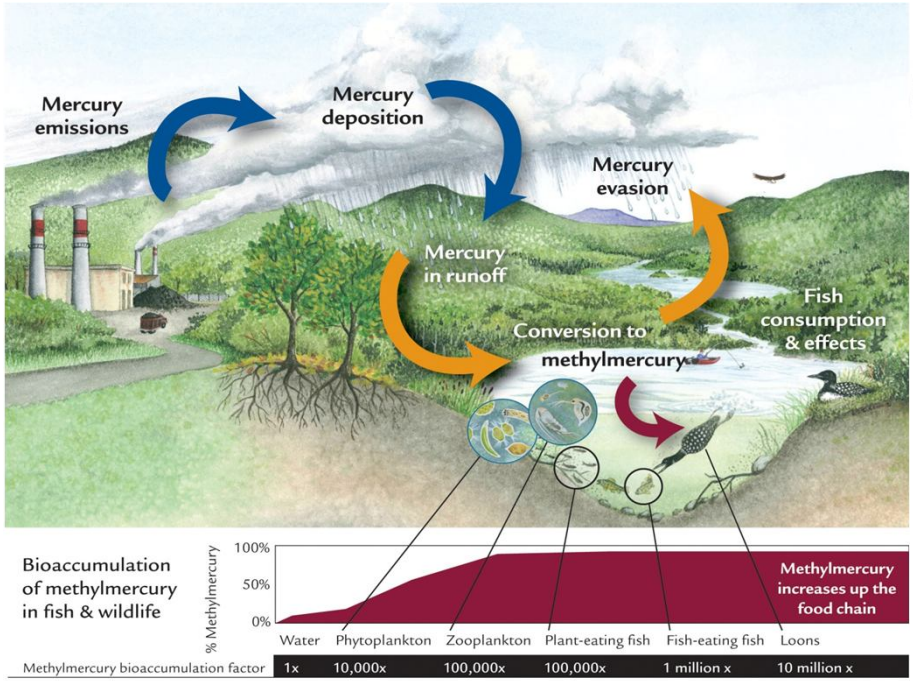
Analytical challenges for the implementation of the Minamata Convention

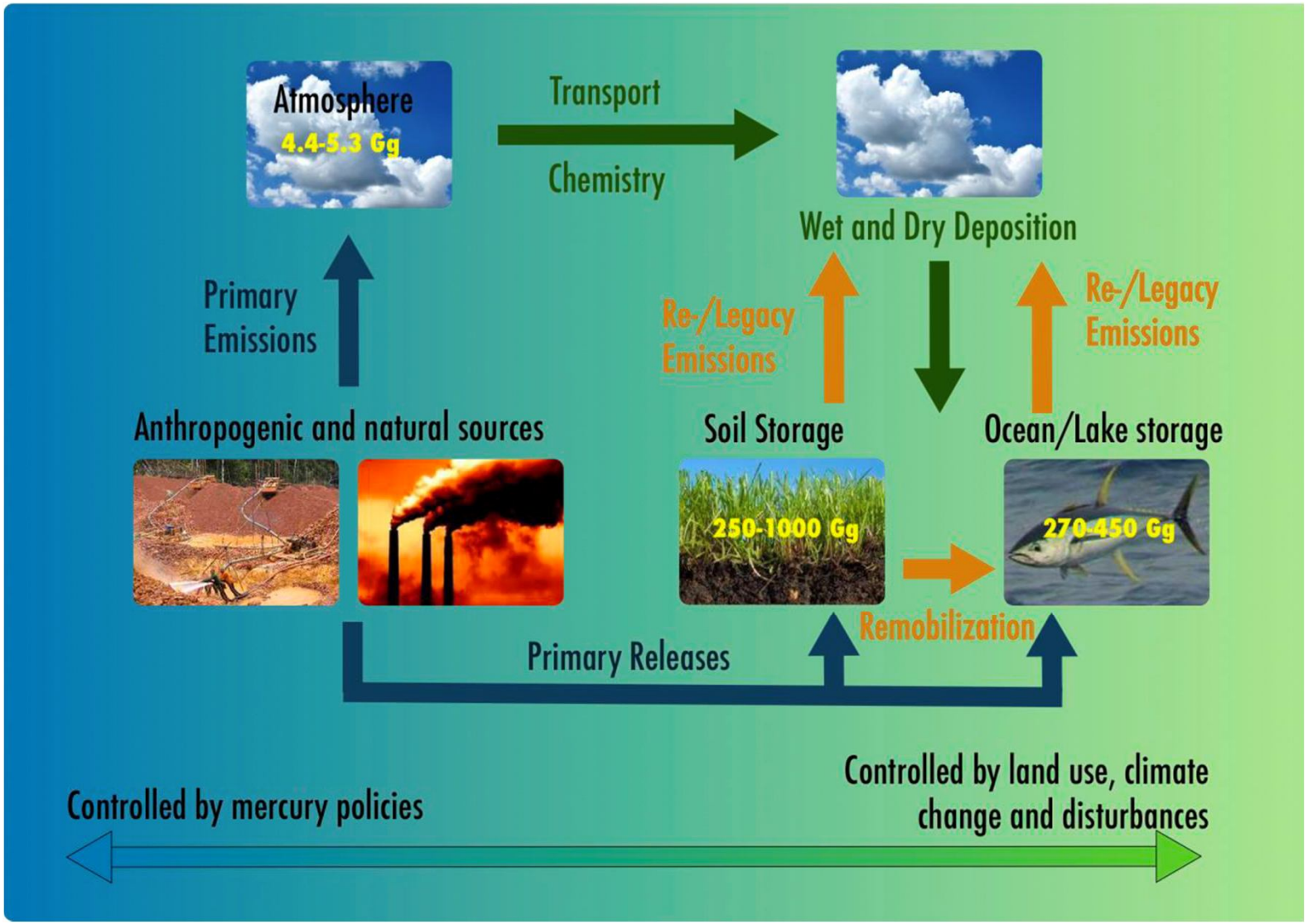
Milena Horvat
Jožef Stefan Institute, Department of Environmental Sciences
Ljubljana, Slovena

Content – how analytical chemist can support the implementation of the Convention?

- Hg is a persistent chemical
- Recognizing that once released it actively cycles in the environment for hundreds-to-thousands of years before being buried in sediment



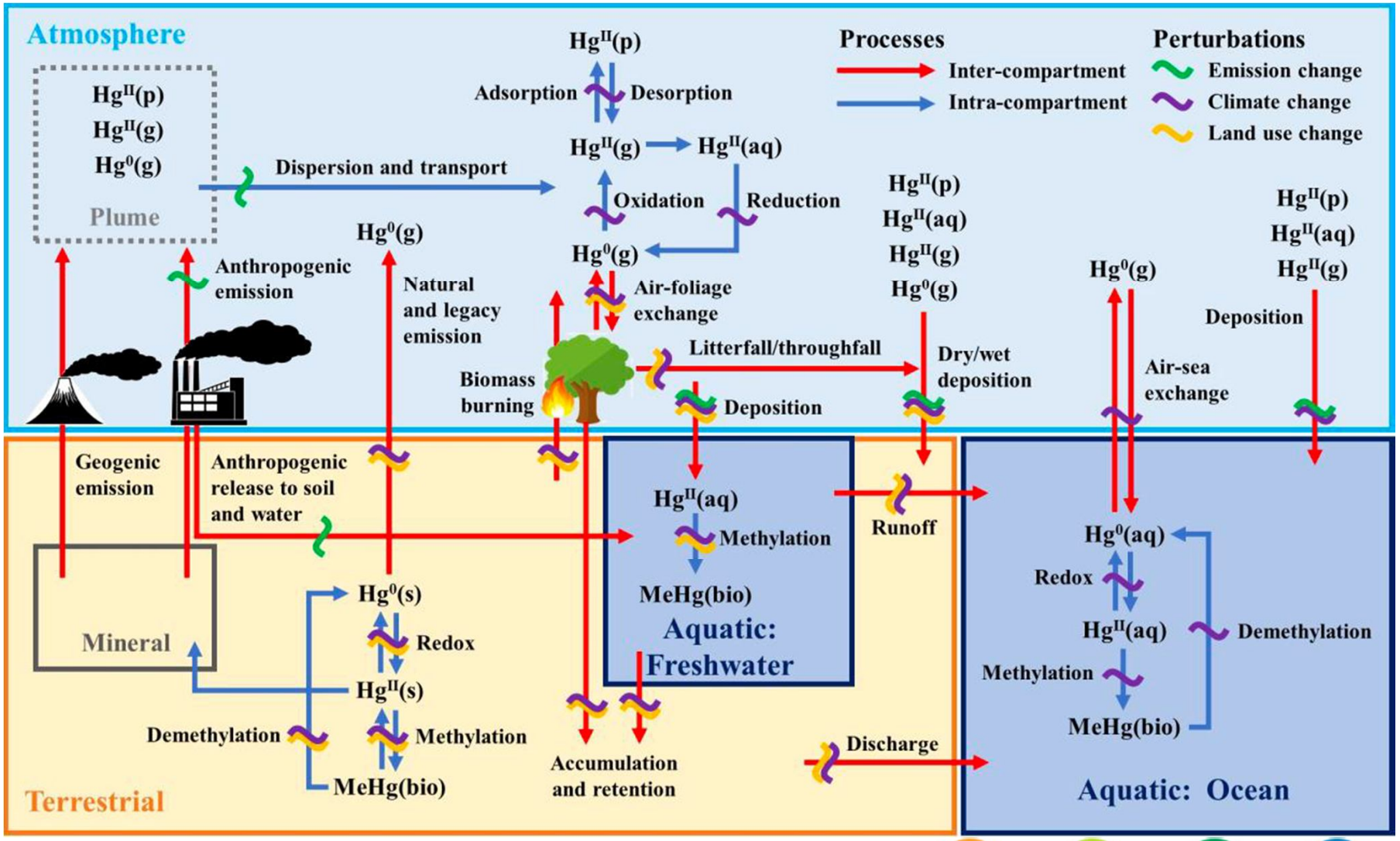
- **Minamata Convention** - a regulatory mechanism to decrease environmental Hg loadings and reduce exposure.
- **Paris Climate Agreement** – reduction of climate changing anthropogenic gases.



