

Air Toxics During MCMA 2006: Mercury

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Overview

- Background
 - Environmental Mercury
 - Atmospheric Mercury
- Hg Measurements during MCMA 2006
- Key Findings
- Conclusions



Environmental Mercury Concerns

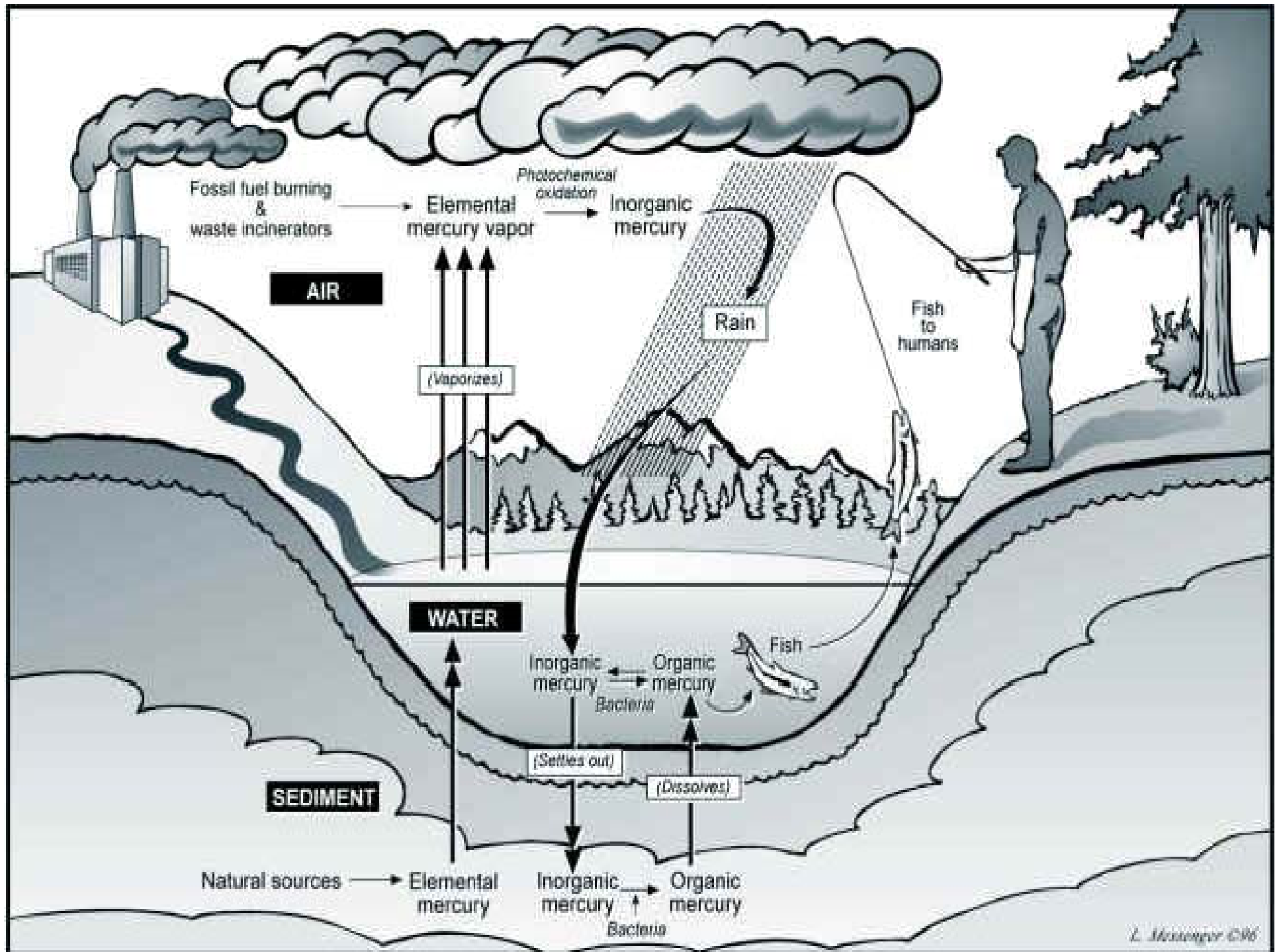
- Neurotoxin (methyl mercury in fish)
- Prenatal and neonatal children at greatest risk (I.Q.)
- CDC NHANES Study:
 - >300,000 newborns per year in US have prenatal exposures expected to have an adverse impact
- Precursors emitted during
 - Energy production
 - Waste incineration
 - Industrial processes
- Local and Global problem (species dependent)
- Regulate mercury emissions
 - Understand source-receptor relationships



