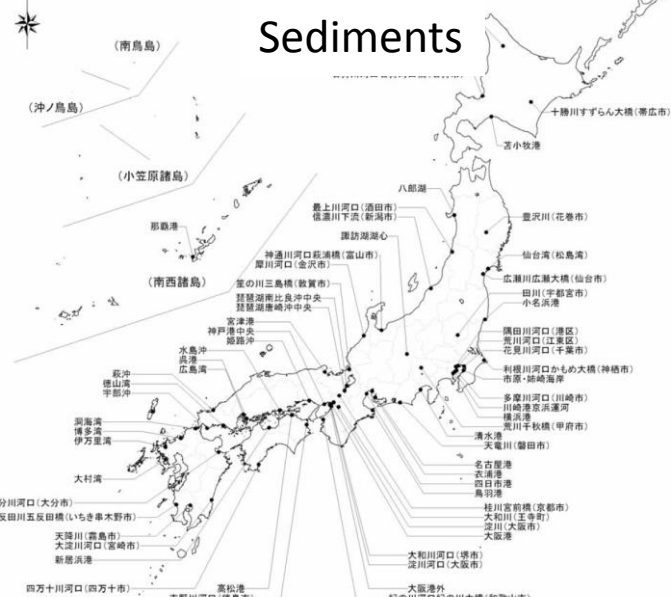
Effectiveness of the Conventions are to be evaluated based on environmental monitoring data



Environmental Monitoring by Ministry of the Environment, Japan

“Chemicals in the Environment”

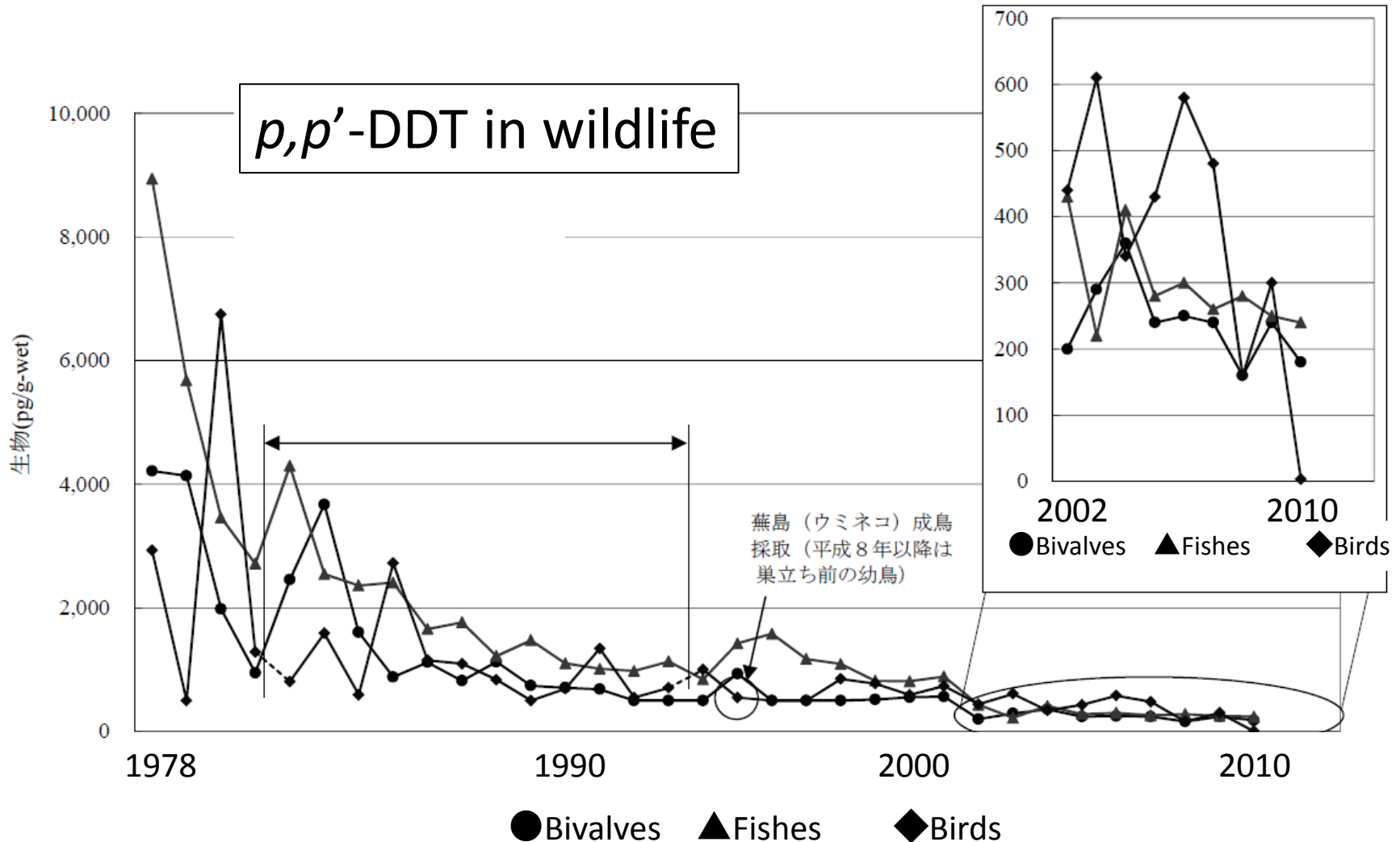
<http://www.env.go.jp/chemi/kurohon/>



Ministry of the Environment



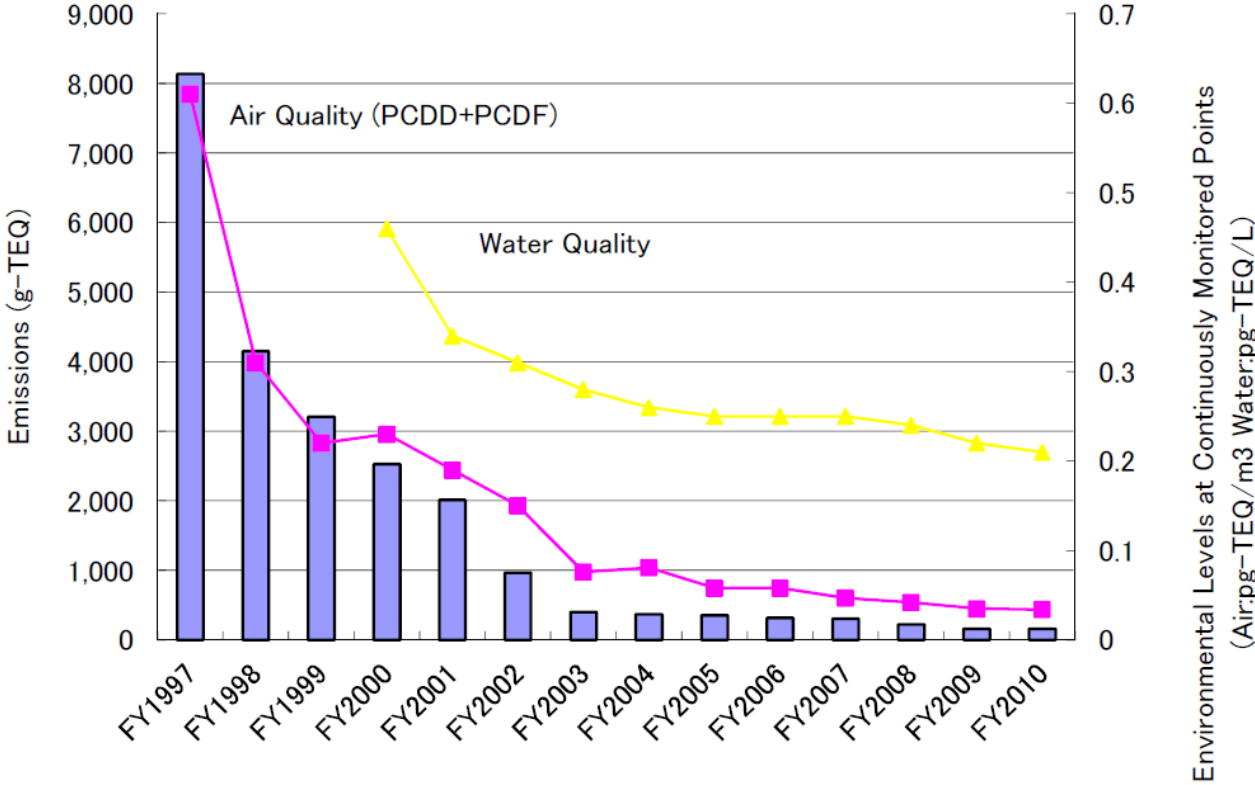
Long history of POPs monitoring by MOE, Japan



