

# **Contamination of the Biosphere with Mercury: Another Potential Consequence of On-going Climate Manipulation Using Aerosolized Coal Fly Ash**

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## **Authors' contributions**

*This work was a joint effort between the authors that is part of an ongoing collaboration aimed at providing scientific, medical, public health implications and evidence related to the near-daily, near-global covert geoengineering activity. Author JMH was primary responsible for geophysical considerations. Author MW was primarily responsible for medical and public health considerations. Both authors read and approved the final manuscript.*

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**Short Communication**

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## **ABSTRACT**

**Objectives:** Atmospheric aerosol climate manipulation has been undertaken since at least the beginning of the 21<sup>st</sup> century, with increasing frequency and duration, without public discussion, and without disclosure of the particulate matter composition being placed into the air we breathe. Nor have the effects of this activity on biota including humans been discussed. Forensic evidence published in the peer-reviewed scientific literature is consistent with coal fly ash (CFA), the toxic waste-product of coal-burning, being the main undisclosed geoengineering-particulate. The objective of this paper is to provide additional evidence that the particulate matter aerosolized in the atmosphere during geoengineering activities is coal fly ash and to consider the concomitant potential consequences of contaminating the biosphere with mercury.

**Methods:** Inductively coupled plasma mass spectroscopy (ICP-MS) was used to investigate evidence bearing on the composition of geoengineering material.

**Results:** Analyses of rainwater and snow provide further evidence that coal fly ash is the primary component dispersed in the atmosphere for geoengineering purposes. Consequently, this near-daily, near-global climate manipulation activity poses a previously unrecognized risk for environmental mercury contamination by deliberately aerosolized CFA that contains mercury in variable amounts (Table 1) ranging as high as 2 µg/g.

**Conclusion:** Despite strengthened mercury emission regulations, mercury measured in rainwater is increasing. Since it is known that the upper troposphere contains oxidized, particle-bound mercury, it is likely that covert aerosolized coal fly ash sprayed into this region is a major source of mercury pollution. Mercury affects multiple systems in the body, potentially causing neurological, cardiovascular, genitourinary, reproductive, immunological, and even genetic disease. Because atmospheric climate manipulation using coal-fly-ash-based aerosols represents a potential globally pervasive environmental-source of this toxic element, it must be recognized and appropriate steps taken to halt climate geoengineering.

*Keywords: Atmospheric aerosols; climate intervention; mercury contamination; geoengineering; coal fly ash; methylmercury; environmental mercury.*

## 1. INTRODUCTION

Pollution of the Earth's environment by mercury (Hg) is a matter of global public health concern [1]. Mercury has been known since antiquity to be one of the most toxic elements/substances on the planet [2]. Human activities have nearly tripled the amount of Hg in the atmosphere, with the atmospheric burden increasing up to 1-2% annually [2]. Rain and soil contaminated by mercury enters the food chain through both plants and animals [3]. Mercury bio-accumulates in the food chain leading to adverse human health effects [2]. Mercury affects multiple systems in the body, potentially causing neurological, cardiovascular, genitourinary, reproductive, immunological, and even genetic disease [3].

Mercury is present in the environment in three chemical forms, classified as elemental mercury Hg(0), particulate-bound ionic mercury Hg(II), and organic mercury, notably methylmercury (CH<sub>3</sub>Hg). The relative proportion of these forms is not necessarily a reflection of the distribution of their source proportions, as mercury interacts chemically in the environment [4,5]. The atmosphere is the main transport pathway of mercury emissions, resulting in the redistribution of Hg in terrestrial, freshwater, and marine ecosystems. As Hg is stable with a relatively long residence time (months to years), it can be transported long distances before wet or dry deposition [6].

Mercury is released into the environment naturally by volcanic eruptions and burning biomass. A much greater anthropogenic release of mercury into the environment occurs, for example, as a consequence of burning coal,

ferrous and non-ferrous metal production, mining, and waste disposal [7,8].

Mercury contamination is observed in locations far removed from industrial activity, for example, in Tibet [9,10] and in the Arctic [11]. Observations such as these are generally taken to infer long-range transport [12]. Other observations, however, suggest the possibility of a yet unrecognized tropospheric source of mercury. For example, based on measurements from three sites in Nevada (USA), Weiss-Penzias et al. infer the existence of a free tropospheric source of reactive gaseous mercury [13].

Reactive gaseous mercury (RGM) is not directly transported from Asia to North America in the lower troposphere, but is thought to contribute to a high-altitude, well-mixed pool of environmental mercury contaminants [14].

