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Introduction: Updates from the OESG

Executive summary of the OESG Scientific Report

This document is the executive summary of the draft scientific report of the Open-Ended Scientific Group (OESG) of the Minamata Convention, as of 21 January 2026. This summary is to be presented at the first face-to-face meeting of the Effectiveness Evaluation Group in February 2026. The full draft report is available from the Convention Website. The OESG plans to make a draft report for Party input in February 2026.

Article 22 of the Minamata Convention commits the Conference of the Parties (COP) to evaluate the effectiveness of the Convention, beginning no later than six years after the Convention's entry into force and periodically thereafter at intervals to be decided by the COP.[1] The effectiveness evaluation is to be conducted on the basis of, among other things, available information on the presence and movement of mercury and mercury compounds in the environment, as well as trends in levels of mercury and mercury compounds observed in biotic media and vulnerable populations. The main purpose of the effectiveness evaluation framework is to assess whether the Parties' collective implementation of the commitments in the Convention is, or is likely to, achieve the objectives of the Convention. To make this assessment, the COP must address the following questions:

1. Have the Parties taken actions to implement the Minamata Convention?
2. Have the actions taken resulted in changes in mercury supply, use, emissions and releases into the environment?
3. Have those changes resulted in changes in levels of mercury in the environment, biotic media and vulnerable populations that can be attributed to the Minamata Convention?
4. To what extent are existing measures under the Minamata Convention meeting the objective of protecting human health and the environment from mercury?

To consider these questions, the COP has created two bodies: the Open-Ended Science Group (OESG) and the Effectiveness Evaluation Group (EEG). The OESG is charged with drafting a scientific report that assesses how changes in emissions and releases attributed to the Minamata Convention have contributed to observed changes in the levels of mercury in the environment and in exposures to biota and human populations (i.e., answering question 3 above). The OESG is also charged with identifying existing data gaps as well as potential scientific actions to address the identified gaps in information and lessons learned for future effectiveness evaluations. The OESG is to submit its scientific report and a summary of lessons learned to the EEG. In addition to the OESG's reports, the EEG will receive other information developed by the Secretariat concerning implementation of the Convention (based on Article 21 reporting) and changes in the global supply, use, and trade of mercury. The EEG is charged with synthesizing the available information into a final report and presenting recommendations for improvement, lessons learned and best practices to the Conference of the Parties. This document is a draft of the scientific report of the OESG.

[1] The Minamata Convention entered into force on 16 August 2017.

The OESG is composed of scientific experts nominated by Parties. It is "open-ended" in that the number of Parties who can participate is not limited; each Party may nominate one relevant expert to participate. Furthermore, Parties and stakeholder organizations may nominate additional individuals with relevant expertise to serve on a Roster of Experts, who may contribute to the technical work and discussions of the OESG. Currently, the OESG has 41 members nominated by Parties and a roster of 146 experts. In contrast, the EEG is a regionally representative body with 25 members, comprised of 5 individuals nominated from each of the 5 UN regions.

In accordance with its terms of reference, the OESG conducted its work in two stages:

- *Stage 1: Planning*
  - Plan for the compilation and summary of available monitoring data
  - Plan for the summary of available emissions and releases data
  - Plan for data analysis consistent with the Monitoring Guidance[2]
- *Stage 2: Implementation*
  - Summary of the compiled monitoring data
  - Summary of the available emissions and releases data
  - Data analysis addressing the guiding questions outlined in the Monitoring Guidance

OESG's plans for data collection and analysis were circulated to Parties prior to COP-5 and documented in UNEP/MC/COP.5/INF/24.

The OESG plan for collecting available monitoring data and estimates of emissions and releases provided

- Descriptions of the types of data and information that the OESG was seeking to inform their analyses. The data dictionary included in the plan evolved into the recommended data formats for each type of data to be submitted.
- List of known mercury monitoring programs and other sources of relevant environmental and human data, which provided a starting point for OESG outreach to data providers
- Principles that would be used by the OESG to guide its collection and analysis of data, which led to the development of data use agreements and practices.