Ministry of the Environment



Dioxin monitoring by MOE, Japan



Temporal trends of dioxin emissions and air / water levels in Japan

Ministry of the Environment



NIES monitoring activity: Perfluorochemicals pollution

<POPs/POPs candidate under the Stockholm Convention>

PFOS: perfluorooctane sulfonate

PFOA: perfluorooctanoate

PFHxS: Perfluorohexane sulfonate

PFOS (perfluorooctane sulfonate)

PFOA (perfluorooctanoate)

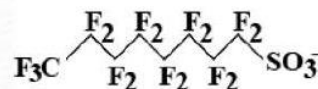
PFNA (perfluorononanoate)

PFDA (perfluorodecanoate)

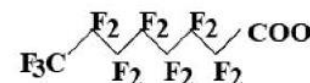
PFuDA (perfluoroundecanoate)

PFdDA (perfluorododecanoate)

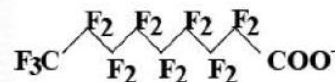
PFOS



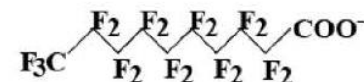
PFOA



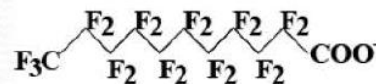
PFNA



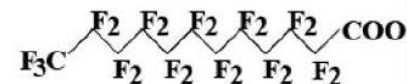
PFDA



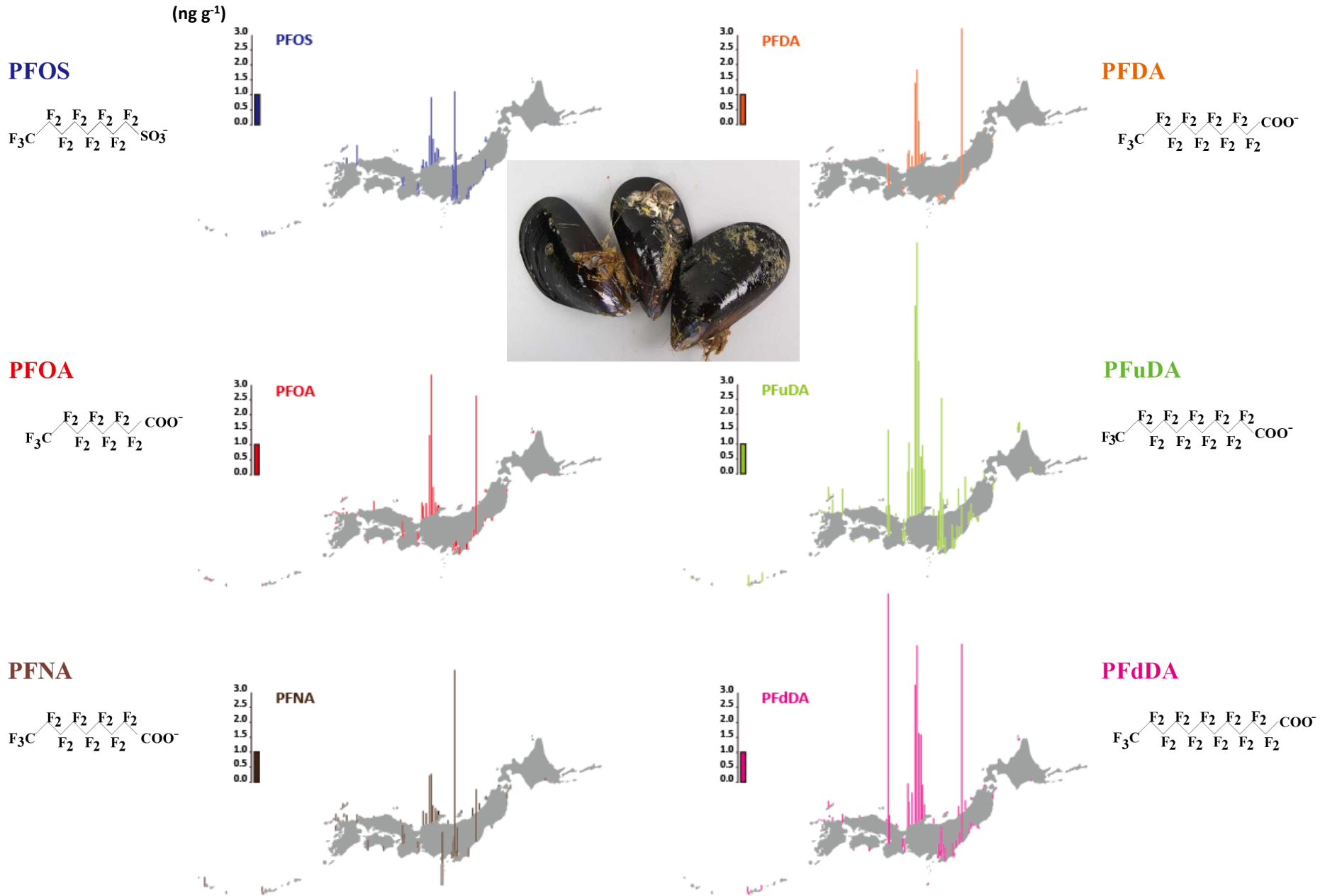
PFuDA



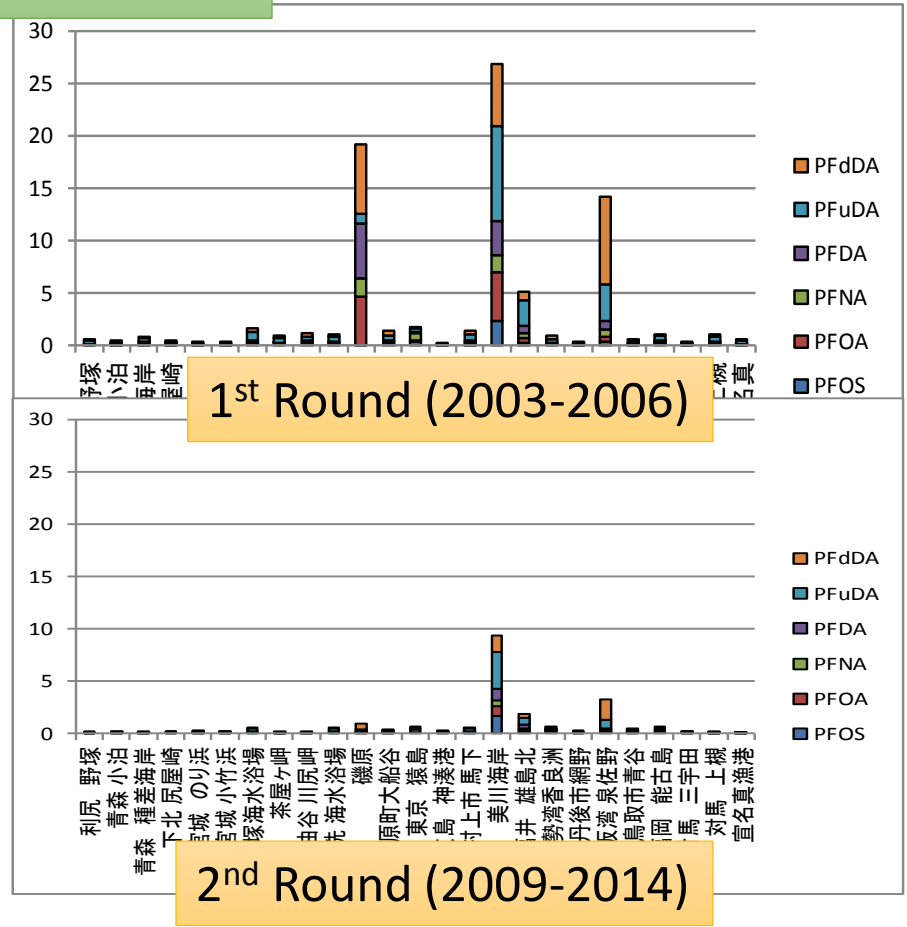
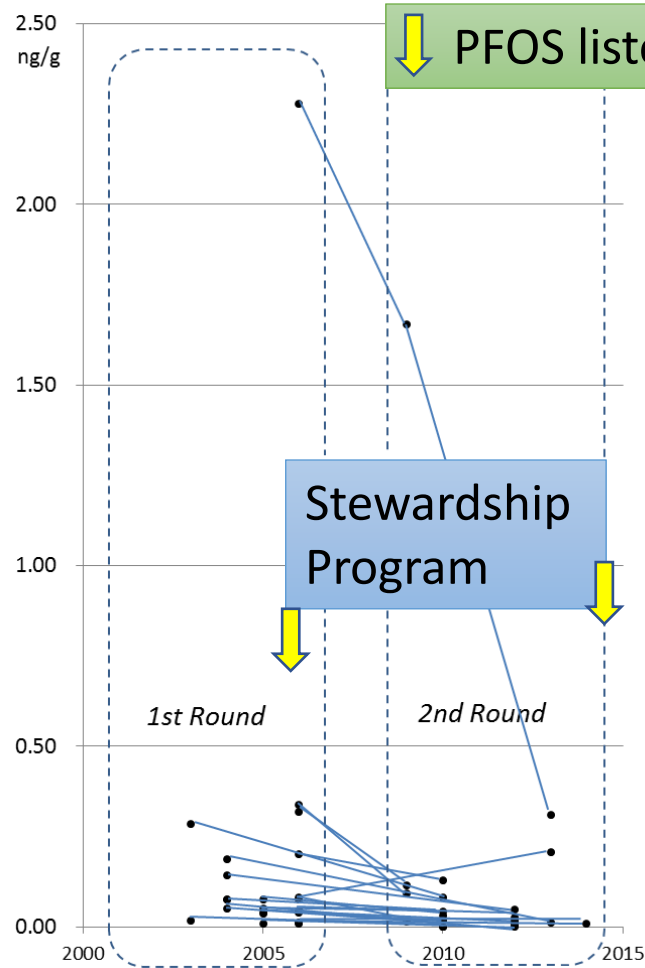
PFdDA



Mussel Watch along the Coastline of Japan (NIES)



Temporal change of PFASs levels in bivalves (NIES)



Temporal change of PFOS levels in bivalves

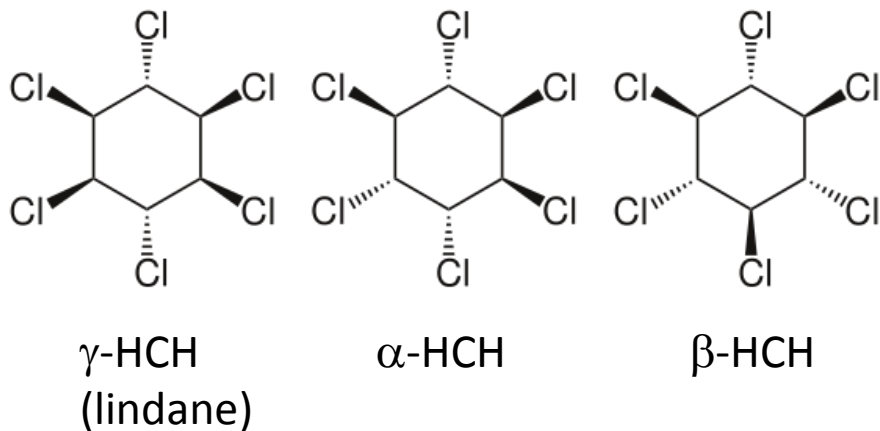
Changes of other PFAs



Temporal trends revealed by the analysis of archived samples in Environmental Specimen Bank (NIES: Time Capsule)

HCHs production and usage

HCHs: Hexachlorocyclohexanes



- China 4.46×10^6 tons (~1983)

Y.F. Li et al., Arch. Environ. Contam. Tox., 35, 688 (1998)

- Japan 0.32×10^6 tons (~1971), or 0.4×10^6 tons

Ministry of the Environment Japan, or Y.F. Li et al.