Because of the serious neurological risks posed by environmental mercury, particularly to pregnant women and their unborn children, mercury emission regulations have been greatly tightened. But instead of mercury pollution decreasing, inexplicably, mercury in rain has been found to be increasing in Western and Central regions of the United States [15]. The purpose of this paper is to suggest a heretofore unacknowledged anthropogenic source of high altitude mercury, namely, from undisclosed efforts to manipulate weather and climate by spraying particulate coal fly ash (CFA) pollution into the troposphere.

There is documentation to indicate [16-18] that the U. S. military intends, in U. S. Air Force words [16], on "Owning the Weather in 2025". Since the 1990s, perhaps before, the U. S.

military, jointly with other nations' militaries, used jet aircraft to spray particulate matter into the regions where clouds form [19]. Millions have witnessed the aerial particulate spraying [20], but they have been intentionally misled to believe that the trails are ice-crystal jet-contrails [21,22], even though the physical behavior observed and public health concerns are strikingly different [23] as illustrated by some examples shown in Fig. 1.

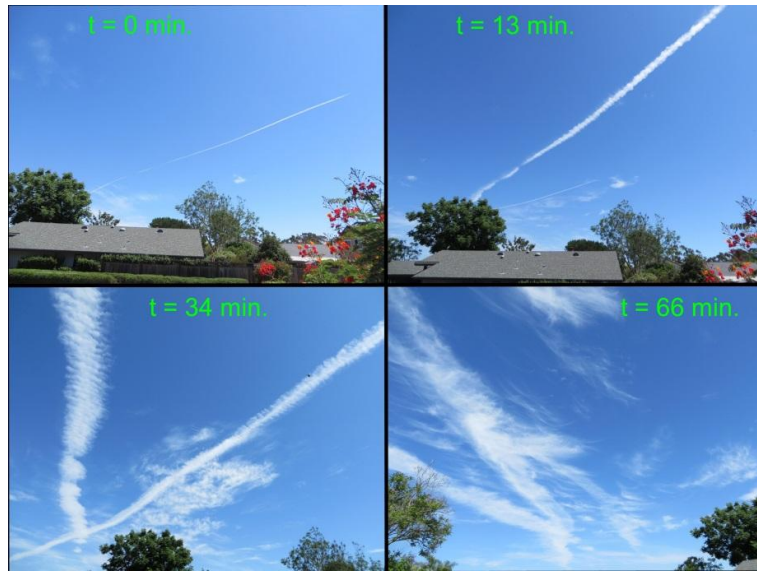
The particulate trails made by the spray-jets typically disperse to form a white haze in the sky. Fig. 2 is a timed sequence of photographs showing the evolution of particulate spraying from the initial emplacement through the natural dispersal in the air on the way to becoming a white haze in the sky. The "t = 0 min." image was photographed in San Diego, California (USA) at 14:50 PDT on July 13, 2017 and shows one trail being made; 13 minutes later, a second trail is

added. It appears that the particulate matter falls downward as it mixes with the air and disperses. The images are taken using the same magnification. This behavior is uncharacteristic of ice crystal contrails formed from jet-engine exhaust.

During the last decade the number and frequency of occurrence of these particulate trails have increased markedly, becoming a near-daily, near-global occurrence [24]. Sprayed into the atmosphere, these particles reflect some sunlight back into space, but they also absorb energy and heat the atmosphere. In addition, they block heat from efficiently escaping Earth's surface, and keep moisture droplets in the atmosphere from coalescing and becoming massive enough to fall as rain [25]. Eventually though, the moisture-laden clouds erupt with torrential rainfall causing storms.



**Fig. 1. Photographs of tropospheric geoengineering particulates showing spraying and subsequent spreading to form artificial cloud-like features before further spreading to form a white haze in the sky. Upper: Sacramento (USA) Courtesy Of Deborah Whitman; Middle: San Diego (USA) Courtesy of Syd Stevens; Lower: Left, Chula Vista (USA), Right, Cabo San Lucas (Mexico) Courtesy of Ricardo Beas**



**Fig. 2. Dispersal into the air of two particulate geoengineering trails at reference time  $t = 0$  and at  $t = 13$  in the air above San Diego, California (USA). The trails appear to fall downward and spread. Eventually, they form a white haze in the sky. This behavior is unlike that expected to result from engine jet-engine exhaust ice-crystal contrails. Photographs by one of the authors (JMH)**

Although initially solely a military operation, the aerial particulate spraying became a global covert operation of unspecified intents. There has been a concerted effort to deceive the public as to evidence of the particulate-matter composition and the concomitant public health risks [26]. Forensic evidence, published in the scientific literature, is consistent with the identification of toxic coal fly ash (CFA) as the principal component [23,24,27,28].