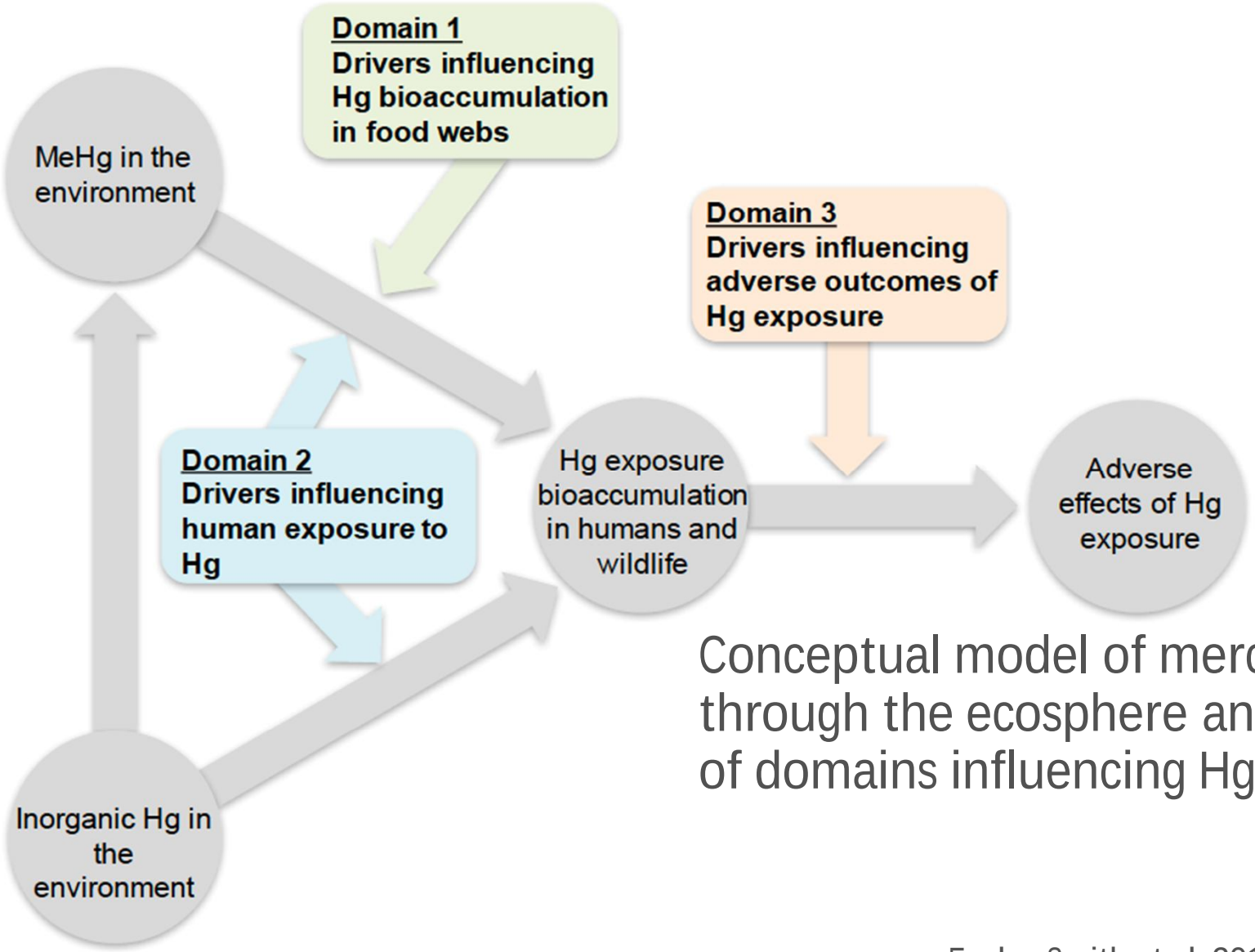
Global Hg cycling and impacts of policies and global change

Obrist et al., 2018

Critical processes of global importance for Hg cycling



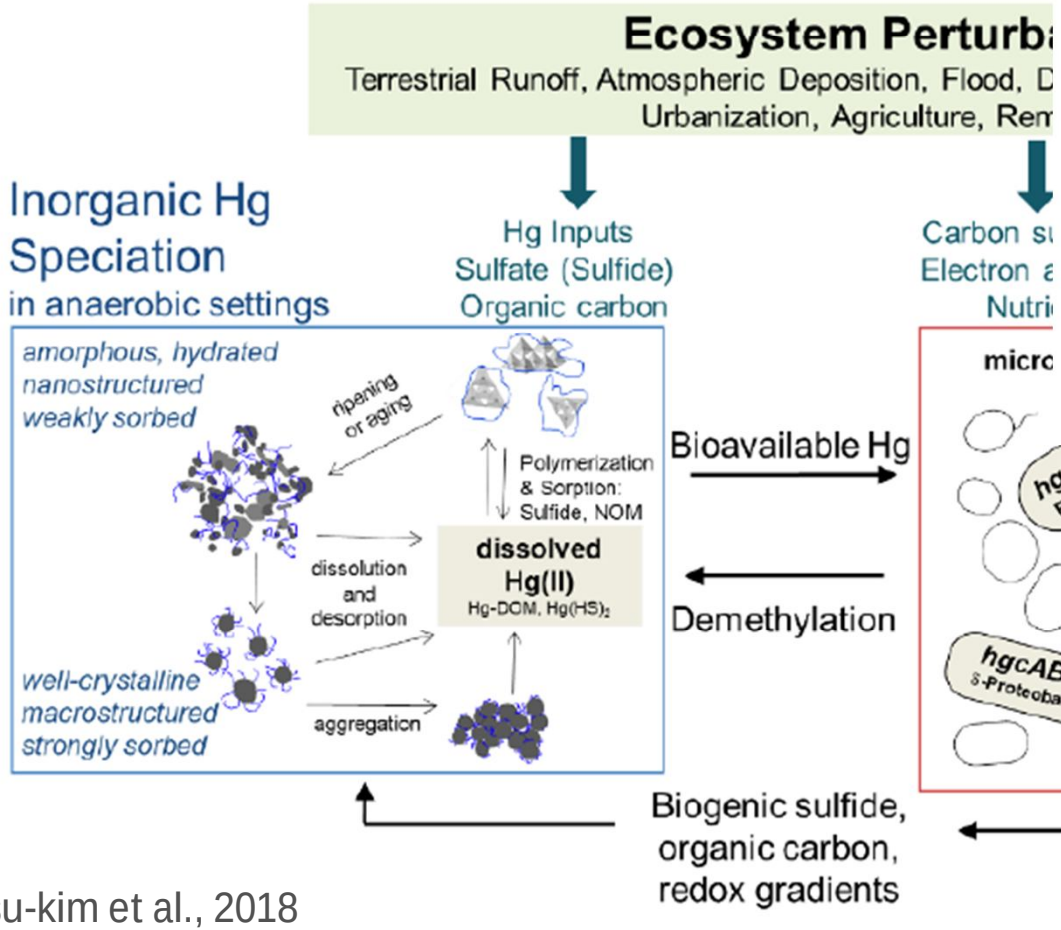
Obrist et al., 2018

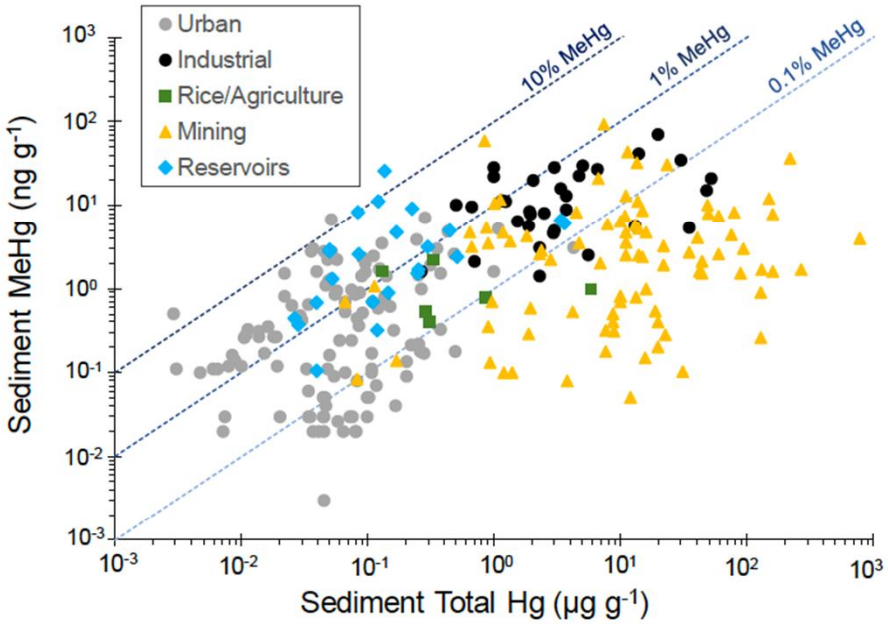


Conceptual model of mercury (Hg) pathways through the ecosphere and the identification of domains influencing Hg risk