Facility and Instruments



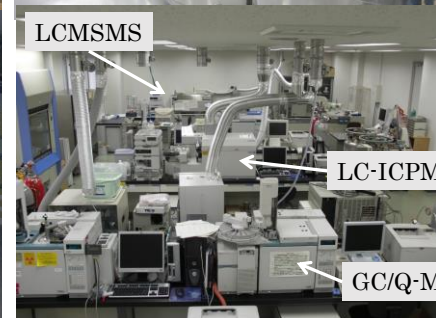
Time Capsule Building



-60 C Cold Rooms



Liquid N₂ Vapor Phase Storage Tanks



LCMSMS

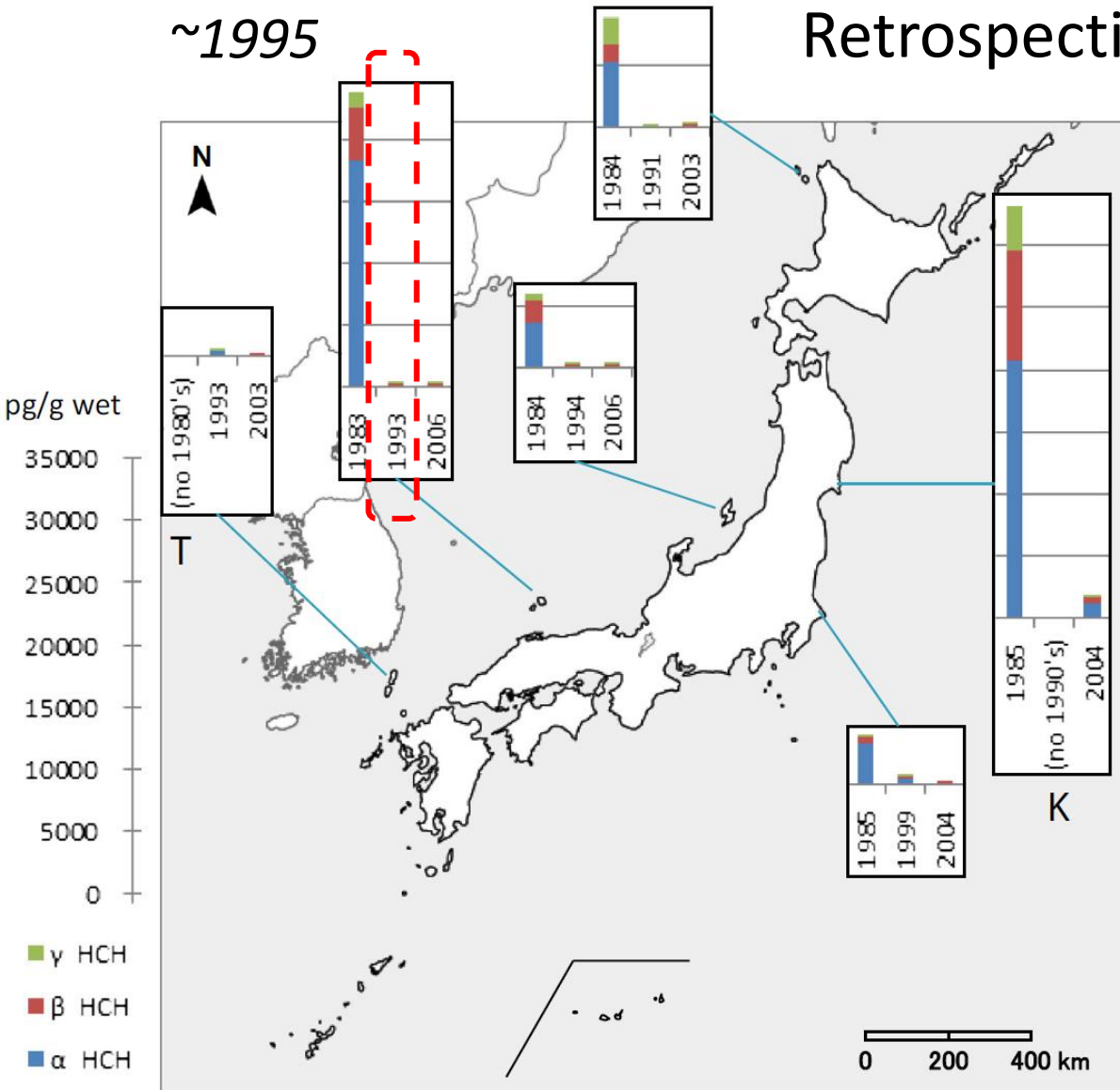
LC-ICPMS

GC/Q-MS



Retrospective Analysis of Archived Bivalve Samples

