Policy Brief 1

Advancing global mercury management through innovation and collaboration

Background

Mercury pollution continues to pose significant risks to environmental and human health globally. The Global Mercury Observation Training Network (GMOS-Train), a collaborative effort supported by the EU's Horizon 2020 program, aims to enhance understanding of mercury dynamics and improve methodologies for mercury monitoring. This initiative aligns with the objectives of the Minamata Convention on Mercury by addressing key challenges in mercury emissions, transformation processes, and deposition pathways.

Key Findings

1. Innovations in mercury measurement:

- **Gaseous Elemental Mercury (GEM):** Developed a continuous flow calibration method traceable to the NIST 3133 standard, ensuring greater accuracy in low-concentration measurements.
- **Gaseous Oxidized Mercury (GOM):** Introduced a non-thermal plasma oxidation technique, reducing uncertainties in ambient air measurements and providing reliable data critical for environmental assessments.

2. Global observations and regional insights:

- Extensive datasets were collected from diverse locations, including the Chacaltaya Observatory (Bolivia), the Maïdo Observatory (La Réunion Island), and Slovenia near industrial sites.
- **Notable findings:**
  - Volcanic influences: Evidence of mercury depletion in volcanic plumes.
  - Industrial emissions: Variability in mercury species linked to cement plant operations.
  - Seasonal patterns: Mercury levels influenced by biomass burning and vegetation uptake.

3. Advanced modeling and uncertainty analysis:

- Applied models such as HYSPLIT and FLEXPART to trace mercury transport and deposition patterns.
- Used statistical techniques like bootstrapping and Monte Carlo simulations to quantify uncertainties, enhancing confidence in mercury datasets.

Recommendations

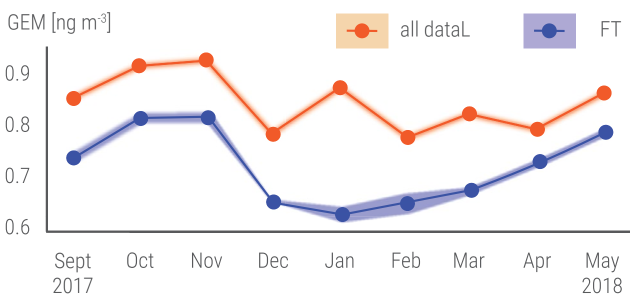
1. **Standardization of measurement protocols:**
   Governments and research institutions should adopt GMOS-Train's advanced calibration methods to ensure consistent mercury monitoring worldwide.

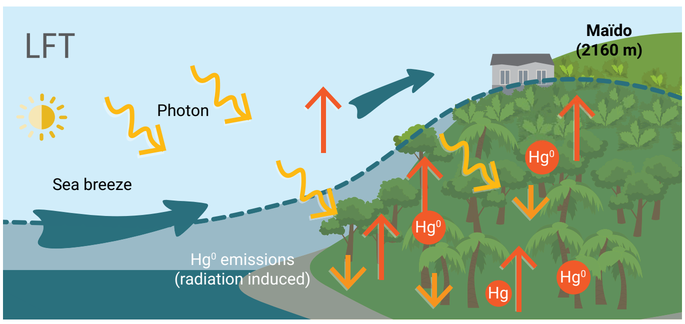
2. **Targeted mitigation in high-risk areas:**
   Focus efforts on regions with significant mercury emissions, including industrial and biomass-burning zones. Promote the adoption of emission-reduction technologies.

3. **Enhanced collaboration and knowledge sharing:**
   Strengthen partnerships among researchers, policymakers, and industries to implement mercury mitigation strategies and advance scientific understanding.

