MERCURY EMISSIONS

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1. Strengths and Weaknesses

Mercury is emitted by anthropogenic as well as natural sources. Moreover, mercury that has been deposited can be re-emitted (the term re-emission is sometimes applied to anthropogenic mercury only; however, since the origin of deposited mercury is a priori unknown, we apply the term re-emission to both natural and anthropogenic mercury). Mercury is present in the atmosphere as gaseous elemental mercury (Hg(0)), gaseous divalent mercury (Hg(II)) and particulate divalent mercury (Hg(p)).

Natural emissions and re-emissions consist primarily of Hg(0), although some Hg(II) can be reemitted from the arctic/antarctic snowpack. Anthropogenic emissions consist of Hg(0), Hg(II) and Hg(p) with the composition of the emissions varying widely among sources. The overall magnitude of the anthropogenic emissions is estimated at about 2000 Mg/year but large uncertainties exist for individual source categories. For example, mercury emissions from coal-fired power plants in the United States are better known than many other source categories because the Hg content of the different types of coal burned at U.S. electric utilities was studied under the Information Collection Request of the U.S. Environmental Protection Agency (EPA). The actual amount of Hg emitted from the stacks to the atmosphere depends also on the pollution control system installed. Stack sampling was conducted at over 80 coal-fired power plants. For example, the removal efficiency of Hg from the flue gas by a combination of a cold side electrostatic precipitators (ESP) and wet flue gas desulfurization system (FGD) (ESPc/FGDw) averages about 50%. However, the range was from 24% to 70%. Similarly, emissions controlled by a fabric filter (FF) show a Hg removal range of 40% to 85% with an average of about 60% (EPRI, 2002).

Mercury emissions of other source categories (particularly those with diffuse emissions, e.g., chlor-alkali plants, landfills) have typically not been as well characterized. Also, emission inventories for North America and Europe are likely to be more accurate than those of other continents. Therefore, significant uncertainties currently exist for global anthropogenic mercury emissions.

The chemical speciation of mercury emissions is also not well known. Until now, speciated mercury sampling has been conducted only for a few source categories, hence, there is typically a paucity of speciated data for most source categories. Even for power plants studied in the ICR, a comparatively well studied category, there were often large speciation ranges. The speciation (sa well as the removal) depends on the chemical composition of the coal and the type of pollution control system. For example, for a power plant controlled by a FF, Hg(II) ranges from 67% to 97% of the emissions, with an average of 77%. For a power plant with ESPc/FGDw controls, Hg(II) is captured in great part in the FGD and it ranges from 2% to 19%, with an average of 11% (EPRI, 2002). These uncertainties are likely to affect the plant-specific estimates but have less effect on

national inventories. Emission speciation is an important source of uncertainty when assessing the atmospheric fate of mercury because Hg(0), Hg(II) and Hg(p) have very different physico-chemical characteristics and, consequently, have very different atmospheric lifetimes.

The magnitude of the natural emissions and re-emissions is poorly known. First, it is not feasible to distinguish between natural emissions and re-emissions, except in cases where there is a strong natural source signal (e.g., areas geologically enriched in mercury). Second, there are few measurements available and current estimates are to a large extent extrapolated from a few data points and constrained by global mass balance estimates. If we examine the estimates made by various researchers, we find ranges of 770-2300 Mg/y for ocean emissions, 20-447 Mg/y for volcano emissions, 500-3200 Mg/y for emissions from soil, 850-2000 Mg/y for emissions from vegetation and up to 100 Mg/y for emissions from fires (Fitzgerald, 1986; Pacyna, 1986; Nriagu, 1989; Lindberg et al., 1998; Ebinghaus et al., 1999; Nriagu, 1999).

2. Alternative Emission Distributions

Other mercury emission inventories besides GEIA have been developed. Seigneur et al. (2001) present a speciated emission inventory for North America and a global emission inventory that is in part based on the 1990 GEIA inventory for anthropogenic sources (the reference years are 1998-1999). The Meteorological Synthesizing Centre-East located in Moscow, Russia, has prepared a spatial distribution of mercury emissions for Europe and for the Northern Hemisphere (MSCE, 2002). Pacyna et al. (2001) have developed an emission inventory for Europe for 1995. The U.S. EPA has developed a speciated mercury emission inventory for U.S. anthropogenic sources with a 1995/1996 reference year (US EPA, 1997).

3. Emission Trends

In the last decade, anthropogenic emissions of mercury have decreased in North America (Seigneur et al., 2001) and Europe (Pacyna et al., 2001). No data were available on mercury emission trends for Asia. However, as a first approximation of possible trends, we can use trends in energy consumption rates that are estimated to have increased in India (UNESCAP, 2000) and China (Weidou and Sze, 1998; Ho et al., 1998) by about 27% and 55%, respectively, over the past ten years.

4. Seasonality of the Emissions

No comprehensive information is currently available on the seasonality of mercury emissions.

5. Factors affecting Natural Emissions

Experimental data have shown that emission of mercury from soil increases after precipitation has occurred (Gustin and Lindberg, 2000). Incident solar radiation also

enhances mercury emissions from soils (Gustin et al., 2002).

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