Following this plan, the OESG began collecting data in September 2023 by inviting national focal points and observer organizations to identify relevant data. The Secretariat, with the support of the Biodiversity Research Institute, established an online data repository where data submissions could be collected for use by the OESG. Some data was submitted by Parties or research organizations, and some data was actively acquired by OESG and rostered experts. The OESG submitted an overview of monitoring, emission and release data to COP-6 (UNEP/MC/COP.6/INF/23)

The amount of data collected and analyzed has been limited by the time and resources available to support the data collection process, the lack of harmonized data reporting formats and existing infrastructure for data management, and limited awareness of Convention activities in the relevant national and international scientific communities.

The OESG's terms of reference specify that the OESG shall analyze the available information to address the "guiding questions" outlined in the Monitoring Guidance.[3] .The Monitoring Guidance outlines a series of six monitoring objectives:

- Estimation of mercury concentrations for areas without (i.e., background sites) or with (i.e., affected sites) local anthropogenic sources
- Identification of temporal trends
- Characterization of spatial patterns
- Estimation of source attribution of anthropogenic mercury
- Estimation of exposure and adverse impacts

The OESG developed a series of analysis questions to systematically address each of these themes. The OESG found that some of these analysis questions could be addressed by the available information, but many of the questions will require additional monitoring and model development. The main findings from this systematic analysis are presented below.

[2] The "Monitoring Guidance" referenced in decision MC-4/11 is the "Guidance on monitoring of mercury and mercury compounds to support evaluation of the effectiveness of the Minamata Convention" available as document UNEP/MC/COP.4/18/Add.2.

[3] Available as document UNEP/MC/COP.4/INF/12

Key Findings from the Analysis Questions

Emissions

Available estimates of Hg air emissions show an increase in global emissions between 2010 and 2022, driven largely by an increase in emissions from artisanal scale gold mining (ASGM), which are believed to be under reported (EDGAR; Cheng et al., 2023; supported by GMA based on the 2019 National Inventory reports). Estimates from EDGAR (Emission Database for Global Atmospheric Research) suggest that global Hg emissions peaked in 2018 at 1.98 Gg/year. 2022 annual global anthropogenic mercury emissions are estimated to be 1.86 Gg/year, with gold mining accounting for 50% of annual emissions.

The regional distribution of emissions has shifted over time. Emissions have declined in Europe, North America, Japan, Australia, New Zealand, Eastern Europe, and West-Central Asia. Emissions have increased in Africa, Eastern Asia, Latin America and the Caribbean, South-East Asia and Pacific, and Southern Asia. Sixty eight percent of current emissions now emanate from Africa, Eastern Asia, and Latin America, where ASGM is dominant.

Global air emissions from non-ASGM sources have generally decreased since 2008 (or 2010), with individual sectors showing slight decreases or almost constant levels over the decades, especially in recent years. This result may indicate that the level of mitigation that has been achieved in specific sectors is different in different regions.

Globally, total Hg (THg) air emissions from chlor alkali production, which is addressed by Article 5 of the Convention, have decreased dramatically, declining 95% since 1970 and 49% since 2010. Coal extraction and combustion accounted for 31% of emissions in 1970 and has declined to 18% of emissions in 2022.

Between 2010 and 2022, major air emission sources (under Article 8) have changed little globally, declining only 2%. While emissions from coal combustion decreased by 21%, emissions from metal production and cement production increased by 18% and 26% respectively.

Gold mining sources under Article 7 have increased by 49%. Chlor Alkali production emissions (under Article 5) have declined by 49%. Sources associated with mercury use in products (Article 4) and other manufacturing processes (Article 5) appear to have increased moderately.

Releases

There are far more data available on Hg emissions (THg and Hg speciation) to air than for Hg releases to land and water (as noted by the pollutant release and transfer registers, PRTR). Furthermore, there are significant data gaps over the reporting period for both releases to water and land. Modelling of anthropogenic releases to land and water can be of help in narrowing or addressing this gap.