Eagles-Smith et al. 2018

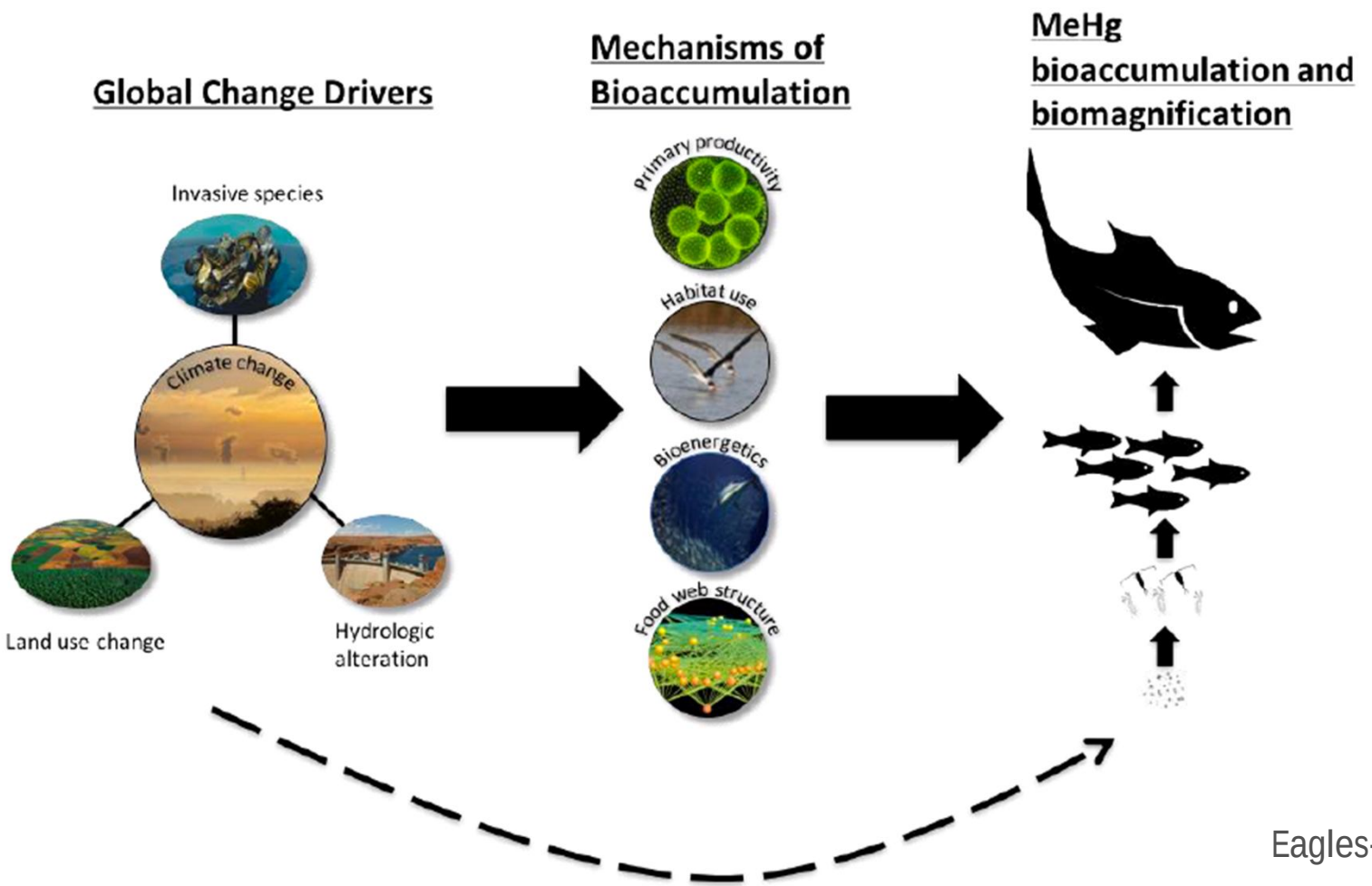
Perturbations to ecosystems & produ
aquatic environme



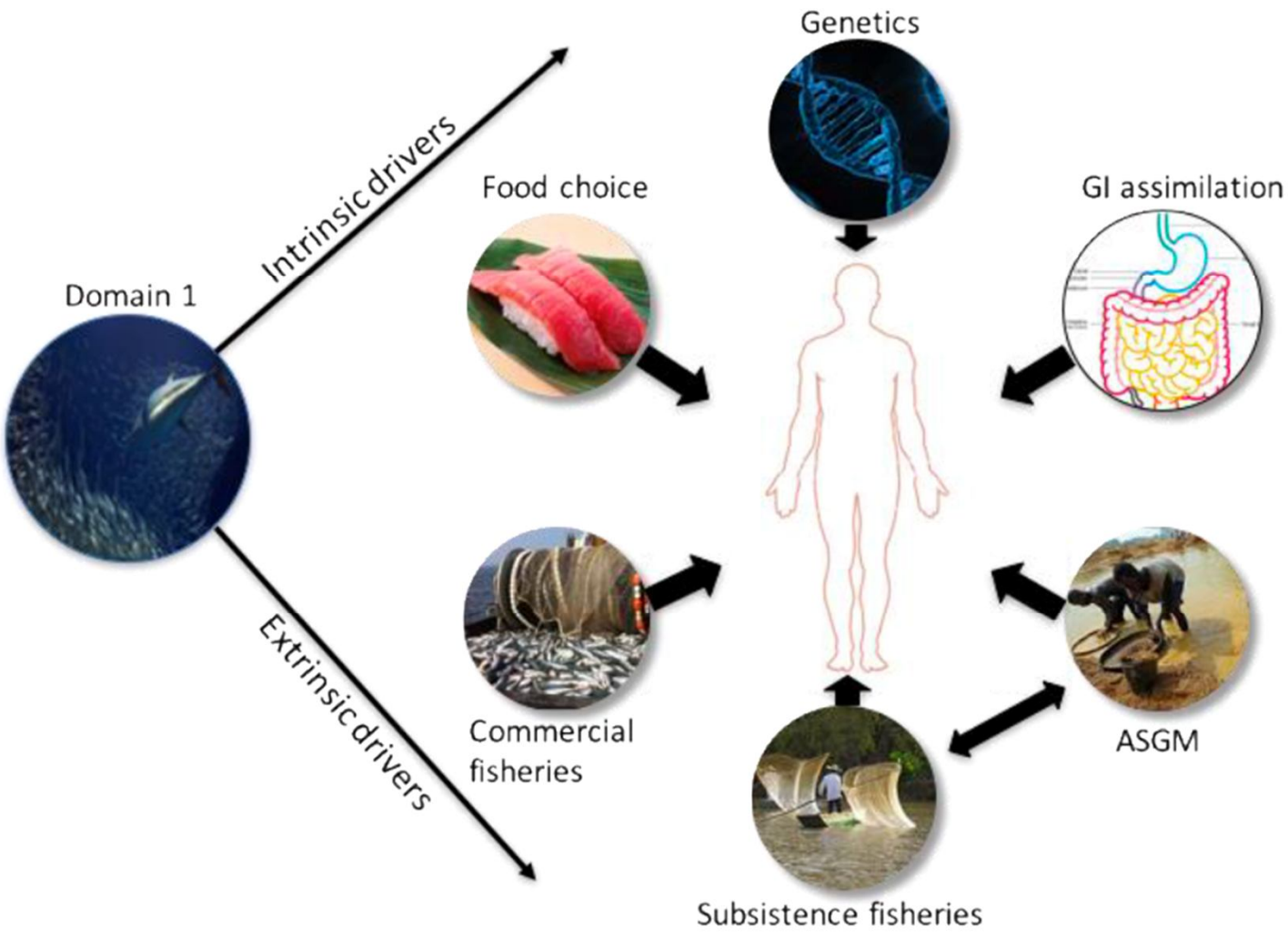


Hsu-kim et al., 2018

Extrinsic drivers of global change



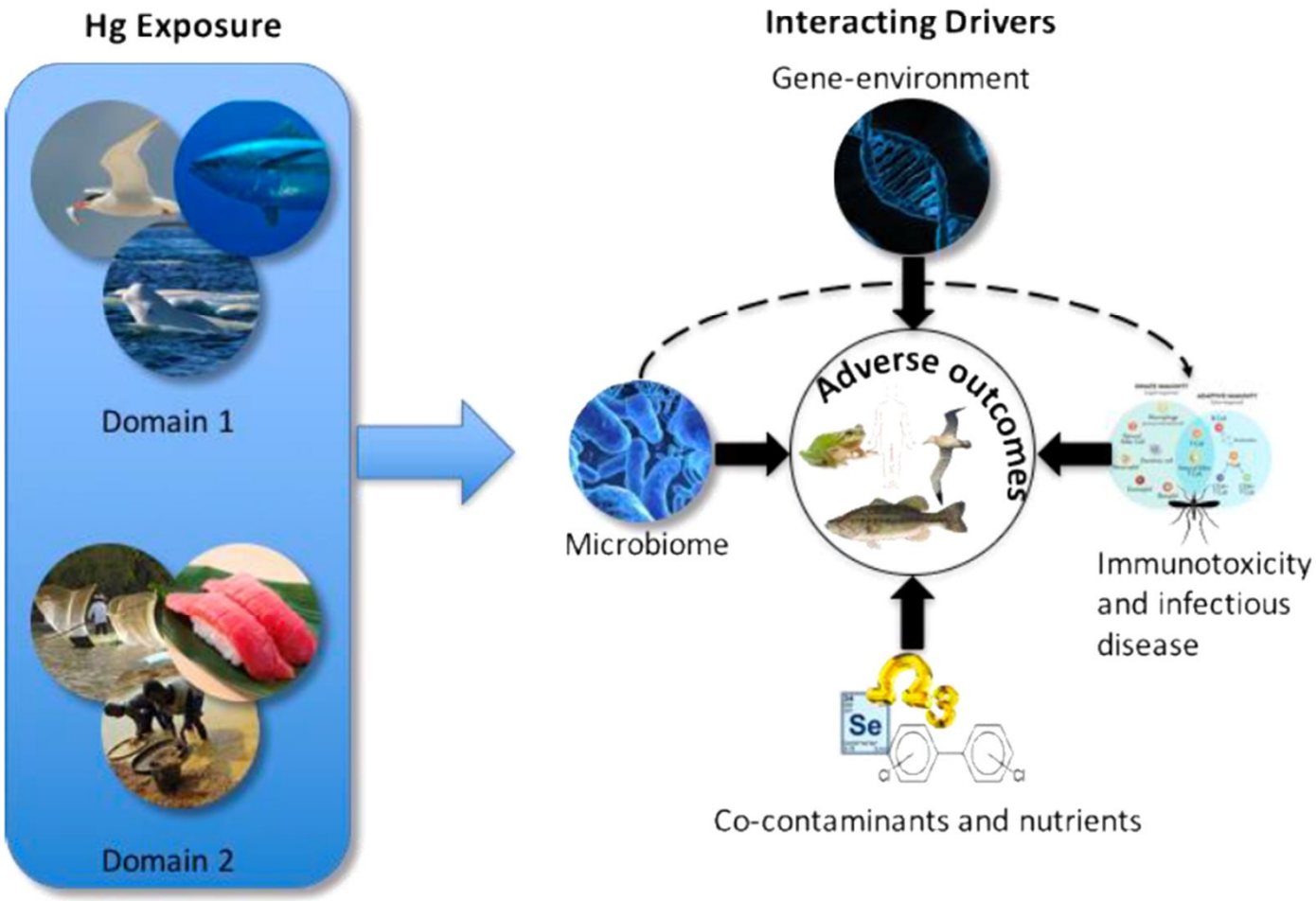
Eagles-Smith et al. 2018



Extrinsic and intrinsic drivers influencing mercury exposure in human population

Eagles-Smith et al. 2018

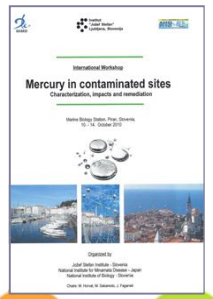
Interaction between Hg exposure and its drivers with key intrinsic and extrinsic drivers on adverse outcomes



Eagles-Smith et al. 2018

Policy relevant research

- US EPA Report to the Congress, **1997**
- EU Mercury Position Paper, **2001**
- UNEP Mercury expert group, UNEP Mercury Assessment Report, **2002, 2013, *2018***
  - Issues: atmospheric emissions, transport and fate, contaminated sites, artisanal small scale gold mining, Hg in products, exposure, ...
- UNEP, Intergovernmental Negotiation Committee INC process
- Membership in UNEP partnership programmes:
  - Fate and Transport
  - Mercury Emission from Coal,
  - .....



