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Sources of Mercury Depositing in the United States

Issue Brief

Analysis of mercury emissions from U.S. sources, including coal-fired power plants, shows that about 2/3 of this emitted mercury leaves the United States. Most of it is assumed to join the global atmospheric pool. Only about 1/15th of the mercury depositing in the U.S. originates from U.S. power plants, even though they account for nearly 40% of U.S. mercury emissions. Mercury deposition occurring over 70% or more of the U.S. surface area originates in other countries, and is often transported thousands of miles before arriving in the U.S. Thus, reducing domestic power plant sources of mercury will not result in proportional reductions in deposition occurring across the U.S.

How Do We Track Mercury's Movement in the Environment?

The investigation of mercury's impact on natural systems and public health is complicated by the intricate cycling of the substance through atmospheric, aquatic, and marine environments and its potential uptake into biological systems. Mercury is present in the environment in low concentrations, making its measurement and predicted movement difficult. Additionally, there are no materials that can be used to simulate mercury's movement by mimicking its behavior. For this reason, researchers must rely on computer models to replicate mercury's behavior in the environment. Those models in turn rely on data collected by research teams to explain the details of mercury cycling. The cycling processes occur over a very large range of scales, from microscopic particles to intercontinental transport; from microorganisms that inhabit certain aquatic systems to food chains present within these systems, including fish that are supported by these food chains. The scales encountered thus range from "local" scale, considered to extend to 30 miles from a source, through regional, continental, and global scales.

How Can We Assess the Impact of Mercury at Different Scales?

Models can be used to apportion the contribution of individual sources and source areas (including both natural and man-made) to mercury deposition at local or global scales. Computer modeling conducted by both EPRI and the U.S. EPA used different approaches but achieved the same general pattern of results, and in some cases the same numerical outcomes despite being conducted independently. In both approaches a global mercury chemistry and atmospheric transport model was the starting point for the simulations. The global models represent land and ocean areas of the world as geographical blocks, and researchers provide information on the amount and types of mercury emitted from each block. The chemical forms of mercury emitted are critical, since the elemental form of the chemical is basically insoluble in water and may travel for many thousands of miles in the atmosphere before eventually depositing to the earth's surface. The divalent form is very water-soluble and is more easily washed out of the atmosphere in precipitation.

The global models are used to provide "background" values for modeling the impact of U.S. emissions on mercury deposition occurring within the U.S. The models can be run successively with the mercury emissions from particular regions of the globe "zeroed out." This allows the models to estimate the contribution of, for instance, Asian emissions to U.S. deposition.

What Data Sources Are Used in Modeling Mercury Deposition?

The distribution of global and U.S. mercury emissions was derived from inventories developed by the United Nations and by state and federal governments for the U.S. Mercury emissions, either measured or estimated at every U.S. power plant in 1999-2000 provided a starting point for estimating the 2004 Base Case (Figure 1).

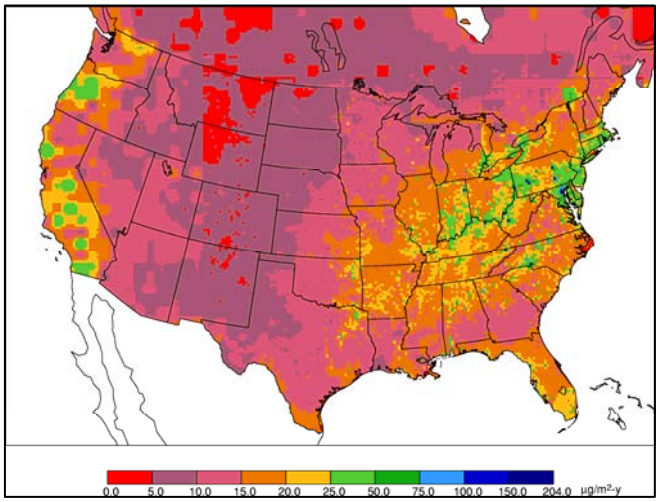

Figure 1
Mercury Annual Deposition—2004 Base Case

Then an emissions-estimating model, simulating economic choices for each power plant regarding selection of coals burned, controls installed, and future operations was run to project power plant mercury emissions into the future under other control scenarios being tested. EPRI scenarios included running its model through year 2020, allowing for full implementation of EPA's new regulations for mercury, SO_2, and NO_x on existing power plants. Figure 2 shows deposition patterns in 2020 under EPA's proposed CAMR and CAIR rulings.