Releases to water and land are estimated using several different methods, including estimating releases from source category-specific air emissions estimates, source-category specific activity rates, and regional Hg consumption patterns. It should be noted that release estimates are highly uncertain.

ASGM is a major global source of mercury, but current data on water releases are too uncertain to be included in existing estimates. ASGM activity is highest in Africa, Latin America, and Southeast Asia.

For source categories for which global estimates are available, the highest releases to water are associated with municipal wastewater (40 to 460 tonnes per year), coal fired power plants (10-130 t/yr), coal washing (10-100 t/yr), and mercury containing products (~ 100 t/yr). The estimated releases from these sources are highest in Asia.

Air

Current levels and geographical coverage:

The levels of mercury observed in the ambient air for total gaseous mercury (TGM) and gaseous elemental mercury (GEM) vary around the world and over time. Globally, TGM (active sampling) levels are 1.51 (0.49-12.2) ng m^{-3}. There are distinct hemispherical differences whereby the northern hemispheric (NH) average concentration is 1.54 (0.50 – 12.8) ng m^{-3} and the southern hemispheric (SH) average concentration is 0.99 (0.33-4.51) ng m^{-3}. For GEM (passive sampling[4]) the global average concentration is 1.46 (0.94-2.62) ng m^{-3}. The NH average concentration is 1.48 (1.06-2.60) ng m^{-3}, the SH average is 1.34 (0.94-2.62)-2.56) ng m^{-3}.

For active air sampling of TGM, most of the levels of mercury fall within the northern or southern hemispheric averages except for East Asia where levels are higher. The passive Hg data has more spatial coverage than the active data and thus shows a similar pattern but different levels. For the passive air sampling data, areas in South America, Africa and East Asia report above average concentration levels in comparison to the hemispherical averages. The West/Central African levels are very high (mean = 14.48 ng m^{-3}).

[4] Several sites submitted for the effectiveness evaluation reported GEM concentrations significantly higher than the global average. To avoid skewing the results, any site found to have a site average 5 times greater than standard deviation of the global average was classified as outliers and excluded from subsequent statistical analysis. Applying this condition resulted in the removal of eight sites from the hemispheric and regional analyses.

The overall "typical" concentration of mercury in precipitation is between 7.5 and 11.5 ng Hg L^{-1} based upon the submitted long-term measurements in North America, Japan and Europe. Dry, western North America has the highest typical concentration of 11-12 ng Hg L^{-1}. Eastern North America, Europe, and Japan have similarly wetter climates and have a typical concentration of 7.5 ng Hg L^{-1}. These values have been consistent since 2010, varying by only 2 to 3 ng Hg L^{-1} over the years. Some of this variability is due to precipitation amount variability between the years; wetter (drier) conditions lead to lower (higher) concentrations when the mercury content does not change. Measurements suggest there is a slight (not significant) tendency for decreasing concentrations over all sites. Despite regional similarities, individual sites themselves can exhibit considerable variability.

Wet deposition measurements of Hg are missing from Asia, Africa and South America and there are no consistent measurements available over the oceans. However, given what we know about the behavior of Hg in the atmosphere and limited measurements reported in the scientific literature, it is reasonable to assume the concentration and deposition rates in the drier regions of Asia and Africa are similar to western North American rates. This is also likely true in South America. The moister regions of the landmasses are likely to have concentration and deposition rates similar to those measured in Europe, Japan, and Eastern North America. Local areas with large and local sources of mercury, with abundant rain will likely have the highest deposition rates (e.g., eastern China, Indonesia).

Time trend and gaps:

Temporal trends for active TGM measurements were estimated for 77 of the sites with at least 5 years of data. The trends calculated are for all years of data that were collected and thus variability is expected. Of the trends reported, 49% show a decreasing trend, 49% show no trend and 1% show an increasing trend. It should be noted that the data from these types of measurements are mostly from northern hemispherical locations. Temporal trends were not calculated with the passive GEM data as there is not yet sufficient data for a statistically significant analysis.