The UNEP Mercury Programme was guided by the seven priorities set out in Paragraph 19 of the UNEP Governing Council Decision 24/3 part IV (2007):

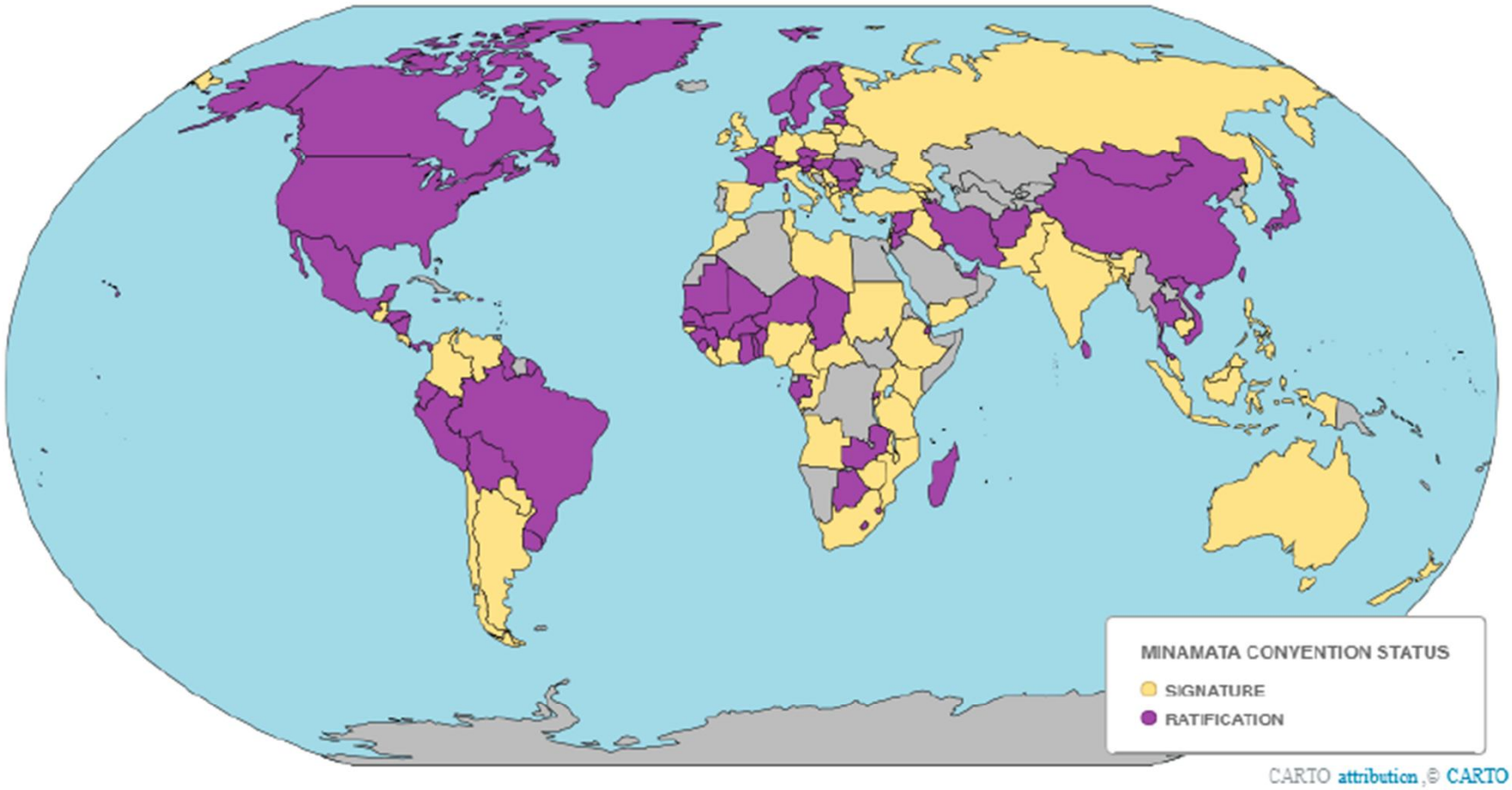
1. To **reduce atmospheric mercury emissions** from human sources;
2. To find environmentally sound solutions for the **management of waste** containing mercury and mercury compounds;
3. To **reduce global mercury demand** related to use in products and production processes;
4. To reduce the **global mercury supply**, including considering curbing primary mining and taking into account a hierarchy of sources;
5. To find environmentally sound **storage solutions** for mercury;
6. To address, the **remediation of existing contaminated sites** affecting public and environmental health;
7. To increase knowledge on areas such as **inventories, human and environmental exposure, environmental monitoring and socioeconomic impacts.**

Minamata Convention on Mercury

- A global treaty *to protect human health and the environment from the adverse effects of mercury*
- Agreed at the 5th session of the Intergovernmental Negotiating Committee (INC) in Geneva, 19 January 2013
- Adopted at the diplomatic conference in Kumamoto, Japan, on 10. and 11. October, 2013

- **Ratified on 16. August, 2017**

www.mercuryconvention.com


MINAMATA CONVENTION STATUS
SIGNATURE
RATIFICATION
CARTO attribution, © CARTO

Highlights of the Convention

Articles can be divided into four main categories:

Operational articles - describe the obligations on Parties which will reduce anthropogenic emissions and releases of mercury and mercury compounds to the environment

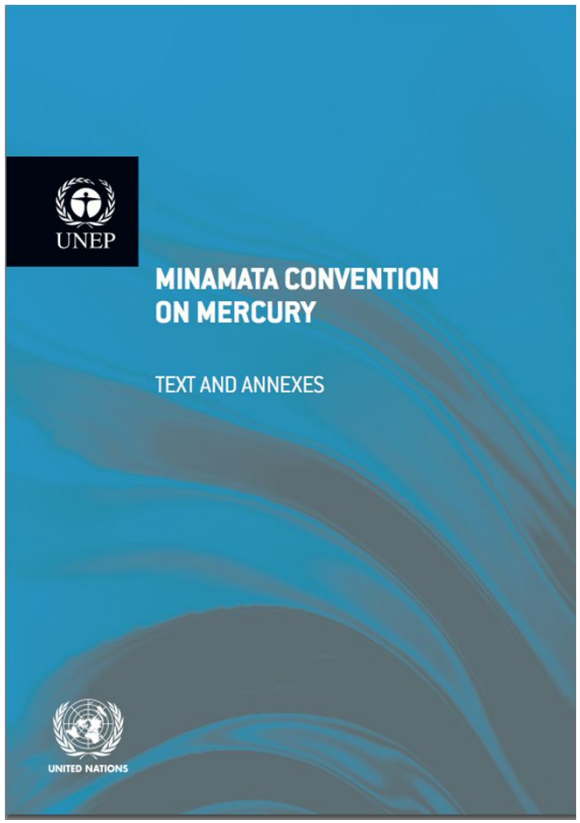
Support to Parties - financial resources, capacity building, technical assistance and technology transfer, implementation and compliance committee

Information and awareness raising, including actions which will reduce impacts of mercury

Administrative matters

Uses, emissions and releases

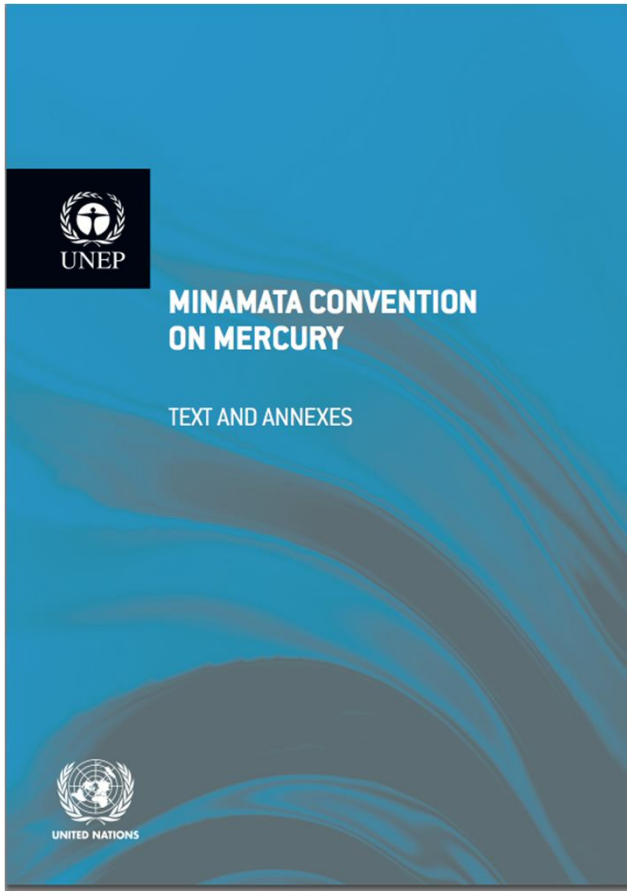
- **Article 3** - Supply and trade
- **Article 4** - Products
- **Article 5** - Processes
- **Article 6** - Exemption to phase-out dates
- **Article 7** - Artisanal small scale mining
- **Article 8** - Emissions
- **Article 9** - Releases
- **Article 10** - Storage
- **Article 11** - Waste
- **Article 12** - Contaminated sites



www.mercuryconvention.co

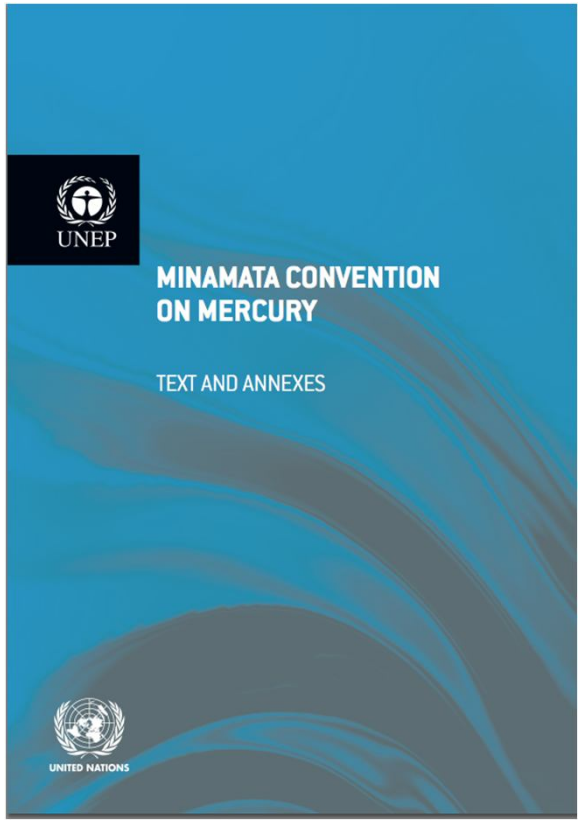
Support, awareness raising, and education