~1995



- HCHs levels in bivalves

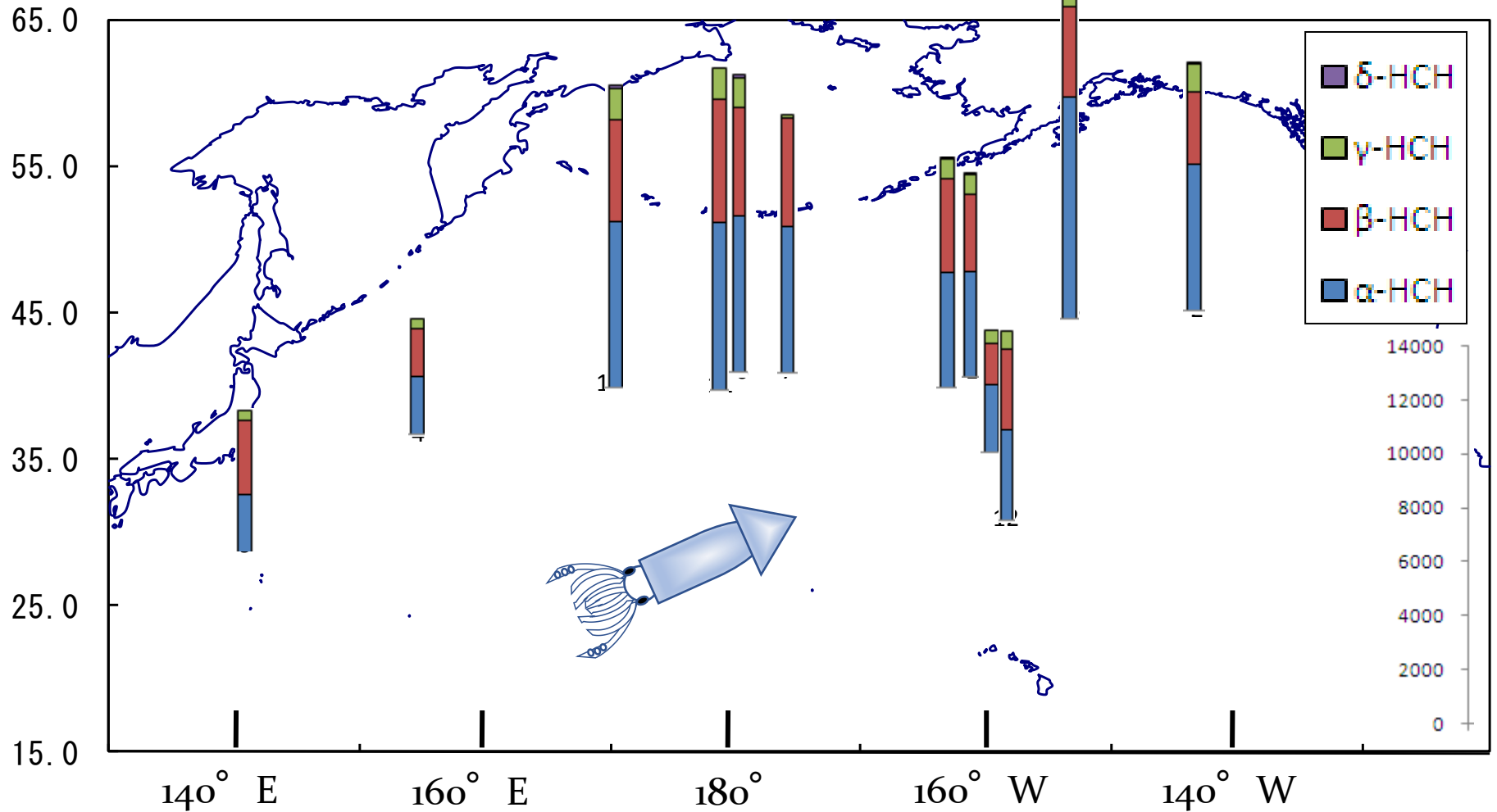


Mussel Watch

Z. Karube et al., *Environ. Sci. Pollut. Res.* 22, 1587 (2015)



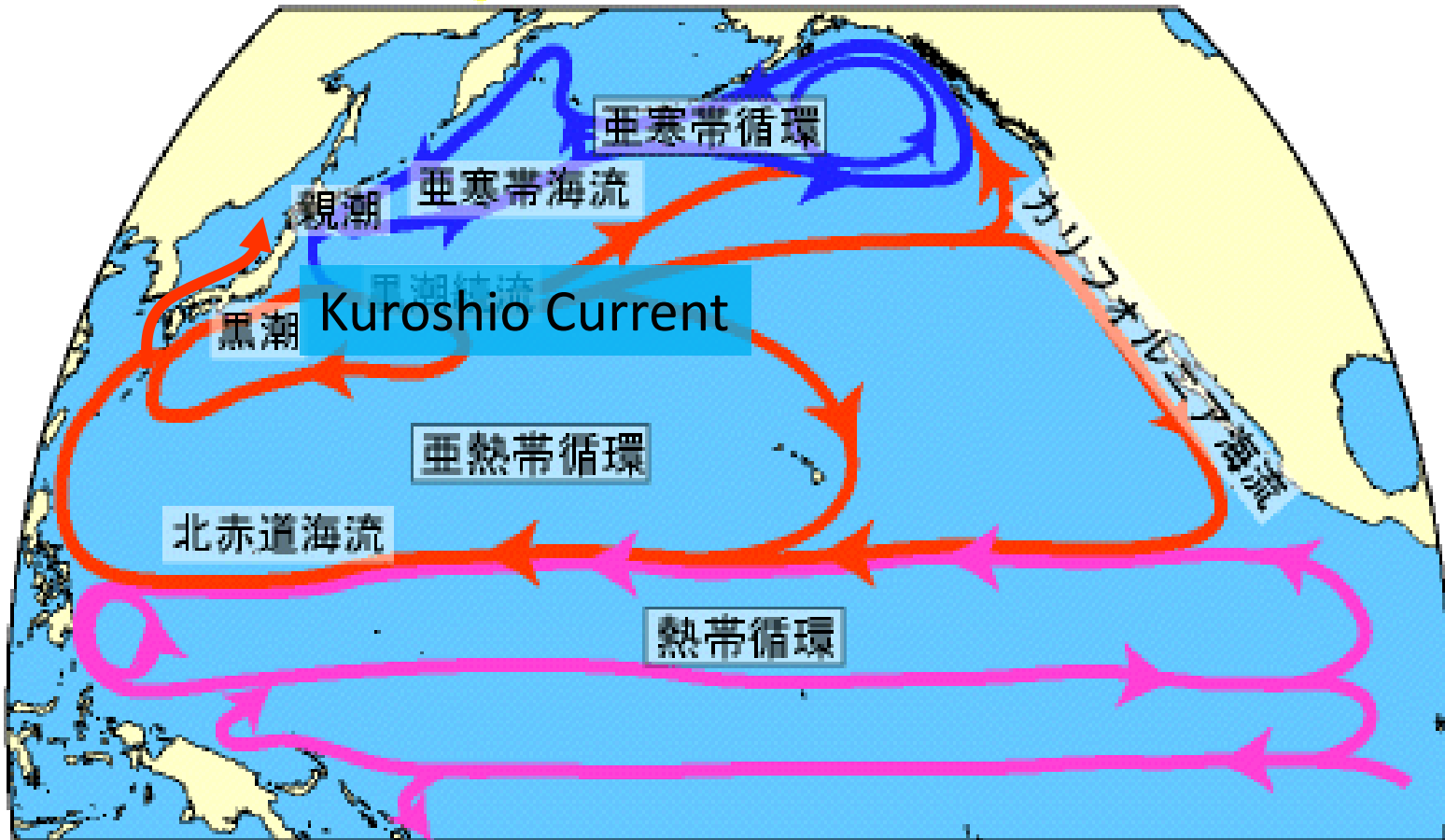
HCHs in Squid Liver in North Pacific around 1995