For precipitation, temporal trends were estimated for precipitation weighted mean concentrations at 132 sites. 80% of sites show no statistically significant change, about 20% of sites show a decrease in concentration and two sites show an increase in concentration. Trends in overall wet deposition of Hg may be driven by changes in both Hg concentration and precipitation amounts. Approximately 87% of sites show no significant temporal trend in wet deposition of mercury. In Asia, no trends were found in the 2 sites in Japan for wet deposition. Five sites situated along the US/Canada border and one site in western North America show significant increases in wet deposition of Hg. Several of these sites have increasing precipitation rates, suggesting more precipitation is driving some of these higher deposition rates.

In general, most of the data presented are from background locations. However, over the years, there are some areas that stand out with elevated levels including parts of Asia, South America, Western Africa and the general tropics areas. At times at some of the locations, ambient levels of mercury exceeded established health guidance levels. These locations are in areas of known ASGM activities.

While the data presented in this report appear, at times, to be a fulsome data set, there are significant gaps in global air monitoring especially in areas of significantly high levels. Active air and wet deposition monitoring information reflects primarily the northern hemisphere. The passive air monitoring has enabled a preliminary look at levels in other areas of the world that are elevated above global/northern hemispherical averages.

Biota

What are current levels of Hg observed in biota?

- Current levels were defined as total mercury measured between 2014 and 2024. Only a small set of the submitted data (31%) represents samples collected during the last decade.
- The majority of the submitted biota data did not reliably support differentiation between sites directly impacted by mercury sources and those that were not. This finding is due to limited information from the submissions.
- The most frequently sampled matrices were fish (muscle), followed by birds (feathers, blood and eggs), invertebrates (soft tissues), and mammals (liver and muscle). Mercury concentrations varied widely, often spanning several orders of magnitude depending on tissues and species.
  - ✧ Across regions and species, THg concentrations in bivalve soft tissues ranged over two orders of magnitude from 10.2 to 2,070 ng g^{-1} d.w.
  - ✧ Across regions and species, THg concentrations in fish muscle samples ranged over four orders of magnitude from <0.1 to 16,400 ng g^{-1} w.w.
  - ✧ Across regions and species, THg ranged from <0.1-6,000 ng g^{-1} d.w and 2-72,790 ng g^{-1} d.w in bird eggs and feathers, respectively.
  - ✧ Across regions and species, THg concentrations in marine mammal individuals ranged over several orders of magnitude: from 16.5 to 5,962,000 ng g^{-1} d.w. in liver and 3-472,000 ng g^{-1} d.w. in muscle.
- The biota data are not suitable for global-scale spatial pattern analysis due to limited geographic coverage and broad variability on the species and trophic position among different regions. Spatial

comparisons may be more feasible at regional levels where the same species are well sampled such as in North America, Europe or the Arctic.

- Data coverage is uneven: intensive monitoring exists in North America, Europe and East Asia, but large gaps remain in Africa (AF), Latin America and the Caribbean (LAC), South Asia, and parts of the Pacific. Monitoring in artisanal and small-scale gold mining (ASGM) regions is critical, as these are major mercury emission hotspots.

Greater use of knowledge, sciences and practices of Indigenous Peoples will strengthen the relevance, inclusivity, and cultural appropriateness of monitoring programs.

How do current levels of Hg observed in biota compare to levels in established guidelines?