- **Article 13** – Financial mechanisms
- **Article 14** – Capacity building, technical assistance and technology transfer
- **Article 16** – Health aspects
- **Article 17** – Information exchange
- **Article 18** – Information, awareness, education



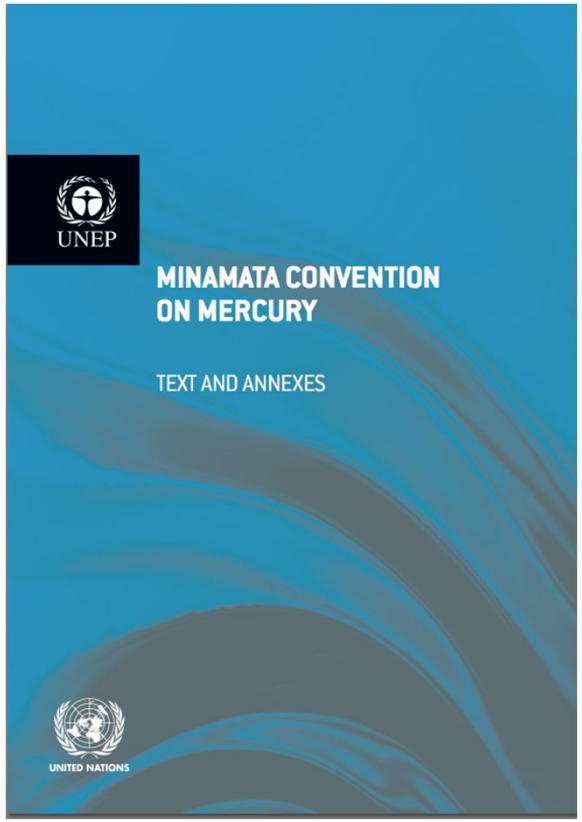
Impacts and effectiveness

- **Article 15** – Implementation and compliance
- **Article 19 – Research, development, and monitoring**
- **Article 20** – Implementation plan
- **Article 21** – Reporting
- **Article 22** – **Effectiveness evaluation**

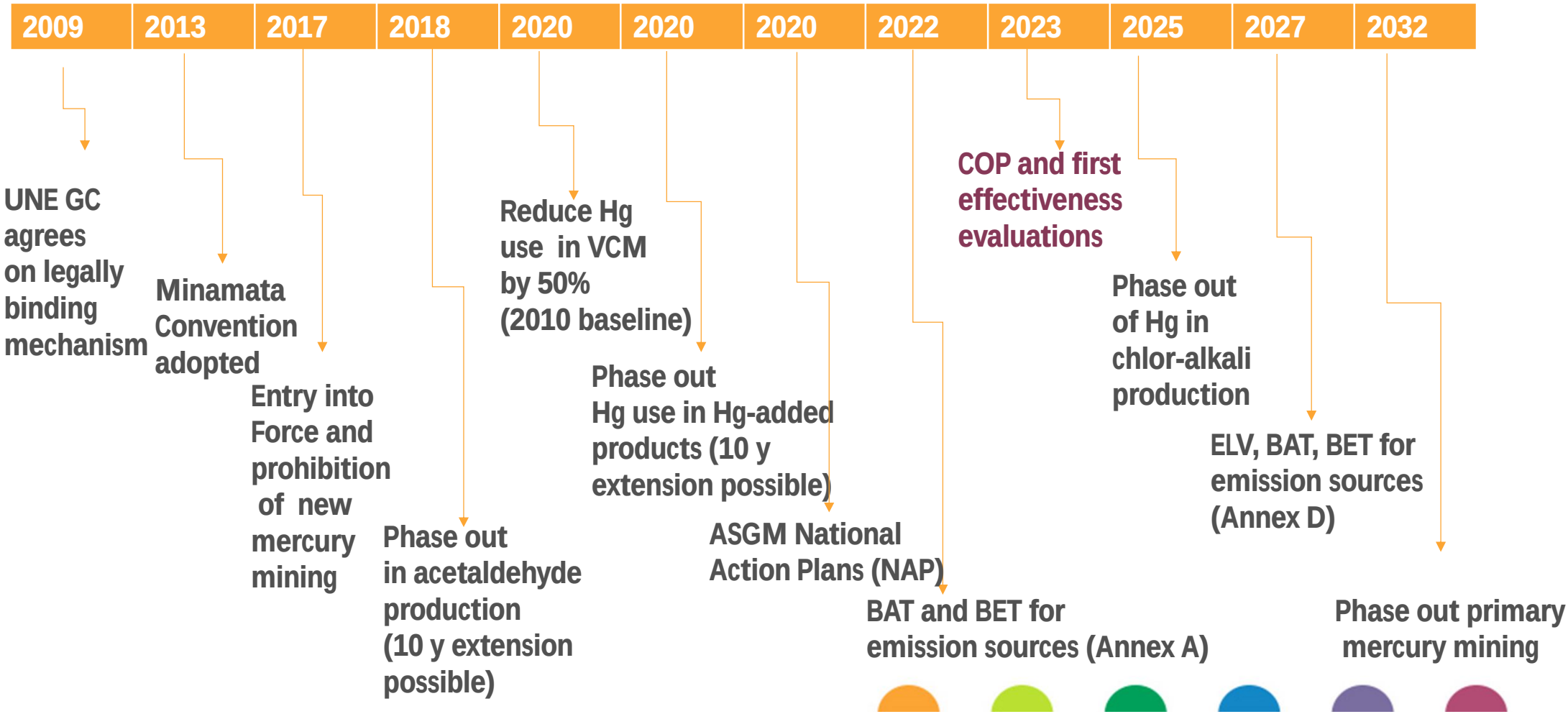


Impacts and effectiveness

- **Article 15** – Implementation and compliance
- **Article 19 – Research, development, and monitoring**
- **Article 20** – Implementation plan
- **Article 21** – Reporting
- **Article 22 – Effectiveness evaluation**



Dates, requirements, deadlines



Measurements & Minamata Convention

Article 19

Research, development and monitoring

1. Parties shall endeavour to cooperate to develop and improve, taking into account their respective circumstances and capabilities:

(a) Inventories of use, consumption, and anthropogenic emissions to air and releases to water and land of mercury and mercury compounds;

(b) Modelling and geographically representative monitoring of levels of mercury and mercury compounds in vulnerable populations and in environmental media, including biotic media such as fish, marine mammals, sea turtles and birds, as well as collaboration in the collection and exchange of relevant and appropriate samples;

(c) Assessments of the impact of mercury and mercury compounds on human health and the environment, in addition to social, economic and cultural impacts, particularly in respect of vulnerable populations;

(d) Harmonized methodologies for the activities undertaken under subparagraphs (a), (b) and (c);

(e) Information on the environmental cycle, transport (including long-range transport and deposition), transformation and fate of mercury and mercury compounds in a range of ecosystems, taking appropriate account of the distinction between anthropogenic and natural emissions and releases of mercury and of remobilization of mercury from historic deposition;

- Monitoring levels of mercury and mercury compounds in environmental and biological media
- Harmonized methodologies
- Comparability of results

Effectiveness evaluation (Article 22)

1. COP to evaluate e… onve… la… after entry into fo…
2. COP to initiate esta…lishment of arrangements for prov…ng itself w… **comparable monitoring data** (presence and movement of Hg/com…ounds in **the environment**, trends in levels of Hg/compounds in **biota and vulnerable populations**
3. Evaluation to be conducted on the basis of available scientific, environmental, technical, financial and economic information, including
   - (a) Reports provided to the COP on monitoring / **paragraph 2**
   - (b) Reporting under **Article 21**
   - (c) Information related to information and compliance committee (**Article 15**)
   - (d) Reporting and information on Article 13 and 14 (**financial systems**, **technology transfer**, **capacity building**)

Which environmental matrix will be used?

Which biota will be used?

Which tissues?