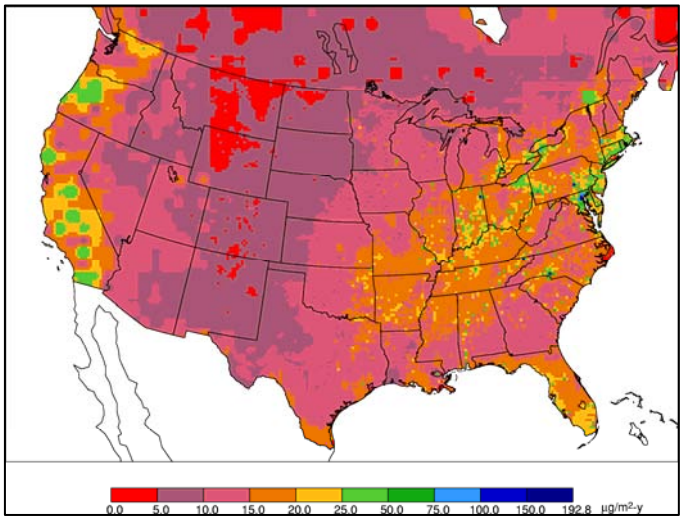

Figure 2
Deposition Patterns in 2020 under EPA's proposed CAMR and CAIR Rulings

Since most of the divalent form of mercury will be removed as part of CAMR, additional mercury reductions will have little impact on deposition in the US. Figure 3 represents an extreme scenario in which all electric utility emissions are "zeroed out," illustrating that there would be little additional change in mercury deposition.

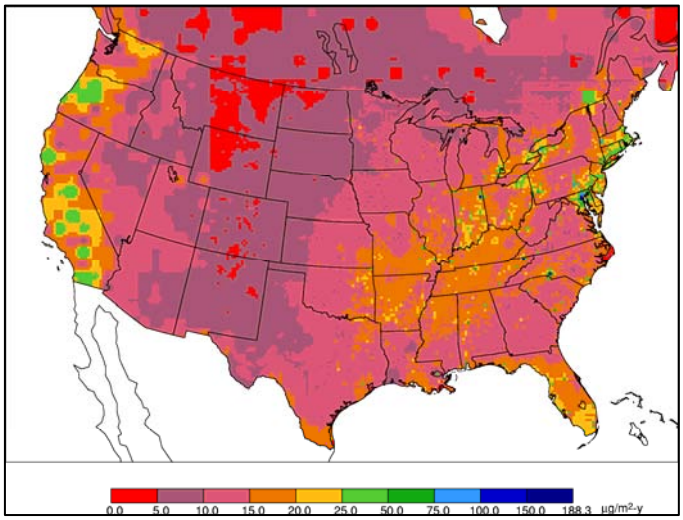

Figure 3
Mercury Annual Deposition if all U.S. Electricity Utility Emissions Were Zeroed Out

What are the Sources of Mercury That Deposit in the United States?

The model runs done by EPRI and later by EPA came to the same conclusion: of the 140-170 tons per year of mercury currently being deposited onto the United States mainland each year, 2/3 originates in other countries. Of the approximately 100 tons arriving from other countries, roughly half originates on the Asian continent, mostly from China. Indian subcontinent emissions are also large; but due to geography and prevailing wind patterns, they appear to play a less prominent role in U.S. deposition.

The pattern of non-U.S. sources dominating U.S. deposition of mercury varies across the country. The western half of the U.S., from the Dakotas westward, is marked by an average yearly precipitation of less than 20 inches, whereas the eastern half is typically above that amount (with, of course, local differences). Mercury deposition west of the Mississippi River is substantially dominated (often more than 95%) by non-U.S. sources. By contrast, U.S. domestic sources of mercury – chlor-alkali plants, waste incinerators, coal-fired power plants – are predominantly located east of the Mississippi valley, both in number and in emission rates.

The occurrence of generally greater precipitation and a greater number of sources as one moves eastward across the U.S. results in an increasing fraction of mercury deposition being attributable to U.S. domestic sources. Despite this general pattern, large swaths of the country, even along the Atlantic coast, are dominated by mercury from non-U.S. sources (Figure 4). The state of Maine, for example, receives about 70% of its mercury from sources outside the United States.

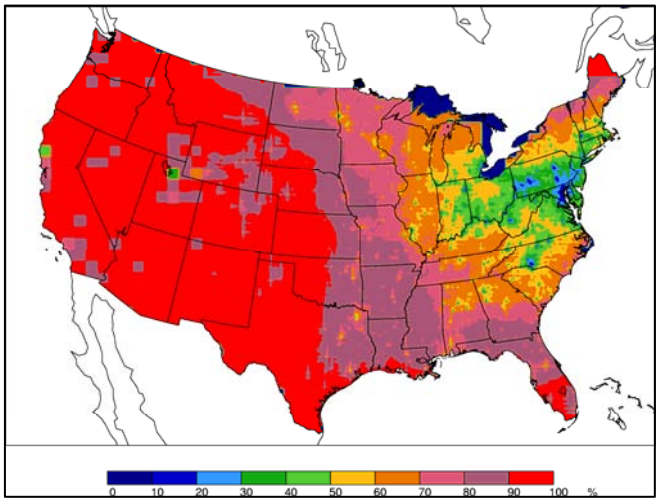

Figure 4
Percent Contribution to Mercury Deposition in the U.S. from Non-U.S. Anthropogenic Sources

The Florida peninsula shows a similarly variable pattern: isolated, relatively small areas receive most of their mercury from Florida sources, but mercury deposition across most of the state is dominated by sources thousands of miles away across the Atlantic and Pacific. The Everglades, which is the site of a mercury wet deposition monitoring station, has consistently recorded the highest national mercury deposition of any of the U.S. sites, due to the heavy summertime precipitation quantity which results from the subtropical atmospheric conditions there.

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