- **Invertebrates:**
  - ✧ Observed total mercury concentrations were compared with OSPAR background assessment concentrations for the Northeast Atlantic region and the EU's Maximum Permissible Concentration in food for the protection of public health by the European Commission (1881/2006/EC) to determine the proportion of individuals exceeding these thresholds from 2014–2023.
  - ✧ 65% of all oyster observations and 59% of all mussel observations were above the background assessment concentrations defined by OSPAR Commission for the Northeast Atlantic region, but none surpassed food safety limits, indicating low human health risk (500 ng g^{-1} w.w).
- **Fish:**
  - ✧ Toxicity benchmarks were selected by choosing Toxicity Reference Values (TRVs) that were mathematically derived using a benchmark dose analysis framework when available, as recommended by the U.S. Environmental Protection Agency and European Food Safety Authority.
  - ✧ When mathematically derived TRVs were not available, the best available benchmarks from recent peer-reviewed review papers were selected.
  - ✧ By comparing observed fish mercury concentrations against these TRVs, we assessed the likelihood of adverse effects on endpoints such as reproductive success, behavior, growth, and survival, thereby providing a consistent framework for evaluating ecological health risks across regions and taxa.
  - ✧ Mercury contamination is widespread, with evidence of reproductive, behavioral, growth and survival risks across multiple regions, including regions of Africa, Asia, Australia, Europe, and North and South America.
  - ✧ Higher level TRVs for behavioral, growth, and survival effects were exceeded less frequently but remained substantial in hotspots such as the North Atlantic, Pacific Ocean, and southeastern Africa, particularly where shark species dominated samples.
- **Birds:**
  - ✧ Toxicity benchmarks were selected by choosing TRVs that were mathematically derived using a benchmark dose analysis framework when available, as recommended by the U.S. Environmental Protection Agency and European Food Safety Authority. When mathematically derived TRVs were not available, the best available benchmarks were selected from the specific recent review papers.
  - ✧ Egg THg concentrations were largely below a toxicity reference value (TRV) of 0.7 µg g^{-1} w.w.
  - ✧ Nearly 35% of feather THg concentrations (d.w.) were above a toxicity reference value at no apparent effect category (Chastel et al., 2022). Nearly 23% (2,872 of 12,123) were at low risk, while 6% (731), 1 % (128) and 3.68% (447) were at median, high and severe risk categories, respectively.
  - ✧ Across all IPCC regions, more than half of adult bird blood samples (54.4%) exceeded the EC01 threshold for low injury (0.09 µg g^{-1} w.w.), with 14.6% surpassing the EC05 benchmark for moderate injury (0.6 µg g^{-1} w.w.). A further 9.6% exceeded the EC10 high injury threshold (1.3 µg g^{-1} w.w.), and 1.2% of samples were above the EC20 level associated with severe injury (3.2 µg g^{-1} w.w.).
- **Marine mammals:**
  - To evaluate the risk of mercury toxicity in marine mammals, total mercury concentrations in liver were compared to the four risk categories: ≤16 µg g^{-1} w.w. (No risk), 16–83 µg g^{-1} w.w. (Low risk), 83–126 µg g^{-1} w.w. (High risk), and ≥126 µg g^{-1} w.w. (Severe risk). Risk categories for adverse effects of mercury on the reproduction, physiology, condition, and behaviour of mammals have been developed by Dietz et al. (2022).

- Marine mammals showed widespread mercury exposure: 53% of species (8 out of 15 species) in the 2014–2024 dataset had individuals above the ≥ 16 µg g^{-1} w.w. risk threshold, and 40% (6 out of 15 species) had individuals in the high to severe risk categories. The species most consistently exceeding these benchmarks include beluga, Blainville's beaked whale, false killer whale, grey seal, long finned pilot whale, polar bear, ringed seal, and strap toothed beaked whale, predators positioned high in marine food webs where mercury strongly bioaccumulates.

How have levels of Hg in biota changed over the available record?

Across regional and local case studies (AMAP, Beluga Case Study, OSPAR/HELCOM, NOAA Mussel Watch, Great Lakes, Fennoscandia, Australian Derwent Estuary Program, Common Loon blood mercury study, Japan's case study), mercury in biota exhibits stable, increasing, and decreasing trends, driven by a complex interplay of local ecology, food-web dynamics, species traits, climate influences, legacy contamination, biogeochemistry, and hydrodynamics. While mercury emission reductions provide benefits, biotic responses are often slow, uneven, and masked by legacy stores and ecological factors. Exceedances of health and environmental thresholds remain common in some systems.

Humans

Current exposure:

The first findings from the cross-sectional studies review show that the highest Hg non-occupational exposures were observed for Indigenous freshwater (inland) fish consumers, which are mostly represented by South American riverside communities. Among them, 86 % population groups were reported to live on ASGM contaminated sites, and their average Hg blood or hair levels were 12 times higher than those of the other riverside Indigenous communities and 13 times higher than in the general population.
Occupational exposures to Hg have been observed at levels 6 times higher than in the general population. Some of the highest exposures have been observed in mercury and gold mining, chlorine production, and thermometer and fluorescent lamp manufacturing.