Global monitoring approach

Report to parties

Implementation& complience

European Association of National Metrology Institutes - EURAMET

Members:

37 European NMIs

28 of them are participating in EMPIR

Associates:

JRC

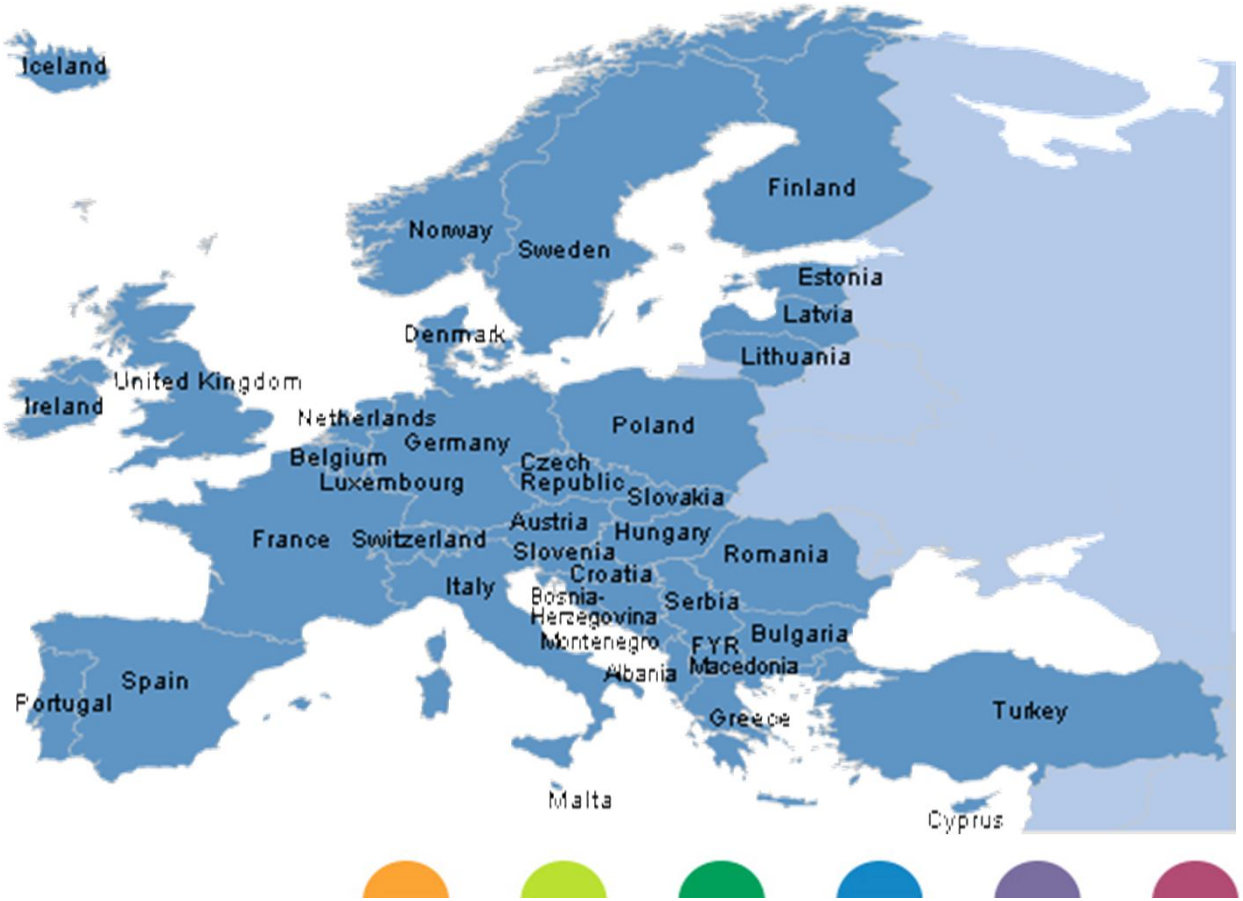
75 DIs (Designated Institutes)

Liaison Organisations:

4 RMOs & BIPM

3 NMIs beyond Europe

6 regional/international Organisations



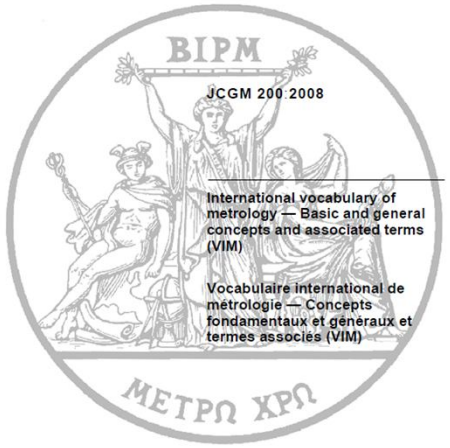
EMPIR

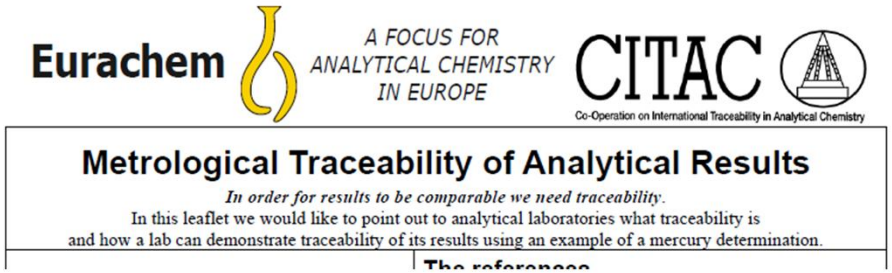
European Metrology Programme for Innovation and Research

- It is about improving measurement to drive innovation and competitiveness.
- **It enables European metrology institutes, industrial organisations and academia to collaborate on joint research projects.**
- It is implemented by EURAMET (European Association of National Metrology Institutes).
- It is based on Article 185 of the Lisbon Treaty.
- It is jointly funded by the EMPIR participating countries and the European Union and has a budget of approximately 600 M€ over seven years.

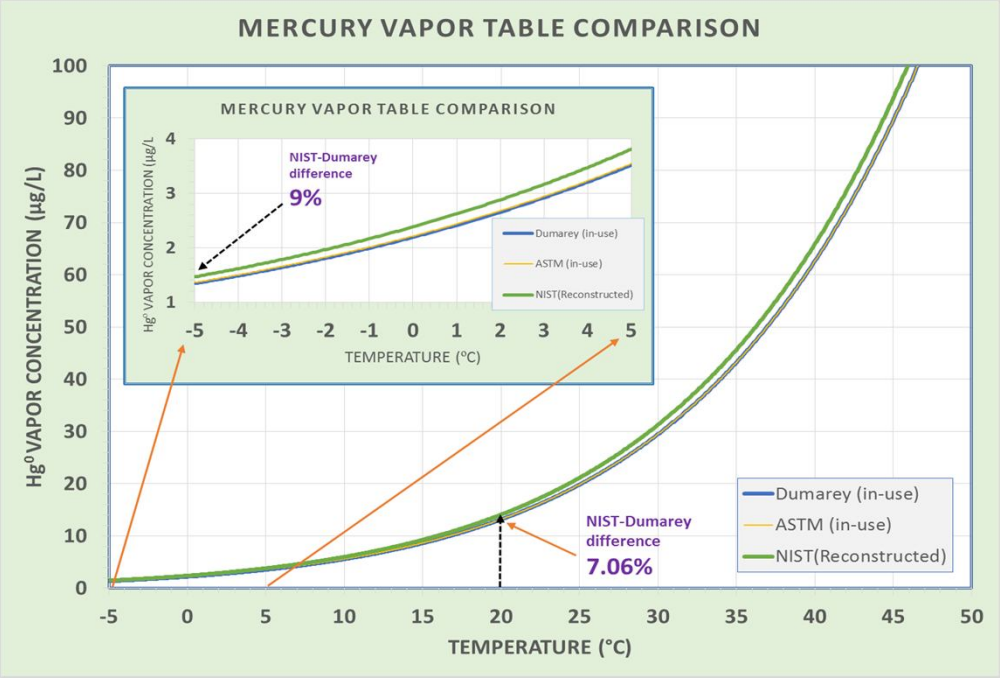
Analytical measurements need to be **comparable** in time and space

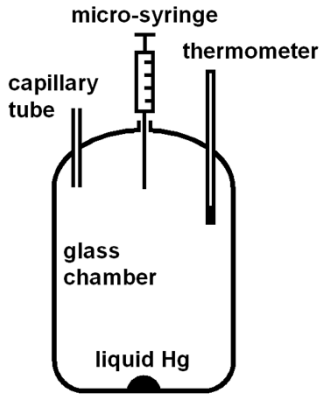
measurement traceability is the best way to achieve this

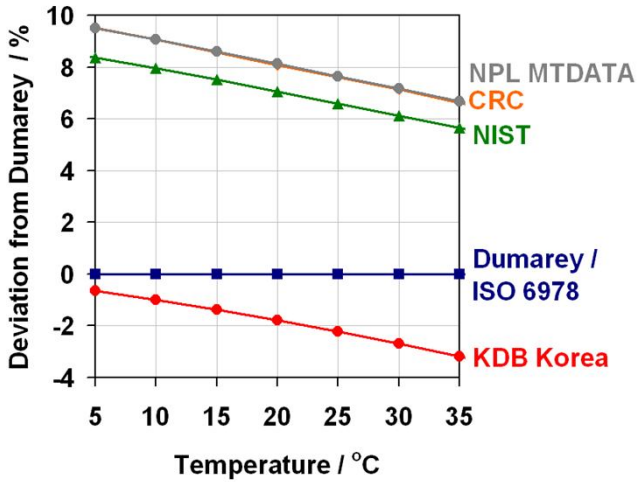




Traceability of the ("*metal*") vapour of the elemental mercury







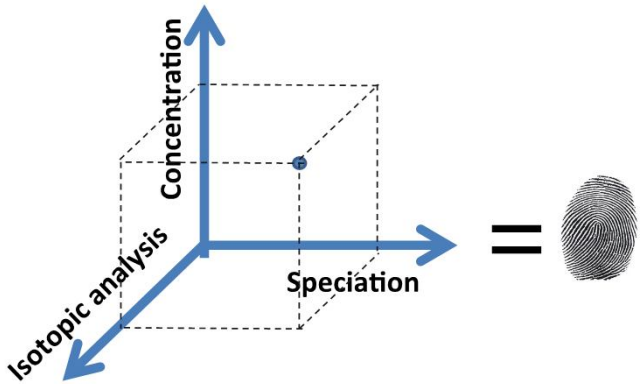
Current situation

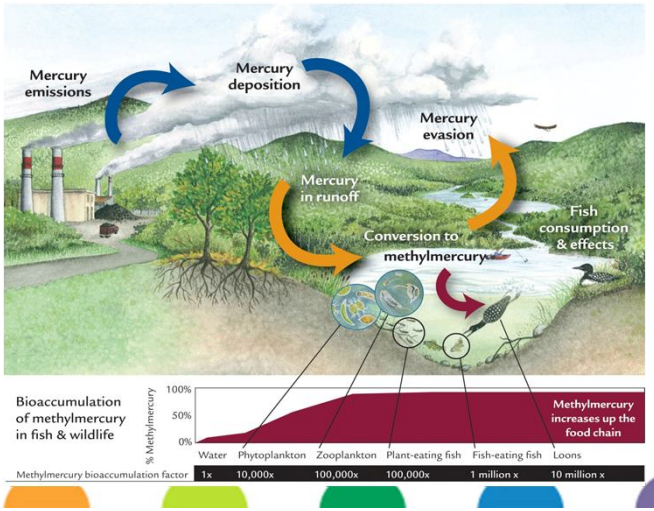
- Bell-jar
- Permeation device
- Gas mixtures
- IDMS

Mercury vapour concentration *dependent* upon equation used

EMRP/EMPIR - Hg related projects

- **Part Emission (2011-2014)** Develop a **gravimetric primary standard** in order to link the mercury (Hg(0)) traceability chain to gravimetry instead of the currently used mercury vapour concentration equations, at ambient level in the range 5 ng Hg/m^3 - 60 µg Hg/m^3.
- **MeTra (2014-2017)** The aim was to develop metrological infrastructure to measure key **mercury species and isotope ratios in all relevant environmental matrices,** aiming to provide tools to ensure reliability and comparability of measurement results.