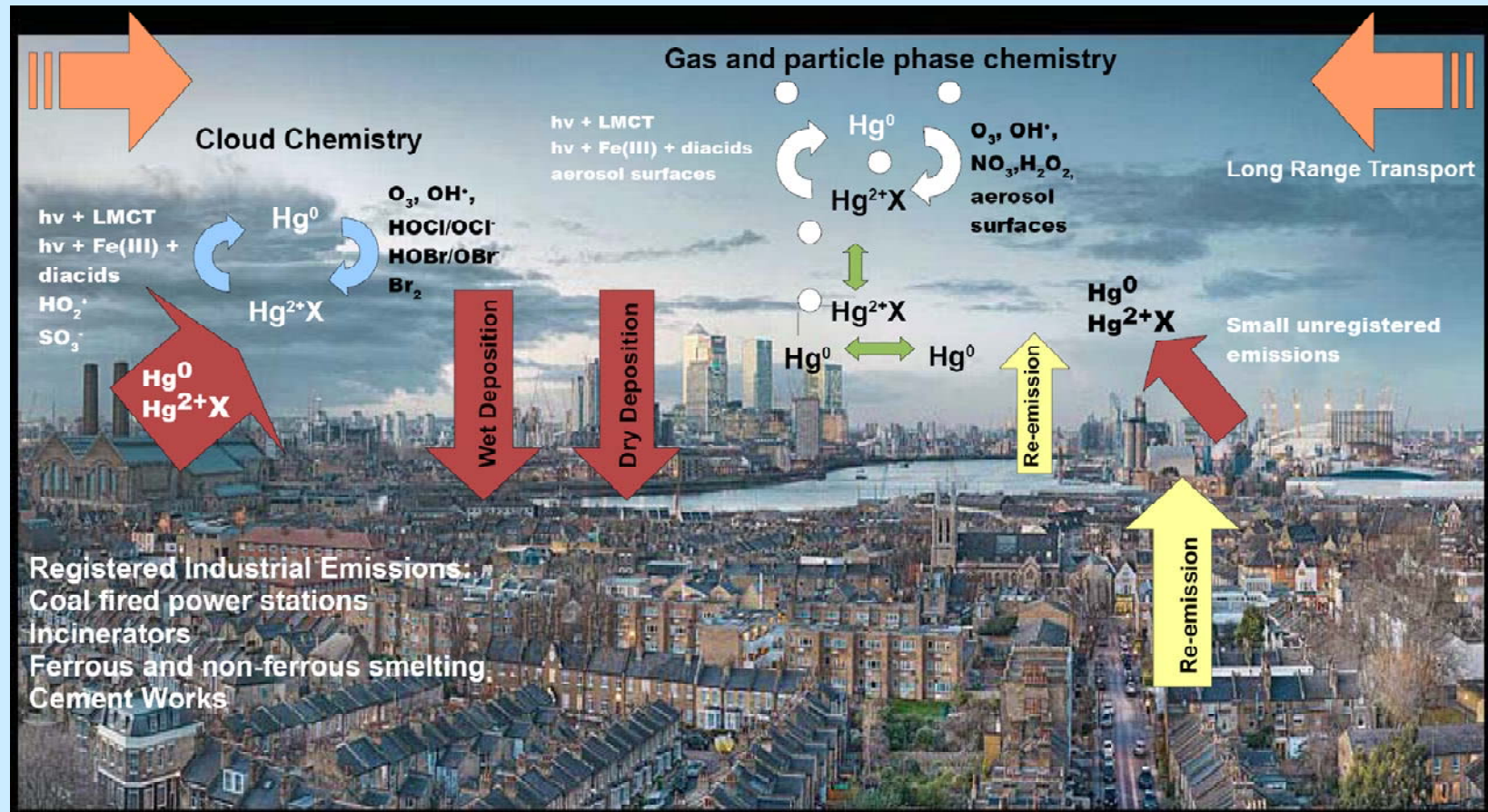
Exposure Pathways

- Environmental
 - Air – Generally not a concern
 - Water – Generally not a concern
 - Soil –
 - Can be important for contaminated soils
 - Food –
 - Major driving force in protecting public health
- Occupational
 - Air
 - OSHA limits on exposure
 - Skin
 - Major concern for handling dimethyl mercury