Geographical patterns:

Due to ongoing ASGM activities affecting wider regions inhabited by fish consuming communities, current human Hg exposures appear to be highest in South America. Among the nationally representative HBM programs, Japan was recently reported to have 3 times higher exposure in adults than the Republic of Korea, and approximately 6 times higher than other available national programs. Across the general (background) population, the exposure is generally higher in populations residing in coastal regions than inland, which is most plausibly driven by dietary habits, particularly seafood and fish consumption.

Time trends and interventions:

Generally, a stable or slightly decreasing trend in Hg exposure can be observed in the last two decades from the available nationally representative data. Regional temporal data is available for pregnant women from the Arctic region of Nunavik and showed marked decrease in Hg exposure from year 2000. However, further analysis of time trends needs to be done using all data from cross-sectional studies to provide a more complete assessment of temporal exposures over different population groups and regions. This will be completed by June 2026.
We have no evidence that the decline in Hg exposure can be directly attributed to the mitigation measures influenced by the Convention. However, there have been case studies conducted regionally or locally that demonstrate decline in exposure following certain measures or interventions, including:

- the phase-down of dental amalgam use has resulted in measurable reductions in children's Hg body burden in Slovenia from 2007 to 2024
- dietary recommendations and interventions to improve access to low-contaminant foods and essential nutrients have resulted in decreasing burdens of Hg and POPs in some Arctic regions
- dietary intervention studies in coastal fish-consuming countries in Europe were successful in lowering the Hg exposures in pregnant women below health-based guidance values.

Other Matrices

Soil

The available data was very sparse except for the USA and Australia, and the available datasets covered different periods, making comparisons and interpretations very difficult. No sites were sampled over time which prevented any evaluation of temporal trends and no mono methyl mercury (MMHg) data was available.
A clear difference between background and anthropogenic levels was difficult to establish with the available data due to the intrinsically high spatial variability of soil THg.

THg levels in soils seem to be regulated by the presence of soil organic matter on the surface and/or the presence of metallic oxides (e.g., iron or manganese oxides) at depth but the relationships observed can strongly vary.

Sediment

Global lake sediment records show that Hg concentrations and fluxes were low and comparable between unimpacted and impacted sites during the pre-industrial period, but diverged thereafter. Unimpacted/remote sites showed steady increases to 2010–2020 while impacted sites collectively peaked around 1990–2000 and declined thereafter, particularly in the IPCC regions of Northern Europe, Eastern North America, Northeast North America, South-Central America, and Northwest-South America.

Flux based enrichment factors (EFs) were used to assess the magnitude of Hg enrichment over various time periods and showed that, as expected and consistent with prior literature, modern (2010-2020) EFs are significantly higher in impacted regions (~7.3) than in unimpacted regions (~3.6). In unimpacted regions, highest modern EFs are observed in Northern Europe, the Tibetan Plateau, and the Arctic while the lowest EFs are observed in South and Southwest-South America.

In unimpacted regions and during some early periods in impacted regions, Hg concentrations were positively correlated with organic matter. This is indicative of the well-established co-transport of Hg and organic matter to lake sediments.

In both impacted and unimpacted regions, Hg fluxes were strongly correlated with aluminum, reflecting the dominant role of sedimentation rates, particularly the delivery of mineral rich catchment material, in controlling sediment derived Hg depositional fluxes.

While catchment:lake area ratios were not a strong predictor of enrichment across the global dataset, watershed development showed a clear influence. Pristine catchments maintained low EFs (<3) over the entire temporal record and minimally to heavily developed catchments exhibited progressively higher and more sustained Hg enrichment (median EFs ~ 5–9 by 2000–2010).

Fresh Water

Freshwater data has limited spatial coverage and is mostly from the Northern Hemisphere. Most data are site-specific or local. Inadequate spatial coverage makes it difficult to assess regional and global patterns. All of the submissions included total Hg and none reported methyl Hg.

