Global source of environmental mercury from commercial products

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Motivation and Project Hypothesis

Global Atmospheric Trend Conundrum A Missing Inventory 2010 1994 1996 1998 2000 2002 2004 2006 2008 12000 2.2 2.2 Mercury to Air ShipNH Mercury to Land and Water Northern hemisphere 2.0 2.0 10000 1.8 Log (ug m⁻³) 1.6 Log 1.4 Mercury in Products MaceHead Mercury (Mg) 0009 0009 1.8 1.6 1.4 1.2 1.2 4000 Slemr et al., 2011 1.0 1.0 2000 3.0 Oceania 0 18 30-19 Asia 2.5 unp ρ Africa/MidEast > Hg emissions (Gg yr⁻¹) 0 2 2 0 0 Former USSR 00 Europe 6000 South America North America 0.5 0.0

Missing environmental releases from commercial Hg use

Global Atmospheric Hg Emissions Inventory, 2008



Global Hg Usage, 2005 Total: 2336 Mg



- Eventually, all Hg used in commercial products will enter the environment
- Emissions inventories for models only include direct atmospheric emissions and are missing potentially significant sources to air, land, and water from commercial products

Large historical evolution of mercury consumption



- Types of applications shift from those that directly use and dispose of Hg in the environment to those that retain the Hg inside a product
- Entrance of Hg into the environment from commercial usage has a regional signature

















Municipal Solid Waste

Wastewater Treatment













Landfill Hg release processes implemented into global box model

- Landfill releases to the atmosphere and to soil, through leachate, depend on landfill design and age
- Implemented Hg releases from landfills into global geochemical box model using data in the literature

Modified

et al., in prep.

Global geochemical box model framework





First-order releases of Hg to atmosphere and soils

Timescales of Hg release from landfills vary greatly

Timescale (yrs)	Landfill
100,000- 1,000,009	Martin, FL, USA ¹
3000	Brevard, FL, USA ¹
	Jin-Kou, Wuhan, China ²
200	Gao-Yan, Guiyang, China ²

Sources: 1. Lindberg et al., 2005; 2. Li et al., 2010b

- Landfills release Hg very slowly and lock up Hg for longer than other disposal methods
- However, historical accumulation of Hg mass in landfills becomes so large that by 2008, landfill atmospheric emissions were ≈100 Mg/yr, 3% of current global inventory and comparable to waste incineration emissions

Summary and Next Steps

- Massive quantities of Hg used in commercial applications have been largely ignored in global biogeochemical Hg models
- All commercial Hg will eventually enter the environment on timescales and spatial scales that need to be quantified
- Landfilled Hg leads to long-lasting contamination, but these releases are too slow to change the atmospheric trend
- Will focus future work on **products with direct releases** to water, soil, and/or the atmosphere (e.g., chemical uses, agriculture)
- Will these products solve the **atmospheric trend conundrum**?

Thank you!

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