CFA forms in the hot gases above the burners of coal-burning utilities, and would exit smokestacks if not trapped by electrostatic precipitators and sequestered. The annual global production of CFA in 2013 was estimated to be  $6 \times 10^{11}$  kg [29]. CFA requires little further processing for use as a climate-altering aerosol as its particles form in sizes ranging from  $0.01 - 50 \mu\text{m}$  in diameter. CFA has the additional property of being leachable by atmospheric moisture [30]. Extracted ionic species makes atmospheric moisture more electrically conducting, which is advantageous for using electromagnetic radiation to influence cloud formations for weather/climate control purposes.

Comparison of elements dissolved in rainwater with corresponding elements extracted into water during laboratory investigations provides one

source of evidence that CFA is being used as the primary aerosol sprayed into the atmosphere [23,24,27,28].

CFA is a major repository of the toxic heavy elements present in the burned coal. These include, but are not limited to, arsenic, barium, beryllium, cadmium, chromium, lead, thallium, and the radionuclides uranium, thorium, and their daughter products [30,31]. Mercury is also present in CFA, in varying amounts that depend on the composition of the coal and the combustion dynamics. Table 1 presents some coal fly ash analyses from the scientific literature. These serve to show that mercury is a contaminant of CFA.

The main source for anthropogenic mercury contamination is usually assumed to be ground-level, coal-fired power generation facilities in the developing world (especially Asia) [7]. We suggest here another possibility, namely, mercury contamination via aerosolized coal fly ash sprayed into the air at altitudes where jet aircraft fly and where clouds form.

## 2. MATERIALS AND METHODS

Rainwater and snow samples (Table 2) were collected according to protocol [27] in containers

**Table 1. Examples of the range and average values of mercury analyzed in coal fly ash samples. (ns means not specified)**

Mercury range (µg/g)	Number of samples	Mercury average (µg/g)	Reference
0.461 – 0.736	4	0.610	[32]
0.009 – 0.933	24	0.355	[33]
0.30 – 1.11	7	0.62	[34]
0.02 – 2	ns	ns	[35]
0.34 – 0.85	2	0.60	[36]

**Table 2. Sample descriptions. All measurements by ICP-MS**

Sample Description	Sample Date (s)	Sample Mass	Location
Rainwater	Feb. 23 2015	~0.5 kg	San Diego California (USA)
Rainwater	May 15 2015	~0.5 kg	San Diego California (USA)
Rainwater	Dec. 28 2015	~0.5 kg	San Diego California (USA)
Rainwater	Feb. 18 2017	~0.5 kg	San Diego California (USA)
Rainwater	Aug. 16 2015	~0.8 kg	La Coruña Spain
Rainwater	July 2 2017	~0.8 kg	Key West Florida (USA)
Snow melt	Jan. 25 2017	~0.5 kg	South Strafford Vermont (USA)
Snow melt	Mar. 2 2017	~0.5 kg	South Strafford Vermont (USA)
Evaporated snow solids	Dec. 14 2016	~0.5 g	Laona Wisconsin (USA)
Evaporated snow solids	Apr. 2 2017	~0.5 g	Laona Wisconsin (USA)

lined with new polyethylene/polypropylene plastic bags. Two ~ 8 kg snow samples from Laona, Wisconsin (USA) were allowed to evaporate to dryness, then the residue was submitted to a certified commercial laboratory for inductively coupled plasma mass spectrometry (ICP-MS) measurement. Melted snow samples from South Strafford, Vermont (USA) and rainwater samples from San Diego, California (USA), Key West, Florida (USA), and La Coruña (Spain) in approximately 250 mL quantities were sent to certified commercial laboratories for ICP-MS measurement after filtration to retain particles >0.45 µm as per U. S. Environmental Protection Agency protocol.

### 3. RESULTS AND DISCUSSION

Since at least 2002, post-aerial-spraying rainwater samples have been analyzed. Typically, only aluminum analysis was requested, sometimes barium as well. Only rarely was strontium requested. CFA is not a natural product formed at equilibrium, but rather a collection of vapor condensates formed in the anhydrous burner-exhaust of industrial coal-burning furnaces. Studies have shown that CFA exposed to water leads to an aqueous extraction of portions of virtually all elements present [30,37]. Comparison of post-spraying rainwater analyses

with analyses of the leachate of CFA water-leach tests provides evidence that the aerosolized particulate is consistent with CFA.