Y. Shibata et al. unpublished

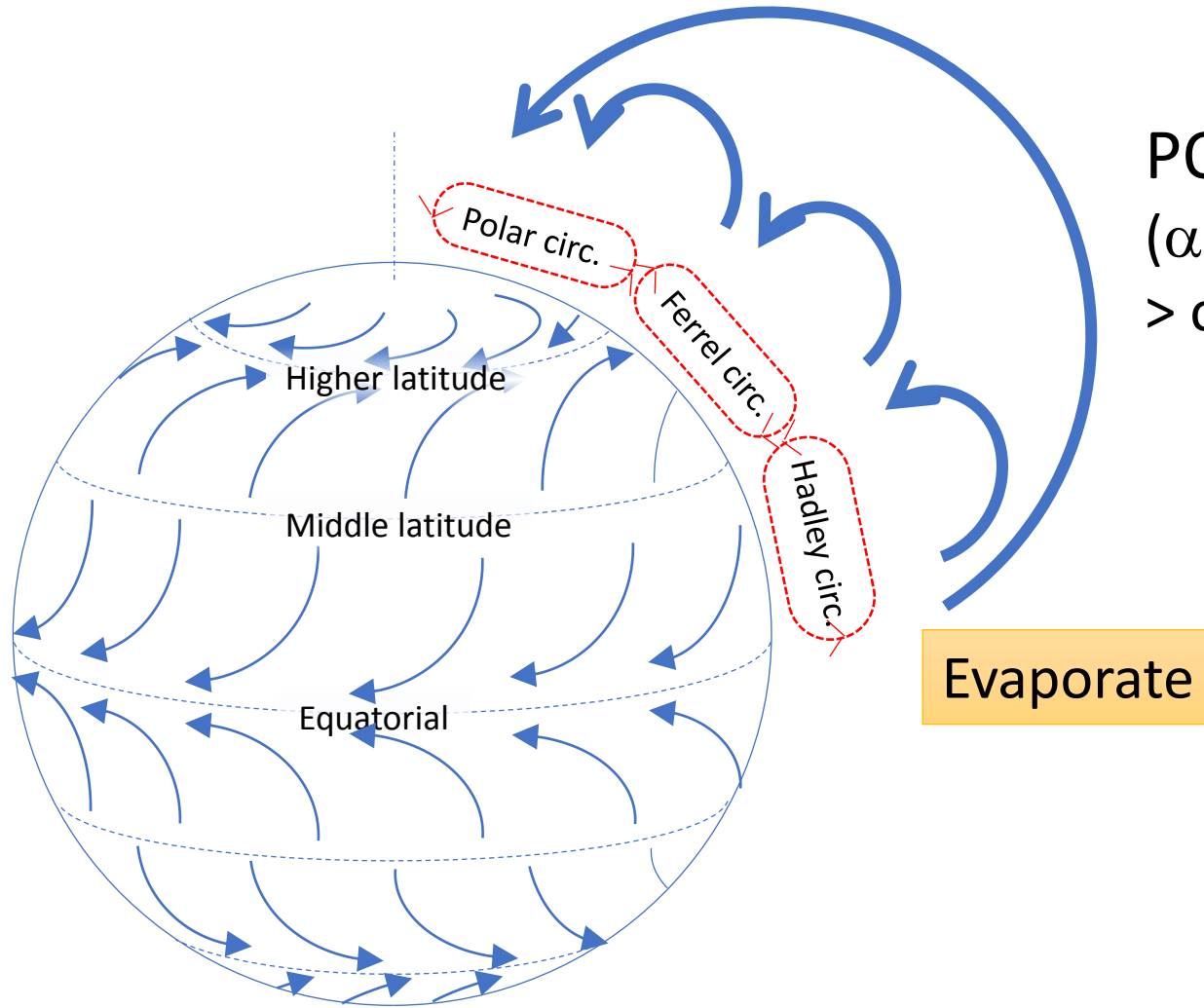


← Warm current
← Cold Current



Global POPs movement

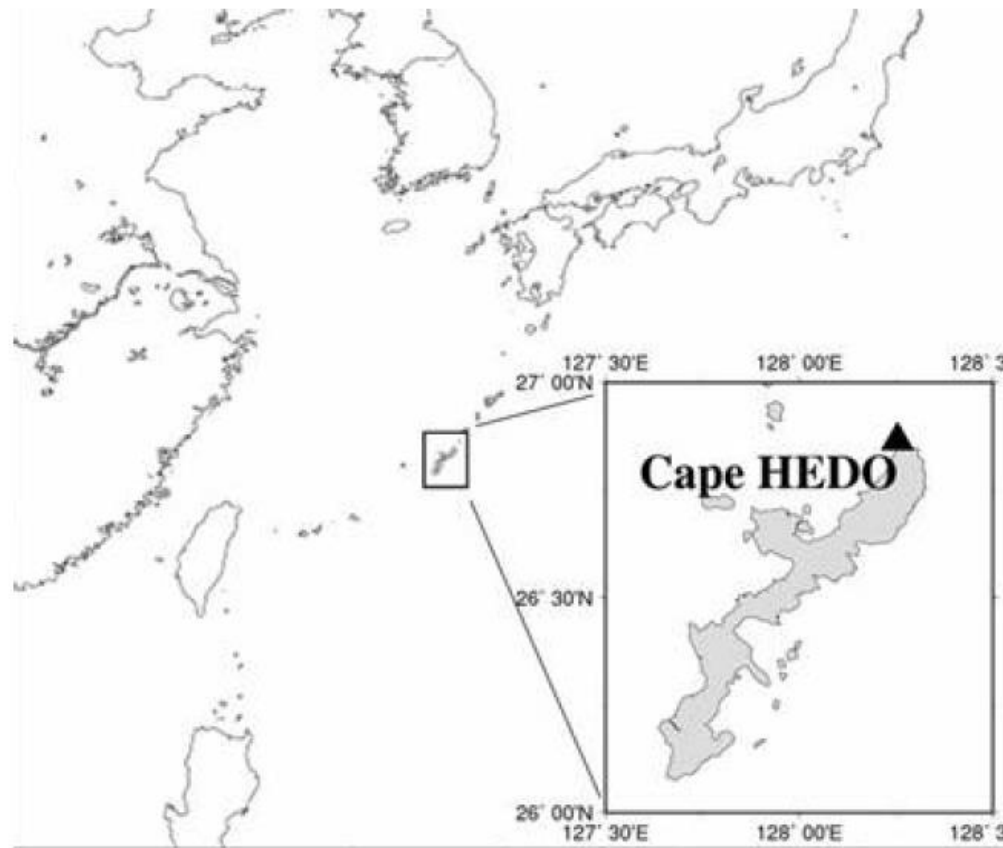
Cold Trapping (mountain trapping)



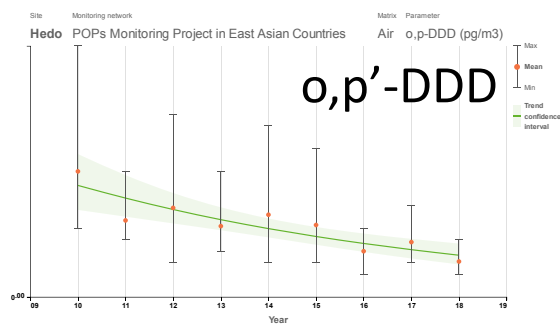
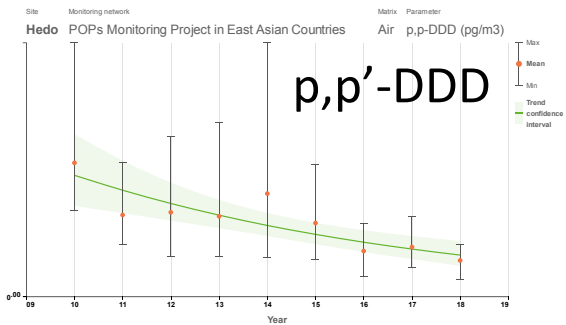
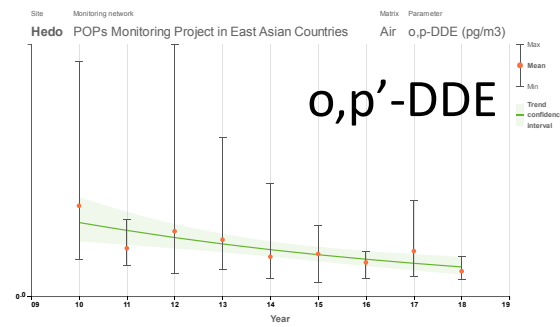
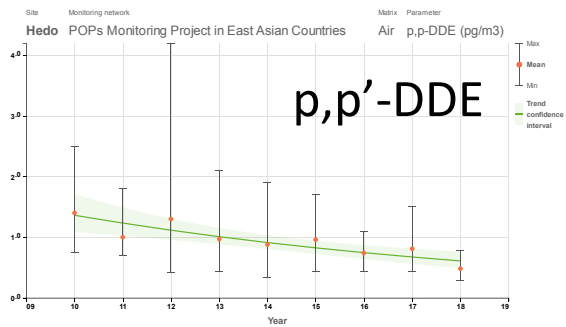
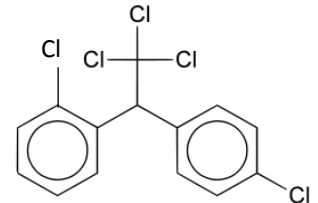
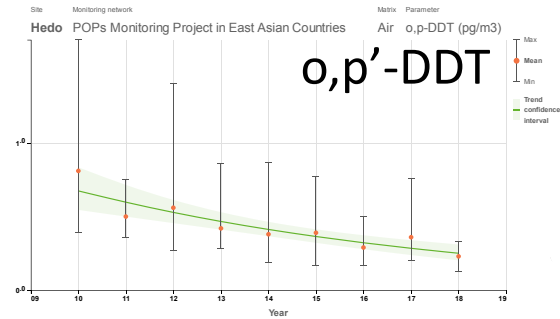
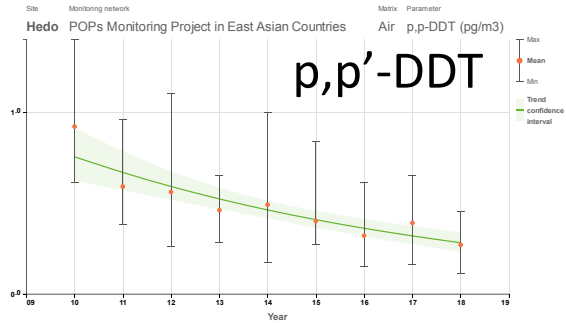
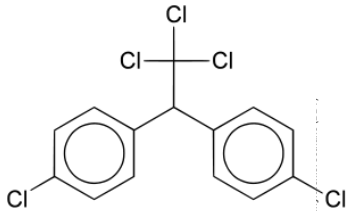
POPs
(α -HCH > β , γ -HCHs
> other POPs)



Background air monitoring of POPs at Okinawa, Japan (MOE)