The usability of the submitted data for trend analysis is limited due to analytical uncertainties and inconsistent methodologies. Many of the datasets with higher analytical detection limits and data were censored at the reporting limit.

Few multidecadal scientific monitoring studies exist on total Hg and methyl Hg in freshwater systems away from point sources, restricting quantitative assessments of change over time.

A national study of rivers in the Northen Hemisphere highlighted shifting trends in Hg concentrations with most recent increases.

In rivers (lotic systems), Hg variability is driven by flow and particle transport, and its mobility is closely linked to dissolved organic carbon (DOC), especially during high discharge.

In lakes (lentic systems), Hg and methyl Hg are influenced by sediment interactions, seasonal redox conditions, lake water level oscillations, or upstream inflow, with DOC playing a stabilizing role.

Ocean Water

Ocean THg and methyl mercury (MeHg) water column data was available in 62% and 42% of the 55 IPCC open ocean and coastal regions, respectively.

There was no water column Hg monitoring data available and data from the scientific literature is not sufficient to conduct an evaluation of temporal trends.

For both THg and MeHg, the highest concentrations in the surface ocean were found in Polar Regions and the lowest concentrations were found in the South Pacific Ocean.

For both THg and MeHg, the largest difference between coastal and open ocean concentrations were found in midlatitudes and equatorial regions, while little difference was seen for the Polar regions.

The %MeHg in the water varied between 2 and 15% for the surface ocean with a similar range found in the open ocean and coastal ocean. However, there is an indication of lower %MeHg in the southern hemisphere open ocean.

THg concentrations correlated with salinity outside of the Polar regions while no correlation was found between MeHg and salinity. Low salinity (coastal) Hg concentrations varied by several orders of magnitude.

Better data coverage including more coastal regions, sampling method development and more laboratory/method intercomparison studies, better collaboration and use of passive samplers, and an official database extending the current data compilation and including more ancillary data are needed.

Cross Media Comparisons of Observed Trends and Patterns

The Northern Hemispheric average concentration is higher than the Southern Hemispheric average concentration, which is consistent with historical anthropogenic emission patterns. In recent decades, anthropogenic emissions in much of the Northern Hemisphere have declined or stayed constant. This trend in emissions is broadly consistent with the trends observed by active TGM measurements, which are mostly in the Northern Hemisphere. Emissions in the Southern Hemisphere, mostly associated with ASGM, have been increasing. Passive air samplers have been used recently to observe high air concentrations in ASGM areas. However, an increase in the Southern Hemispheric average air concentrations has not been observed at the limited number of sites where long-term observations are available. Additional sustained observations in the Southern Hemisphere are needed.

Given available data, it is unlikely that quantitative conclusions will be drawn from the direct cross-media comparison at broad spatial scales. However, several regional case studies provide information on the linkages between media in the specific contexts of the cases studied. Those studies include:

- Spatial and temporal trends and the distribution observed in tropical tuna in global ocean relate to the spatial/temporal trends of cross media levels and emissions.
- The Mediterranean case study showed holistic datasets in the region, which could be further analysed for cross media comparison.
- The impacts of long-term national efforts on the emission reduction and environmental monitoring around historical contamination sites would be the basis of further analysis of cross media comparison after the Convention.
- Analysis of ASGM sites and observation in East China Sea would also be the basis of further analysis of cross media comparison after the Convention.

Model Evaluation and Process and Source Attribution for Air and Oceans

Quantitative information about the processes and sources driving trends and patterns in global atmosphere and oceans is available from the ongoing Multi-Compartment Mercury Modelling and Analysis Project (MCHgMAP), including comparison of model estimates and observed levels.

Model simulations generally reproduce observed spatial patterns and deposition, but uncertainties in emission inventories – particularly for ASGM, waste, and regional sources – cause discrepancies with observed trends.