Fig. 3 shows analyses of post-spraying rainwater and snow expressed as ratios relative to barium. Ratios are useful in this instance to obviate the effects of varied amounts of dilution. Table 3 presents data as µg/L and identifies previously published data that are shown for comparison.

The authors have presented evidence that post-spraying snowfall can collect aerosol particulates in a manner similar to the physical-chemical technique called co-precipitation [23]. Fig. 4 presents analytical data of the solid residue from evaporated post-spraying snow, expressed as ratios. These are compared to the average value of five analyzed samples of fibers found beneath the melting snow (Fig. 5) that apparently trapped snow-captured aerial particulates released during snow melting. Table 4 presents data as µg/g and identifies previously published data that are shown for comparison.

The data presented above extend the geographical sampling range, and are consistent both with previous data and with CFA being the main particulate matter used for atmospheric climate manipulation.

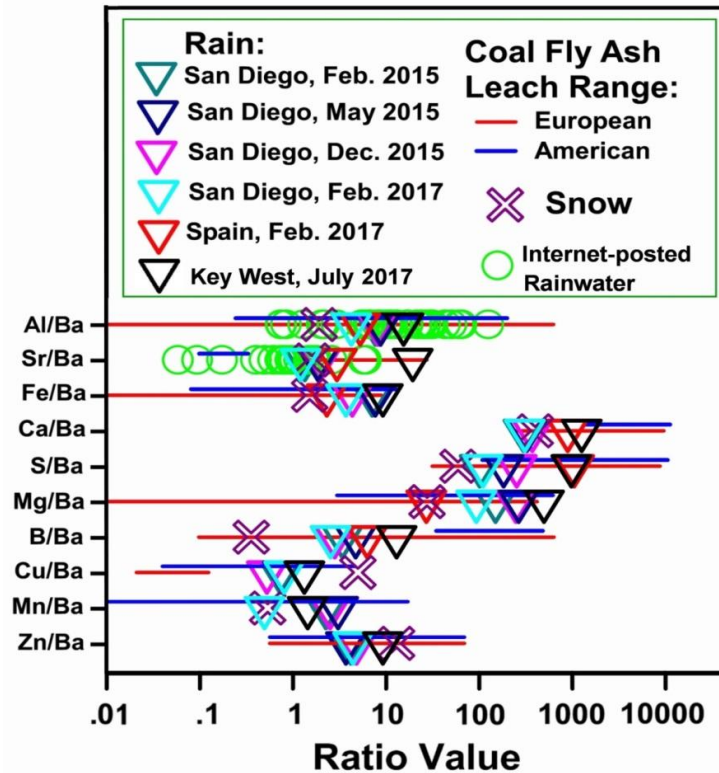


Fig. 3. Element-ratios determined in post-aerial-spraying snow and rainwater. Magenta X's are data from the Vermont snow sampled on March 2, 2017; the snow sampled on January 25, 2017 is not plotted due to excessive dilution. Internet-posted rainwater data are from several investigations [24]. Red lines and blue lines, respectively, are ranges of European [30] and American [37] CFA leach-experiments

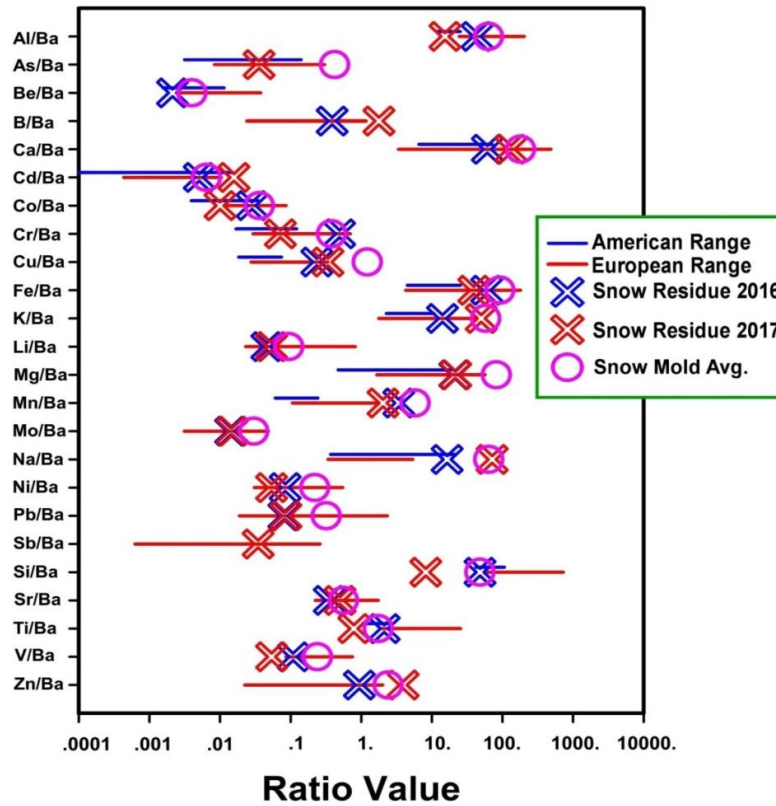
Table 3. Analytical ICP-MS data for snow and rainwater samples identified by date (Table 2). February 2015 data was in part previously published [24]