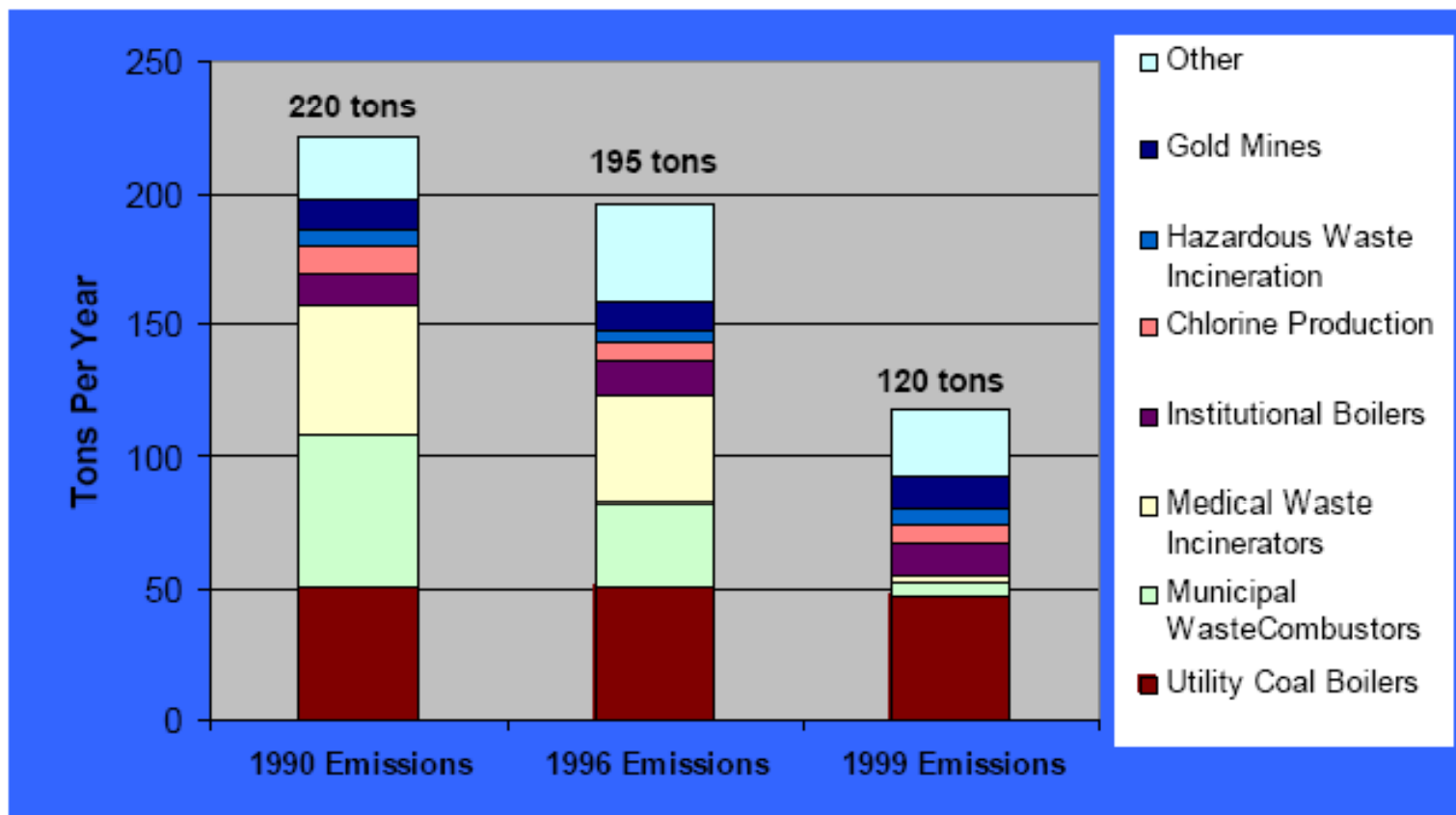




Atmospheric Mercury Cycle



U.S. Emissions of Human-Caused Mercury Have Dropped 45% Since 1990



Source: EPA 1990, 1996 NTI and EPA 1999 NEI. Short tons per year. Adjusted for gold mines in 1990 and 1996.

