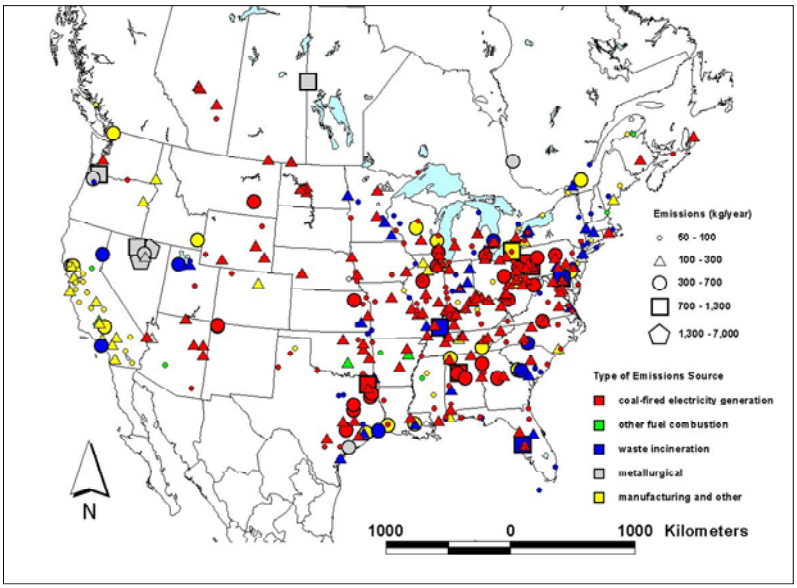
National Oceanic & Atmospheric Administration
Air Resources Laboratory
Mercury Modeling and Observations

What We Do

The Air Resources Laboratory (ARL) conducts world-class research into the atmospheric mercury cycle. A cornerstone of these efforts is the development and application of a state-of-the-art modeling system that tracks mercury emission sources and links these emissions to atmospheric transport, transformation, and deposition. In addition, ARL conducts long-term intensive monitoring of mercury in ambient air, as well as short-term process level field studies. Data collected are analyzed to gain useful insights into the origin, transport, and deposition of atmospheric mercury and for interpreting and evaluating the mercury modeling system.

Mercury Modeling System

The HYbrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) Model, a very powerful and useful analytical tool, is used at NOAA and throughout the world to investigate atmospheric dispersion in numerous applications. ARL has created a special version of the HYSPLIT model to simulate the atmospheric fate and transport of mercury. The model starts with a mercury air emissions inventory; then utilizes meteorological data assembled by NOAA and others to estimate the atmospheric dispersion of mercury from each source. Chemical reactions in the air, phase-partitioning of the mercury, and wet and dry deposition are then simulated by the model. A key feature of this modeling system is that it can estimate the overall atmospheric concentrations and deposition arising from emissions of mercury to the air and at the same time keep track of the individual contributions of each source to the overall totals. ARL evaluates the model by comparing its predictions against ambient measurements carried out by ARL and other scientists.

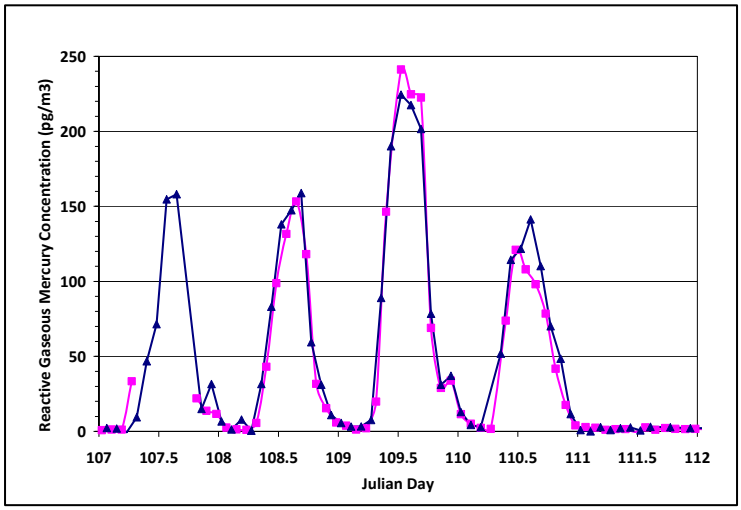


An ARL map showing 2002 mercury emissions sources based on data from the U.S. EPA and Environment Canada

To date, model results are encouragingly consistent with observations. However important research continues to be needed to evaluate, refine, update and extend the modeling system. Future improvements to the model include extending the emissions inventory beyond the United States and Canada to sources throughout the world. This will allow a better estimation of the relative contribution of different source types and source regions to deposition to sensitive key ecosystems.

Mercury Monitoring and Process-Level Research

In conjunction with the National Atmospheric Deposition Program's Mercury Initiative, ARL established and operates three long-term, research-grade monitoring stations as part of a new multi-agency national monitoring network designed to address total mercury deposition across the country. Each station measures concentrations of mercury



A time series plot of concentrations of reactive gaseous mercury collected from two independent analytical systems sampling out of phase of each other to provide truly continuous measurements. Data from April 16-21, 2008, Beltsville, Maryland monitoring station.

species and other trace pollutants in the atmosphere. Empirical analyses of the pollutant concentrations; time-dependent behavior; relationships with co-emitted primary (Sulfur dioxide, Nitrogen Oxides, Carbon monoxide) and secondary (Ozone) trace species; and dependence upon local and regional meteorology provide valuable insight into the mechanisms controlling the transport, distribution, and fate of the mercury compounds. Coupled with model parameterizations to describe turbulent transfer, the observed concentrations may be used to understand how particles and gases released into the air are exchanged with the Earth's surface—termed air-surface exchange. Deposition in precipitation is quantified through chemical analysis of collected rain and snow samples.

To complement long-term deposition monitoring, ARL also conducts process-level research. This research typically takes the form of short-term field studies that test emerging chemical measurement technologies and improve our understanding of the atmospheric and terrestrial processes and factors (i.e., wind, temperature, surface roughness) controlling air-surface exchange of these compounds.

Why It Is Important

Human exposure to mercury is primarily from the consumption of contaminated fish and other aquatic organisms. Methylmercury, a highly toxic form of mercury, adversely affects the nervous system, particularly those of fetuses and young children. The greatest input of mercury to aquatic and terrestrial ecosystems is atmospheric deposition from mercury emissions. Yet, there are large gaps in our understanding mercury emissions, transport and transformation hampering the implementation of cost-effective management strategies.

ARL's Mercury Research directly supports air quality decision-makers and forecasters in protecting human and ecosystem health through three primary ways:

- ARL's HYSPLIT-based predictive mercury model provides information on source-attribution for atmospheric mercury deposition and allows the consequences of potential management options – e.g., different emissions reduction scenarios – to be analyzed.
- ARL's research on air-surface exchange helps support the development of effective air quality policies and plans and more accurate air quality models to protect human and environmental health.
- ARL's mercury program provides information about sources of atmospheric mercury that affect key ecosystems and human health so that effective emissions regulations and policies are developed.

For More Information:

ARL Mercury Modeling
http://www.arl.noaa.gov/Mercury_modeling.php
ARL Mercury Measurements
http://www.arl.noaa.gov/Mercury_meas.php

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