	Rain	Rain	Rain	Rain	Rain	Rain	Snow	Snow
	Feb.	May	Dec.	Feb.	Aug. 2016	July	Mar.	Jan.
	2015	2015	2015	2017		2017	2017	2017
	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Al	41	26.3	88.9	13.7	16	68.5	13.9	
Ba	5.3	3.2	10.1	3.2	3	4.4	7.2	0.8
B	18.2	9.1	48.2	8.2	19	57.6	2.6	
Ca	1600	1200	3300	1000	2701	5600	2900	200
Cu	3.9	1.7	8	2.6		5.9	36.3	0.6
Fe	38	14	78	12	7	41	11	
Mg	800	800	2700	300	82	2200	200	
Mn	12.1	8.1	31.2	1.6		6.4	3.9	1.5
Sr	7.2	6.3	19	3.9	9	85.8	11.6	0.6
S	540	815	1860	355	3160	4330	430	90
Zn	22.4	15.6	37.8	14.3		41	94.3	9.0

CFA contains ultrafine and nanoparticles in greater relative proportion than in other material derived from combustion [38]. Submicron CFA particles contain a greater proportion of volatile elements, such as mercury, relative to larger

particles. Moreover, the surfaces of larger particles, relative to their interiors, contain a greater proportion of volatile elements [39]. That makes mercury more readily available for reaction with substances to which it is exposed.





**Fig. 4. Analytical data for post-spraying snow residue after evaporation expressed as ratios and indicated by X's. Blue X's are previously published [23] 2016 data. Red X's are 2017 data. The pink circles are averages of five sets of analyses from fibers, thought to be snow mold, found beneath melting snow. Red lines and blue lines, respectively, are the range of measured element-ratios of 23 European CFA samples, collected in Italy, Greece, Italy, Spain, and The Netherlands [30], and 12 American CFA samples, collected in Colorado, the Illinois Basin and North Dakota [37]**



**Fig. 5. Fibers observed on grass as snow was melting on March 19, 2015. (Photo and sample collection courtesy of Robert West)**

**Table 4. Analytical ICP-MS data for post-spraying snow residue after evaporation, and average values determined on fibers, thought to be snow mold, observed beneath newly-melted snow. Snow residue data for 2016 was previously published [23]**

Element		Snow residue	Snow residue	Snow mold
		2016 µg/g	2017 µg/g	Avg. µg/g
Aluminum	Al	3700	4300	3170
Arsenic	As		10	21
Barium	Ba	85	280	50
Beryllium	Be	0.18		0.2
Boron	B	33	500	
Cadmium	Cd	0.43	4.4	0.32
Calcium	Ca	5200	37000	9040
Chromium	Cr	42	20	19
Cobalt	Co	2.4	2.8	1.8
Copper	Cu	20	95	61
Iron	Fe	5100	11000	4600
Lead	Pb	6.8	24	16
Lithium	Li	3.9	15	4.7
Magnesium	Mg	1800	6100	4100
Manganese	Mn	290	570	290
Molybdenum	Mo	1.2	4.2	1.5
Nickel	Ni	7.1	15	11
Potassium	K	1200	14000	2900
Silicon	Si	4100	2300	2400
Sodium	Na	1400	20000	3200
Strontium	Sr	30	140	28
Tin	Sn			43
Titanium	Ti	180	220	87
Vanadium	V	9.2	15	12
Zinc	Zn	80	1100	120

Considerable efforts have been made to attempt to understand the complex nature and range of chemical reactions involving atmospheric mercury [4,5,7]. In light of the hypothesis that a significant source of environmental mercury contamination is derived from aerosolized CFA sprayed into the region where clouds form and jet aircraft fly, the complexity is greatly enhanced. It is not our intention to propose additional chemical reactions, but rather to make a few generalizations.