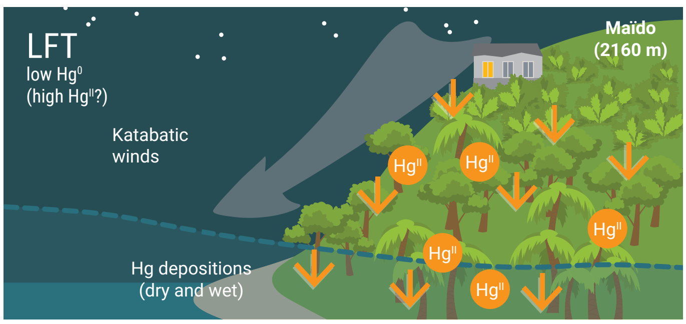
4. **Investment in monitoring infrastructure:**
   Expand monitoring networks in underrepresented regions and support innovations in atmospheric mercury modeling.

Visual Insight





Net Hg emission during the daytime



Net Hg deposition during nighttime?

Figure 1: Mercury Species Variability Across Global Monitoring Sites, highlighting data from the Chacaltaya Observatory (Bolivia), the Southern Hemisphere. This figure highlights the significant diurnal and seasonal patterns influenced by atmospheric and environmental dynamics (Adoptem from Koening et al., 2023, https://doi.org/10.5194/acp-23-1309-2023)

Case Studies

1. Volcanic mercury scavenging:

- Observed complete gaseous elemental mercury depletion in volcanic plumes from Piton de la Fournaise on La Réunion Island, indicating significant mercury scavenging by sulfate-rich volcanic aerosols.
- Estimate: Volcanic aerosols may globally remove 210 Mg of mercury annually, acting as an atmospheric mercury sink.

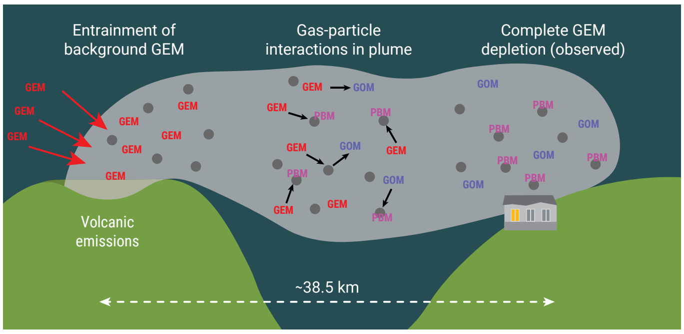


Figure 2: Observed in-plume gaseous elemental mercury depletion suggests significant mercury scavenging by volcanic aerosols (adopted from Koening e al. 2023)

2. Industrial emissions and air quality:

- Analysis near a Slovenian cement plant revealed mercury levels strongly correlated with emissions and wind direction, providing actionable insights for industrial emission control.

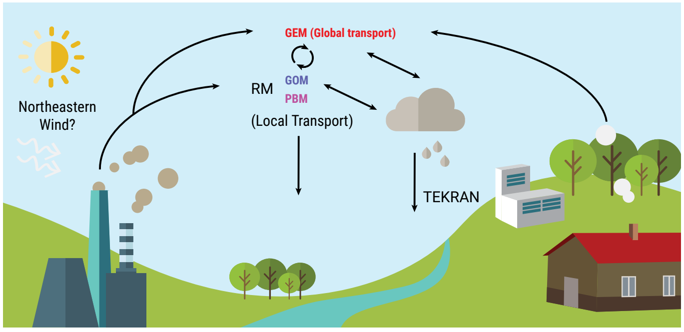


Figure 3: Demonstration of the the impact of industrial emissions on atmospheric mercury levels by highlighting the correlation between wind direction and mercury species distribution. Specific findings include elevated levels of gaseous oxidized mercury during northeastern winds, which are linked to emissions from the cement plant, and evidence of contributions from both regional and global transport mechanisms. (Adopted after Nair et al. 2022).

Conclusion

The GMOS-Train initiative provides a robust foundation for combating mercury pollution through innovative measurement techniques, comprehensive datasets, and advanced modeling. Policymakers and stakeholders are encouraged to adopt these findings to mitigate mercury's adverse impacts on ecosystems and public health. Enhanced collaboration and investment in monitoring infrastructure are essential for achieving the goals of the Minamata Convention on Mercury.

References

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