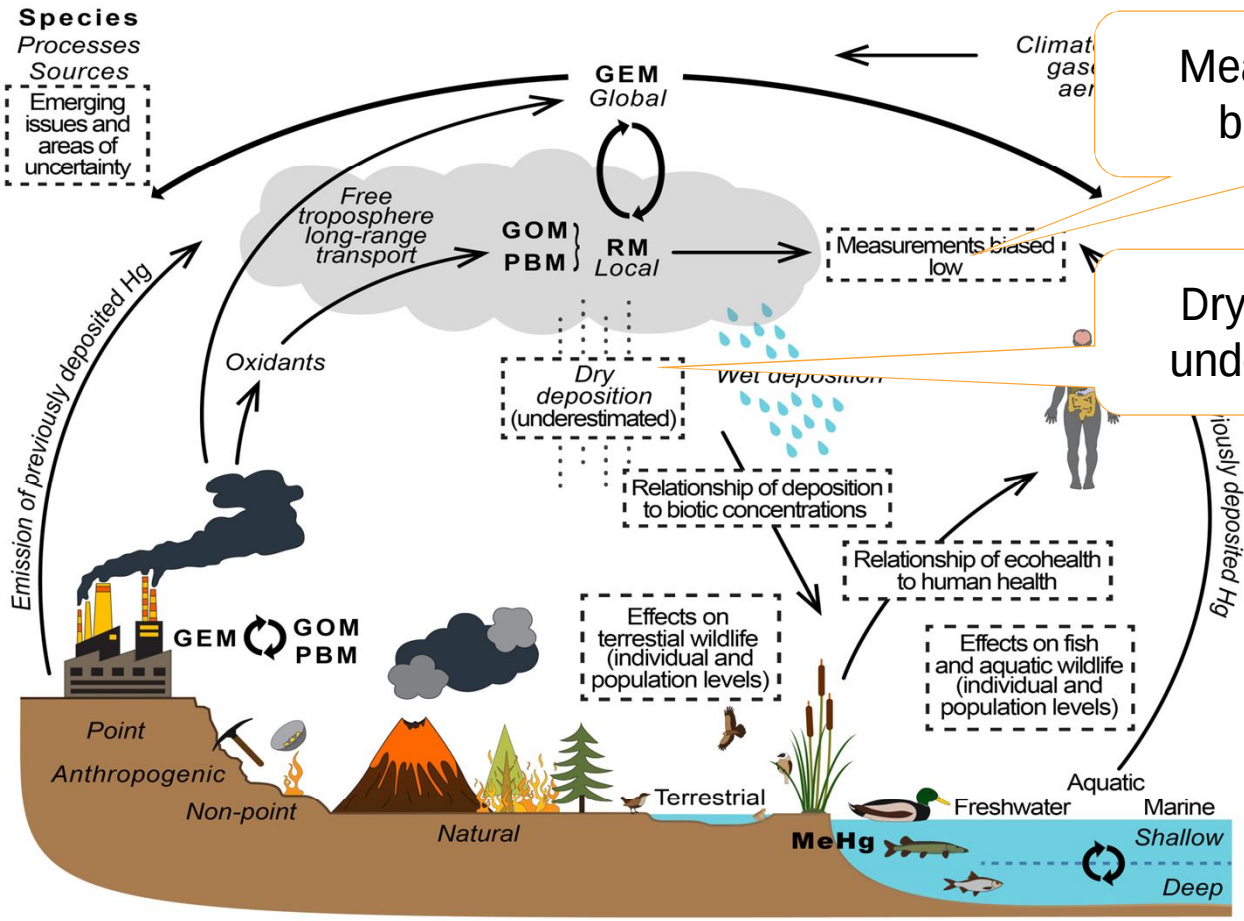


Emerging issues and areas of uncertainties

GEM – gaseous elemental Hg

GOM – gaseous oxidized Hg

RM- reactive Hg



Measurements biased low

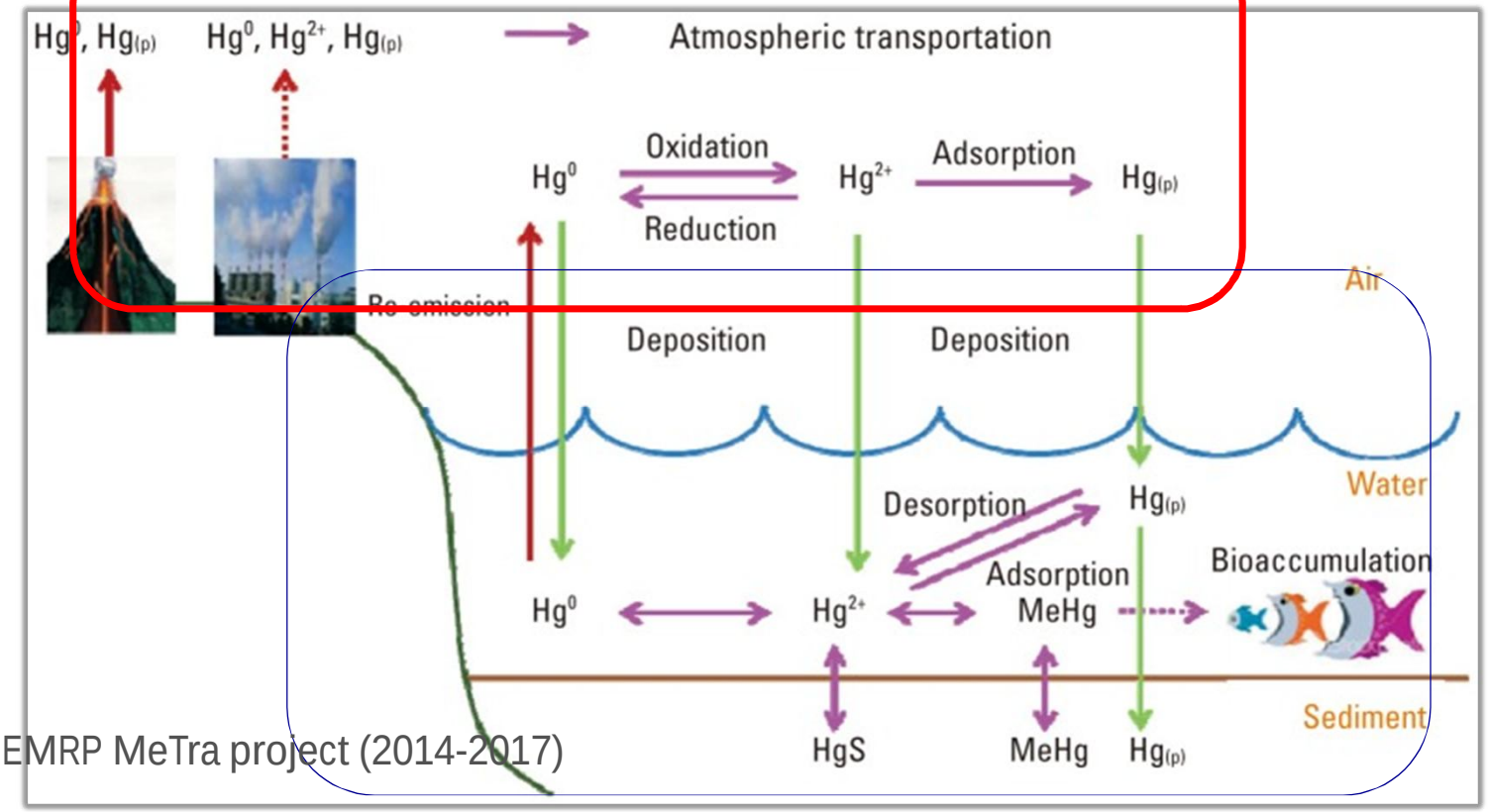
Dry deposition underestimated

Adopted from Gustin et al. 2016. EST

Currently no metrological infrastructure for traceable, validated and accurate measurements of oxidised mercury species in the atmosphere and emission sources exists.

MeTra & MercOx

EMPIR MercOx project (2017-2020)