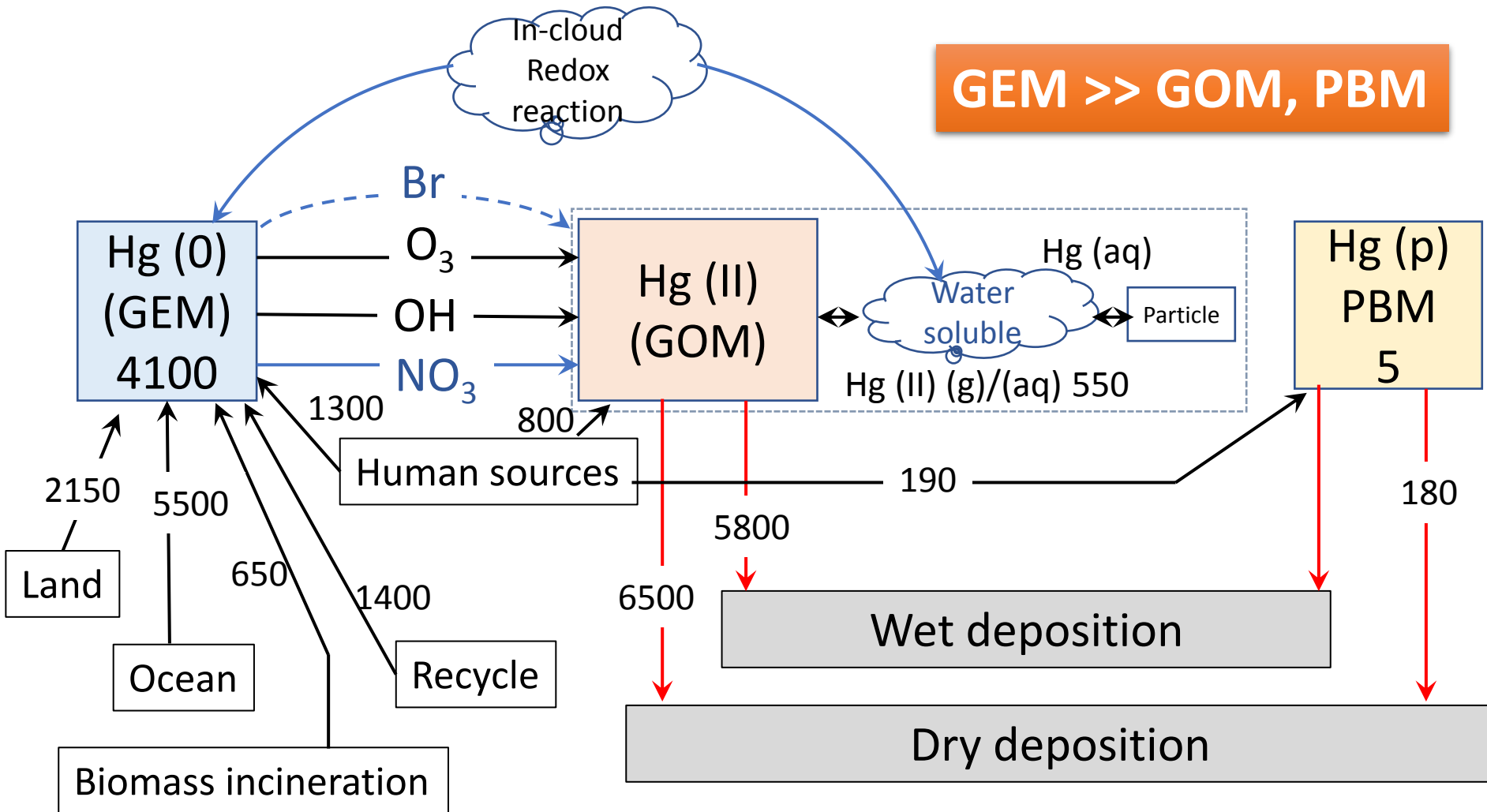
Background air monitoring station at Cape Hedo, Okinawa Island, Japan



DDT and its metabolites in the air at Hedo, Okinawa



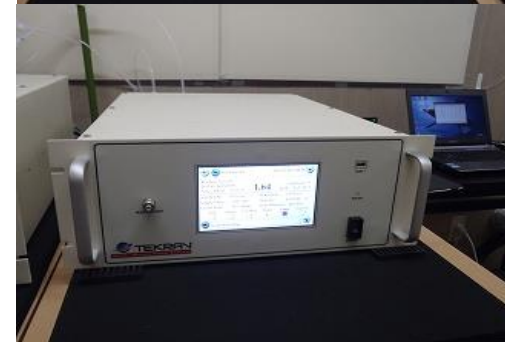
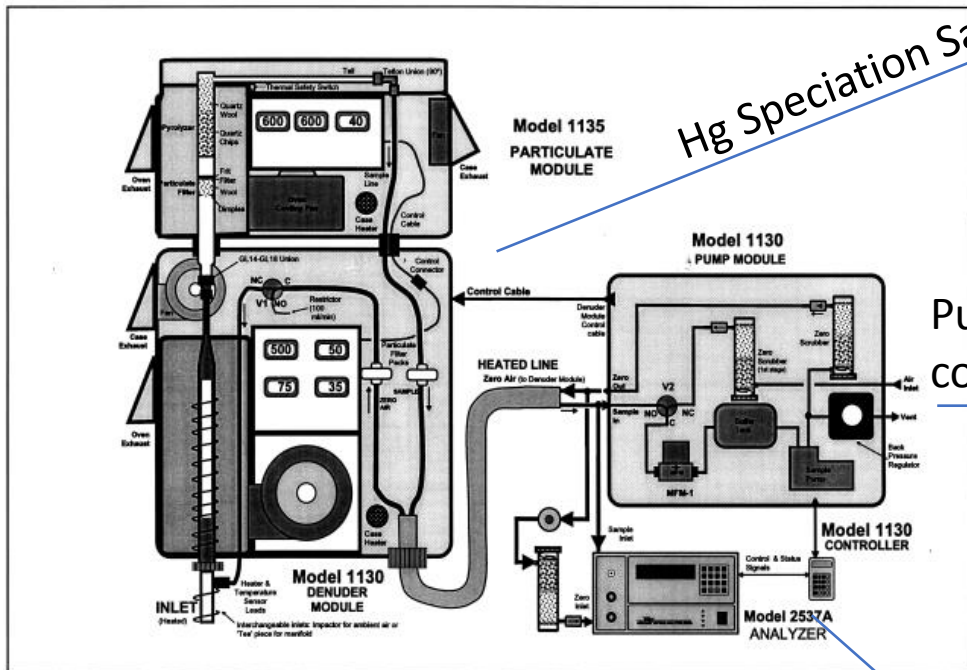
Atmospheric Hg cycling