Global mercury (Hg) cycling is dominated by legacy re-emissions from soils and oceans (~70% of annual fluxes), with ongoing anthropogenic emissions contributing ~25%. Atmospheric Hg shows elevated concentrations over industrial and artisanal mining regions, with deposition highest in tropical forests and northern mid-latitudes. Observed declines in the Northern Hemisphere largely reflect reductions in anthropogenic emissions, indicating early effectiveness of the Minamata Convention, while ASGM-driven trends dominate the Southern Hemisphere. Model simulations generally reproduce observed spatial patterns and deposition, but uncertainties in emission inventories – particularly for ASGM, waste, and regional sources – cause discrepancies with observed trends. Ocean Hg levels are largely stable, with upwelling regions, polar areas, and the Northern Hemisphere showing highest concentrations; atmospheric inputs strongly control surface ocean Hg. Full Minamata implementation could reduce global anthropogenic Hg emissions by ~18% by 2050.

Key findings on global Hg sources, trends, and future prospects (2010–2020)

- **Primary and secondary sources:** Global natural Hg emissions (~270 Mg/year) come mainly from volcanoes and rock weathering, while biomass burning (~280–600 Mg/year) drives interannual variability. Secondary Hg emissions from soils (~2200 Mg/year) dominate the land–atmosphere exchange and are influenced by soil properties, climate, and vegetation, though uncertainties remain high due to sparse measurements.

- **Atmospheric patterns:** Hg concentrations are elevated over industrial regions and artisanal mining areas, with deposition highest in tropical forests and northern mid-latitudes. Dry deposition dominates over land, wet deposition over oceans. Current monitoring is geographically biased toward the Northern Hemisphere; models fill major gaps, especially in the tropics, Southern Hemisphere, and parts of Asia and Africa.

- **Drivers of trends:** Observed declines in Northern Hemisphere atmospheric elemental mercury (Hg(0)) are largely driven by reductions in anthropogenic emissions, particularly non-ASGM sources, reflecting early Minamata Convention impacts. Environmental drivers had minor effects on Hg(0) trends but modest effects on wet deposition. ASGM emissions dominate trends in the Southern Hemisphere, though attribution is limited by sparse observations and uncertain inventories.

- **Oceanic Hg:** Surface ocean Hg concentrations are highest in upwelling regions, polar areas, and the Northern Hemisphere, strongly influenced by atmospheric inputs. Global levels remained largely stable (2010–2020), with natural variability (e.g., ENSO) driving short-term changes. Ocean Hg acts as a net emitter (300–900 Mg/year) but shows limited temporal trends over the period. Observations are sparse; models provide continuous coverage and reveal features not captured by measurements.

- **Mass balance and re-emissions:** Legacy soil and ocean re-emissions (~70% of annual fluxes) dominate global Hg cycling, while ongoing primary anthropogenic emissions contribute ~25%. Approximately 76–86% of the increase in secondary emissions from soils and oceans (2010–2020) is attributable to changes in anthropogenic emissions. The atmosphere holds <0.5% of total Hg, with soils and the deep ocean as major reservoirs.

- **Future projections:** Under current legislation, global anthropogenic Hg emissions are expected to remain stable, but full implementation of Minamata Convention National Action Plans and co-benefit air pollution controls could reduce emissions by ~18% relative to 2015. Predicted regional trends vary as follows: declines in China, rising emissions in India (non-power sectors), and high uncertainty in ASGM-dominated regions of Africa, South America, and Southeast Asia. Fossil fuel and industrial emissions are relatively well constrained; waste and ASGM emissions remain highly uncertain.

Process and Source Attribution for Biota, Humans, and Other Media

The available observations and models are not sufficient to provide quantitative statements about process and source attribution for biota, humans, and other media.
However, several case studies give information on cross media comparisons in the context of the case studies. Those include:

- A case study on tropical tuna showed non-detectable temporal trends in current decades. Long-term monitoring is necessary to detect the substantial change in tuna levels, in 10 to 25 years.

- Case study on the Great Lakes showed different temporal trends in observations in emission, atmospheric deposition and fish concentrations in monitoring data. Fish levels were rather unchanged in contrast to change of emissions and deposition.