(US EPA, 2005)



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Chemical Forms of Mercury

- **Elemental Mercury – Hg^0**
 - Very inert, low water solubility
 - Under most atmospheric condition is a gas
- **Divalent Mercury - HgX_2**
 - Oxidized form of mercury
 - Dominate component of atmospheric deposition
- **Methyl Mercury - CH_3HgX**
 - Mercury form that bioaccumulates in food web
 - Much more toxic than elemental or divalent Hg
- **Dimethyl Mercury – $(\text{CH}_3)_2\text{Hg}$**
 - Very toxic form of mercury
 - Role in Atmospheric cycle not well understood



Traditional Approaches to Hg Source Apportionment

- Emissions Inventory
 - Emissions inventory estimates are much more difficult than other pollutants
 - Speciation of emissions is clearly important
- Deposition Network
 - Typically measures wet deposition
 - Has been used in receptor based models
- Atmospheric Transport Models
 - Assumes good knowledge of emissions (and atmospheric chemistry of mercury)



Atmospheric Monitoring Approach

- Long history of receptor based modeling for source apportionment
 - Compliments mechanistic air quality models
 - Receptor based models are largely based on linear combinations of sources
 - Source to deposition relationships are not linear due to “fractionation” during deposition
- Divide deposition apportionment into 2 parts
 - Sources of atmospheric concentrations
 - Deposition velocity and wash out ratios



MCMA 2006 Approach

- 17 days of Speciated Mercury Measurements at Instituto Mexicano de Petroleo (T0 Site)
- Determined average elemental mercury, reactive gaseous mercury, and particulate mercury for study period
- Analyzed plumes to assess local and regional impacts
- CFA Analysis

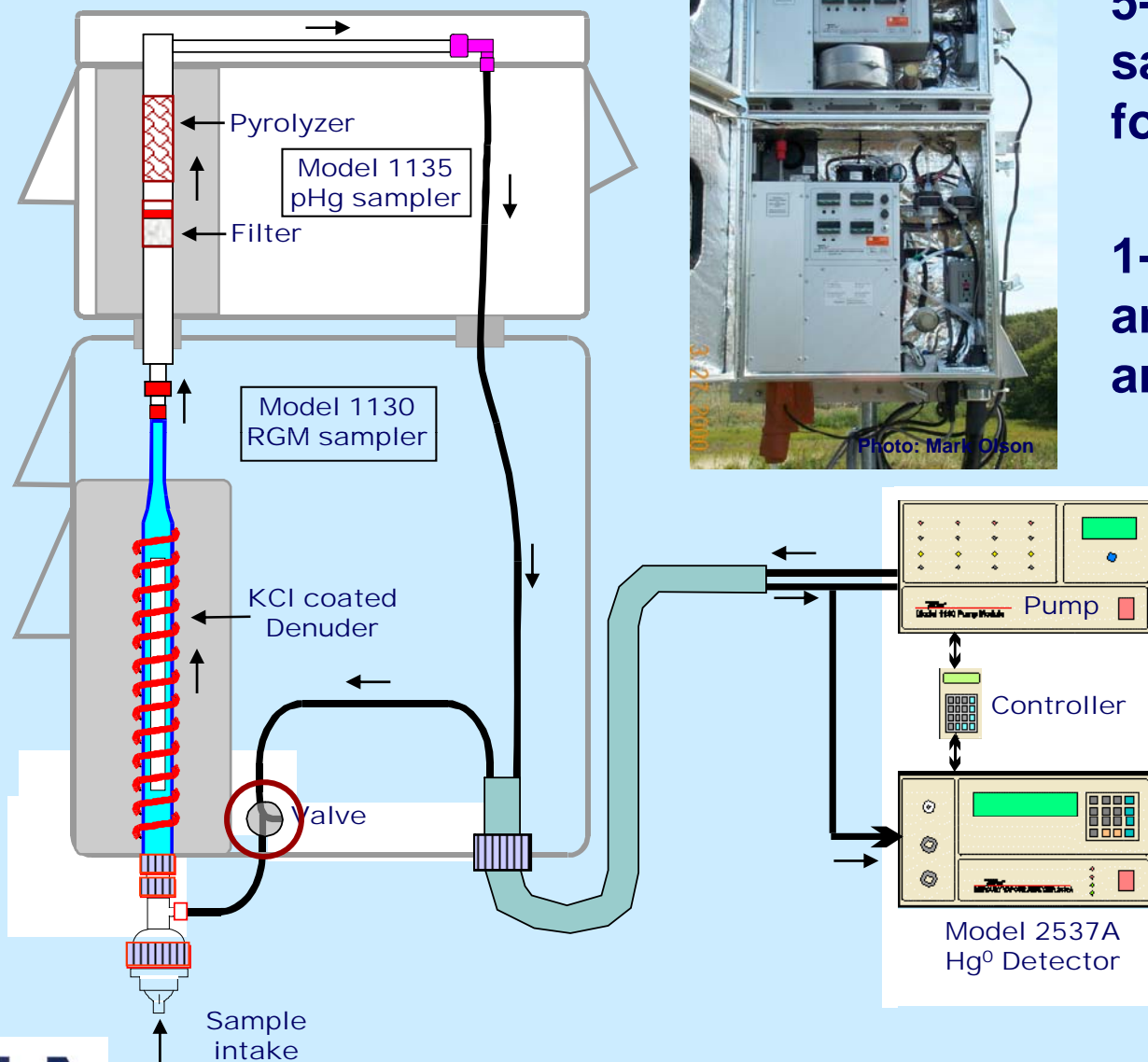
Reference:

In situ measurements of speciated atmospheric mercury and the identification of source regions in the Mexico City Metropolitan Area, *Atmospheric Chemistry and Physics*, 2009, 207-220.