GEM >> GOM, PBM

De Simone et al., ESPR (2014) 21:4110





Mercury monitoring system
Tekran 1130+2537



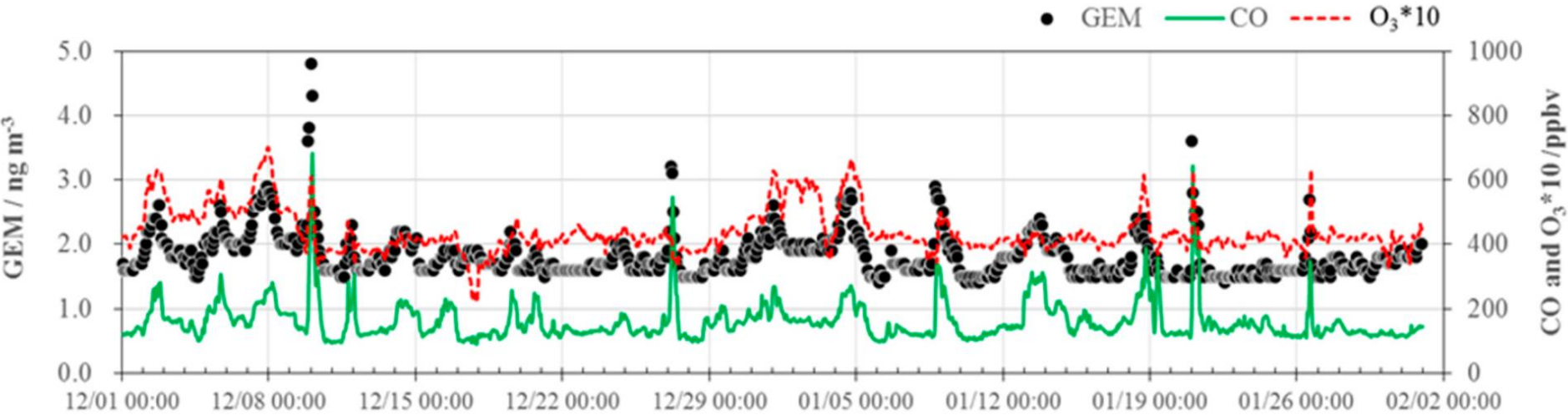
Article
Long-Term Observation of Atmospheric Speciated Mercury during 2007–2018 at Cape Hedo, Okinawa, Japan

Atmosphere 2019, 10, 362; doi:10.3390/atmos10070362

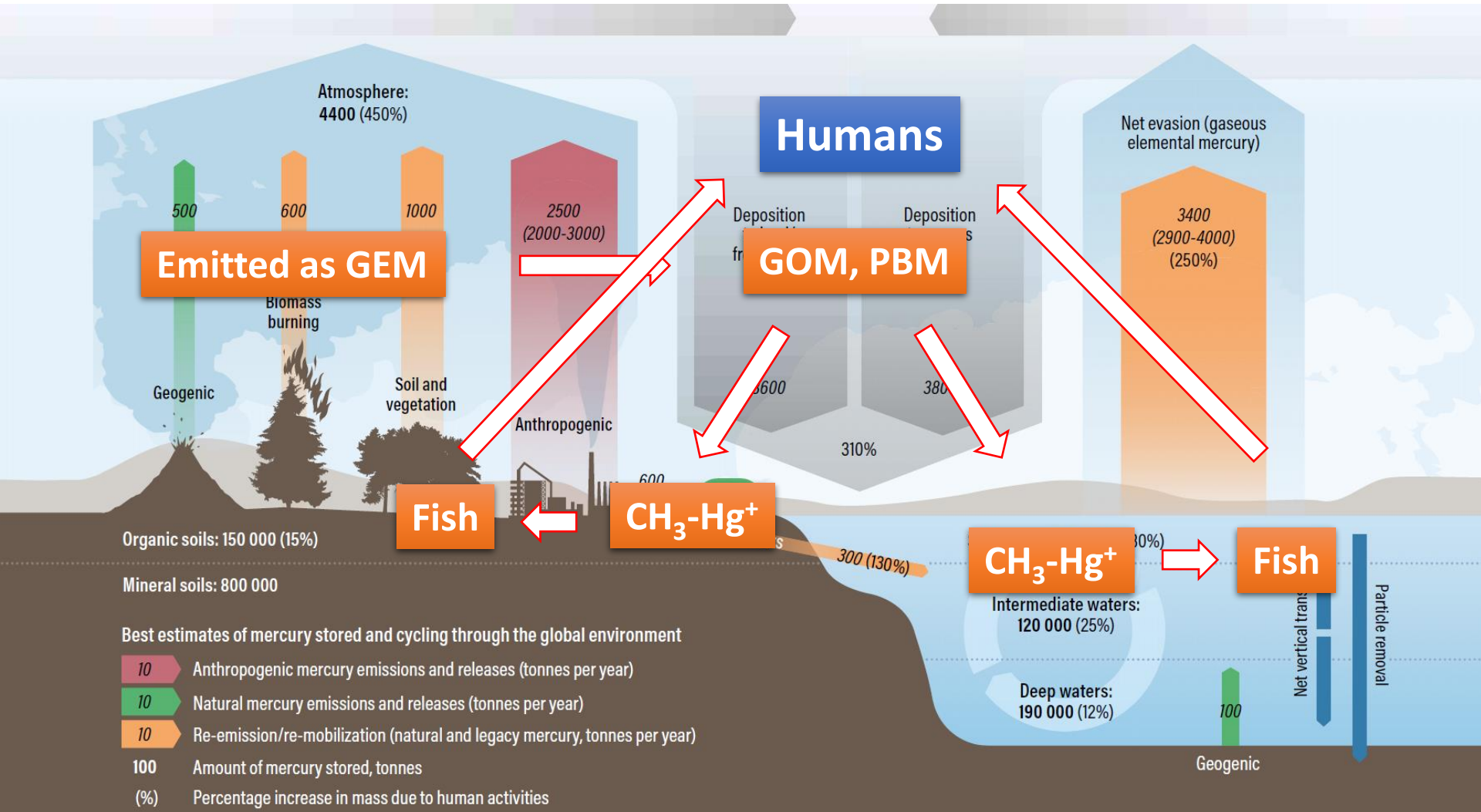
Kohji Marumoto ^{1,*}, Noriyuki Suzuki ², Yasuyuki Shibata ³, Akinori Takeuchi ³, Akinori Takami ⁴, Norio Fukuzaki ⁵, Kazuaki Kawamoto ⁶, Akira Mizohata ⁷, Shungo Kato ⁸, Takashi Yamamoto ⁹, Jingyang Chen ⁹, Tatsuya Hattori ¹⁰, Hiromitsu Nagasaka ¹⁰ and Mitsugu Saito ¹¹

Hg monitoring at background station Hedo, Okinawa

GEM correlated well with CO \Rightarrow Hg from Coal combustion !



Global Circulation of Mercury



“Global mercury assessment 2018”



<Summary>

- POPs and mercury are priority pollutants due to their persistent, bioaccumulative, toxic properties as well as their transboundary transport potential.
- Environmental monitoring supports the Stockholm (POPs) and the Minamata (mercury) Conventions by providing data for identifying sources and hotspots, and for evaluating effectiveness of the Conventions.
- Development of reliable models based on detailed monitoring will be useful to make better policy towards establishing sound chemical management.



Acknowledgments

Ministry of the Environment Japan

- POPs monitoring data
- Mercury monitoring data
and contracted companies to provide reliable data;
Shimadzu Techno-research, Inc., Idea Consultants, Inc.

National Institute for Environmental Studies

1) POPs analysis

Yoshikatsu Takazawa, Mai Takagi, Mitsuha Yoshikane, Ayako Kinoshita, Miyako Kobayashi, Sumiko Komori, Tomoko Hosoya

2) Environmental Time Capsule program

Atsushi Tanaka, Akinori Takeuchi, Zinichi Karube, Yuko Kanda,
and other members





Thank you very much!