- The mercury content of jet-sprayed, aerosolized CFA will contaminate the environment: a portion may be released into the atmosphere where it might remain for some time, while the balance, particulate-bound mercury, will settle to ground more quickly.
- Some of the aerosolized CFA may be exposed to jet-combustion heat/products, which would re-vaporize the mercury and potentially expose it to

the possibility of reactions with the components of the jet engine-exhaust.

- Components of the aerosolized CFA, e.g. magnetite, could catalyze reactions at the solid-moisture interface.
- Reactions with ozone and ultraviolet light may be especially important.

Mercury (Hg) is ranked 3<sup>rd</sup> after arsenic and lead among the most toxic elements on Earth by the U.S. Government Agency for Toxic Substances and Disease Registry (ATSDR) [40]. Mercury continues to be discharged into the atmosphere, released into our waters and soil, and consumed in our food and water [41]. Environmental mercury can be found in its elemental form, as inorganic mercury, or as organic mercury. The most common form of organic mercury is methylmercury (CH<sub>3</sub>Hg), the primary source of organic mercury in ecosystems. CH<sub>3</sub>Hg builds up in the food chain and bio-accumulates, especially in fish, and constitutes the main source of mercury poisoning in humans [2].



All humans are exposed to some level of mercury. Factors that determine health effects of mercury include the dosage and type of mercury, the route of exposure (inhalation, ingestion, or skin contact), and the age and developmental stage of the host, with the unborn child, infant, and young child most susceptible [42]. Elemental Hg and CH<sub>3</sub>Hg are toxic to the central nervous system (CNS) and peripheral nervous systems, causing tremors, cognitive effects, neuropathy, and neuromuscular problems. The inhalation of mercury vapor can produce harmful effects to the nervous system, the lungs, the immune system, and the kidneys, and can be fatal. The inorganic salts of mercury are corrosive to the skin, eyes, and gastrointestinal tract and can induce kidney failure if ingested [43].

At the cellular level mercury is associated with changes in membrane permeability, changes in molecular structure due to its affinity for sulfhydryl and thiol groups, and DNA damage. Mercury induces oxidative stress (especially in the CNS), mitochondrial dysfunction, alterations in calcium homeostasis, and increased lipid peroxidation [44]. Mercury has adverse effects on our protective white blood cells. In the CNS, mercury damages the blood-brain barrier and facilitates entry into the brain of other toxic metals. Mercury concentrates in the pituitary and thyroid glands, disrupting their function [2]. Mercury is known to cross the placenta, thereby inhibiting fetal brain development and producing a wide variety of birth defects [45].

Inhalation is the major route of exposure to elemental mercury, with 80% of this mercury vapor absorbed by the lung, diffused into the blood, and distributed throughout the body [43]. Elemental mercury easily crosses the blood-brain barrier, the blood-placenta barrier, and even the lipid bilayers of cellular and intracellular organellar membranes [43].

Elemental Hg is oxidized in body tissues and accumulates in its inorganic divalent form. The primary organs of mercury deposition following inhalation of Hg are the brain and the kidney; with chronic exposure, the greater burden of Hg in the kidney [43]. Elemental Hg binds strongly to selenium after oxidation, leading to long-term deposition in the brain [46].

#### 4. CONCLUSION

There is no physiological benefit of Hg, and no safe level of exposure to this element. Mercury is

a persistent, bio-accumulating, and globally cycling element that severely affects the environment and human health. Although the atmosphere is the main transport route for mercury, Hg is unlike other air pollutants because its health impacts are only partly related to ambient atmospheric concentrations of Hg(0) and Hg(II). The effects and toxicity of Hg frequently result from the net conversion of Hg(II) to CH<sub>3</sub>Hg, a process that occurs when rain brings Hg down to the soils and waters of the Earth's surface [7]. Since it is known that the upper troposphere is enriched with oxidized, particle-bound mercury [47], it is likely that aerosolized coal fly ash sprayed into this region is a major source of this mercury pollution. The undisclosed, near-global source of atmospheric Hg probably offsets any decreased emissions or pollution control measures currently being enacted by the world community of nations. The deliberate spraying of aerosolized coal fly ash into the atmosphere must be stopped in order to prevent further mercury contamination of the biosphere. No one has the right, not even the military, to poison the atmosphere and damage the health of humans and other creatures.

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#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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