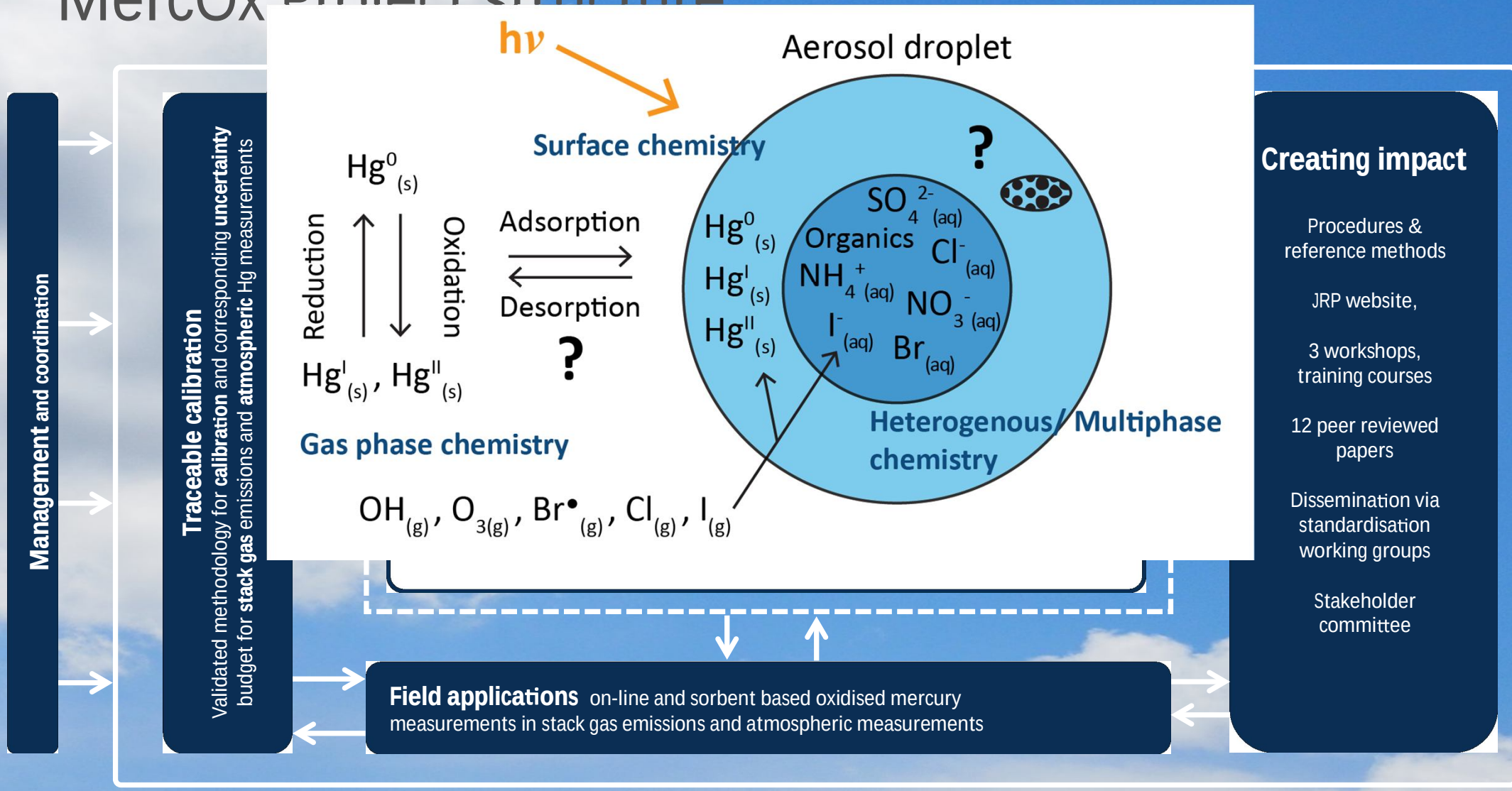


EMRP MeTra project (2014-2017)

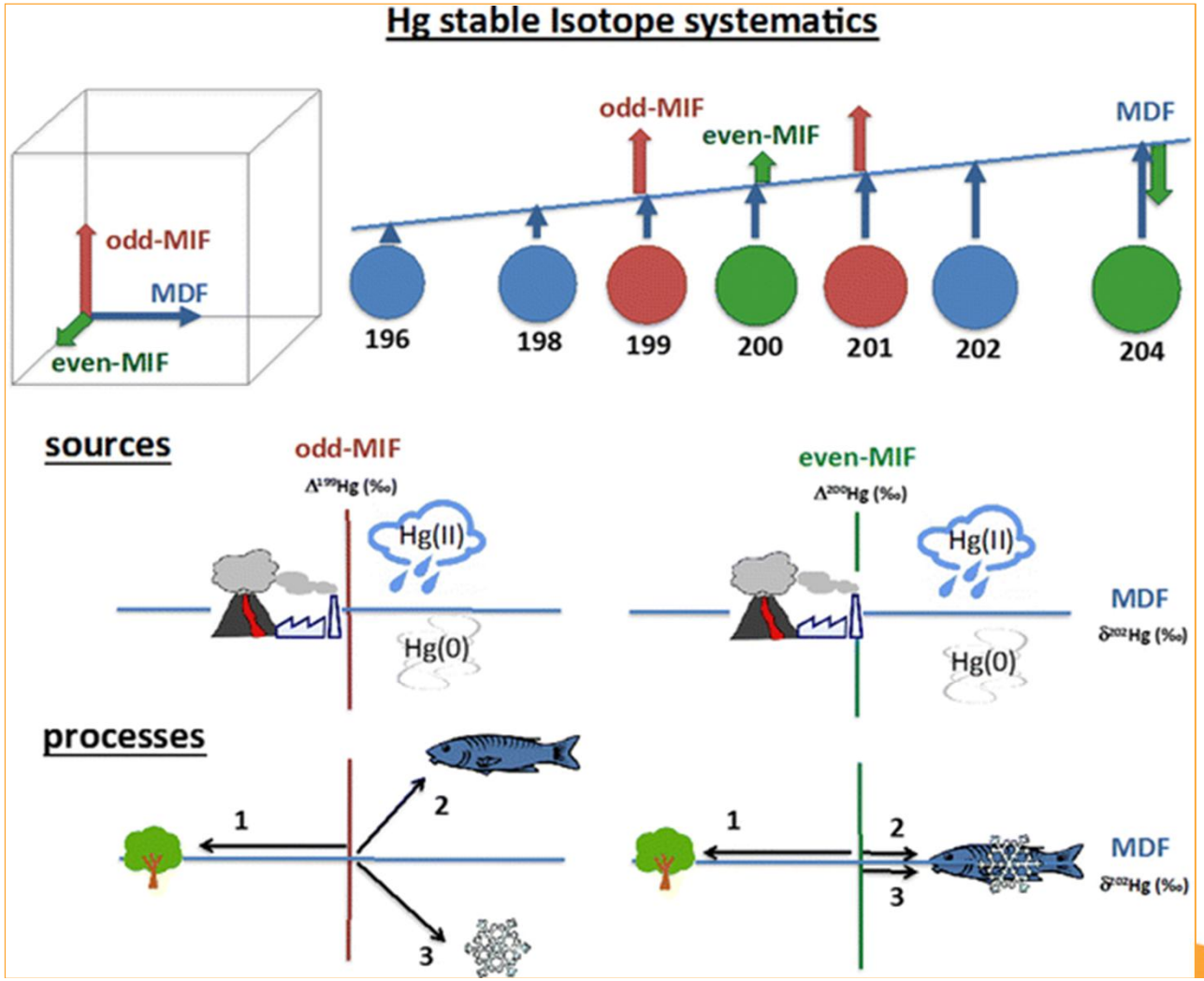
Aims

- MercOx aims to **validate and develop traceable oxidised Hg standards** and methods for **sampling and analysing oxidised Hg species** in **flue gas** emissions and in **the atmosphere**. This will result in significant improvement in measurement **uncertainty and comparability** of measurement results.
- MercOx will introduce **comparability of measurement** results to enable legislation and support Europe's international obligations to reduce Hg emissions. Europe and the NMIs involved will be able to take a leading role in the future of metrology for mercury measurements.

MercOx Project structure



Simplified schematic of Hg stable isotope systematics



MDF – mass dependent fractionation

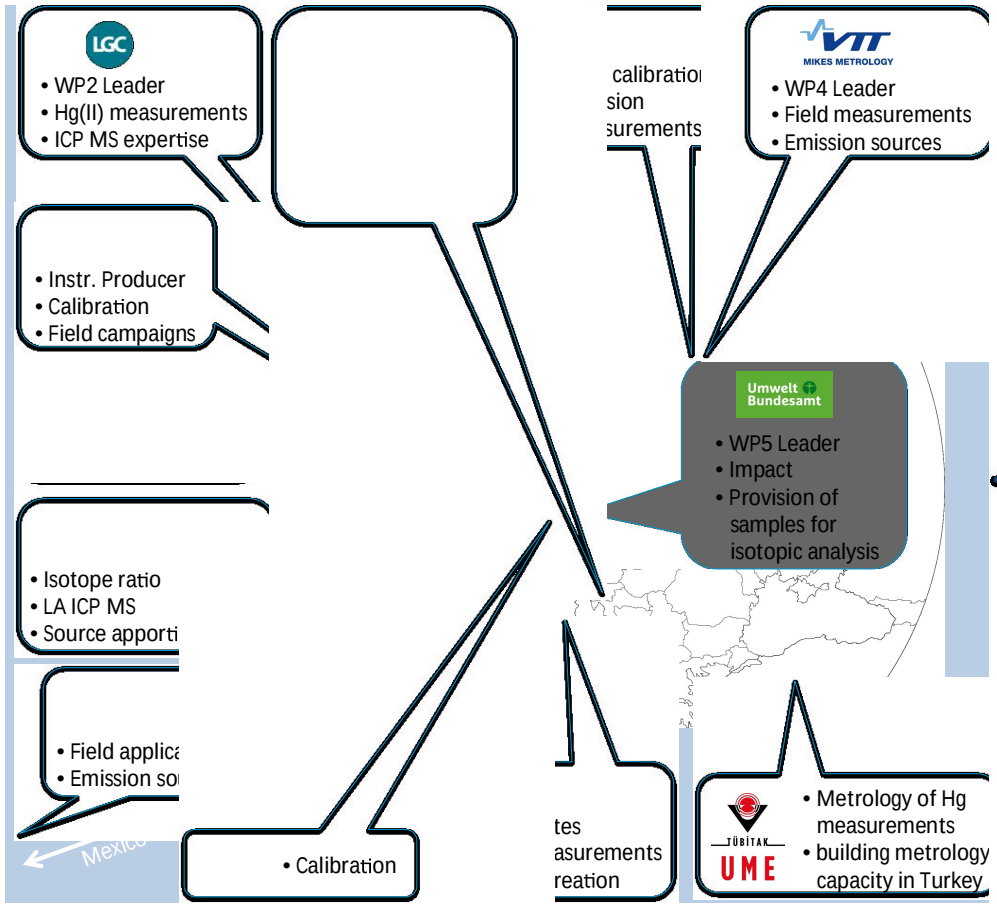
MIF – mass independent fractionation

Odd-MIF – ^{199}Hg and ^{201}Hg

Even-MIF- ^{200}Hg, ^{204}Hg

Wiederhold et al., 2010, Obrist et al., 2018

Partners and stakeholders



User group & Stakeholders
(28 Support Letters)

Regulation and policy makers:
UNEP, US EPA, IEA CCC, SAICM, EA (UK), CEMBUREAU, INECC;

National metrology institutions:
NIST, CENAM;

Monitoring programmes:
GEO, AMAP;

Standardisation bodies:
ISO/TC 158, ISO/TC 264;

Industrial partners:
Uniper, Finnsementti, Salonit, Ekokem, Helen, CFE;

Instrument manufacturers:
Tekran, ESI, PS Analytical, Mercury Instruments;

SMEs:
Arcadis, Ohio Lumex;

Academic institutions:
McGill University, University of Reno, UNAM