**A. P. Rutter, D. C. Snyder, E. A. Stone, J. J. Schauer, R. Gonzalez-Abraham,
B. L. T. Molina, C. M´arquez, B. C´ardenas, and B. de Foy**



Tekran Hg analyzer

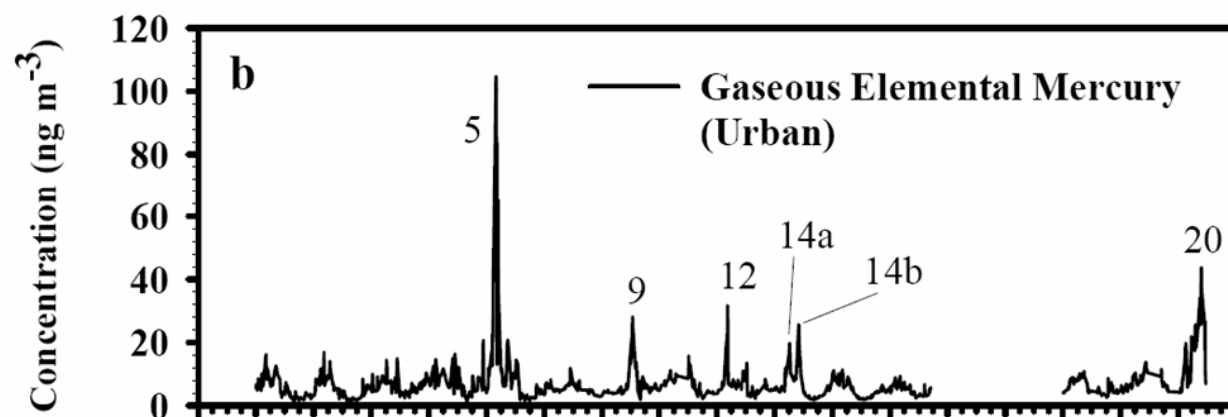
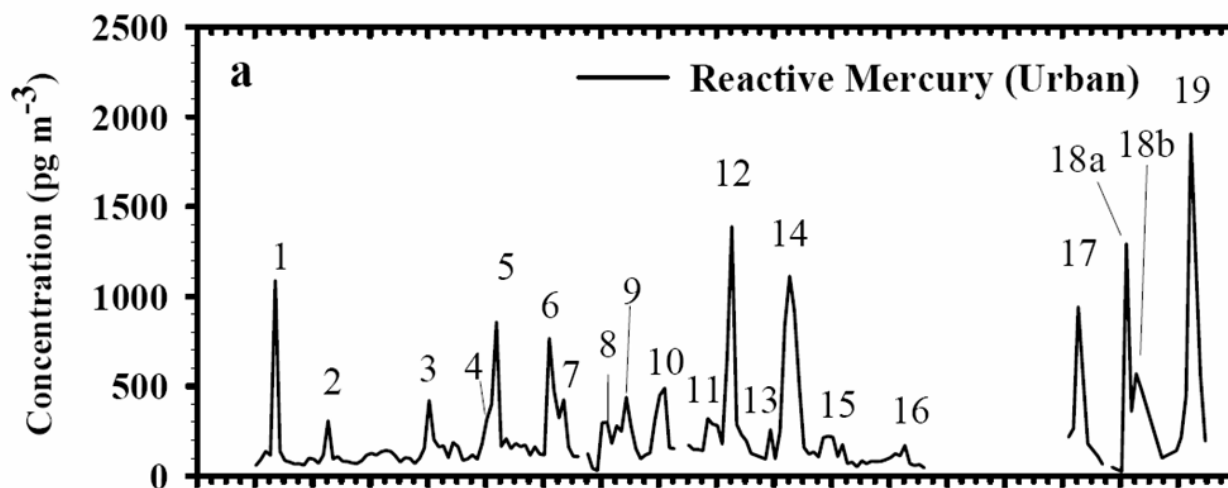


5-min composite samples are collected for Hg^0

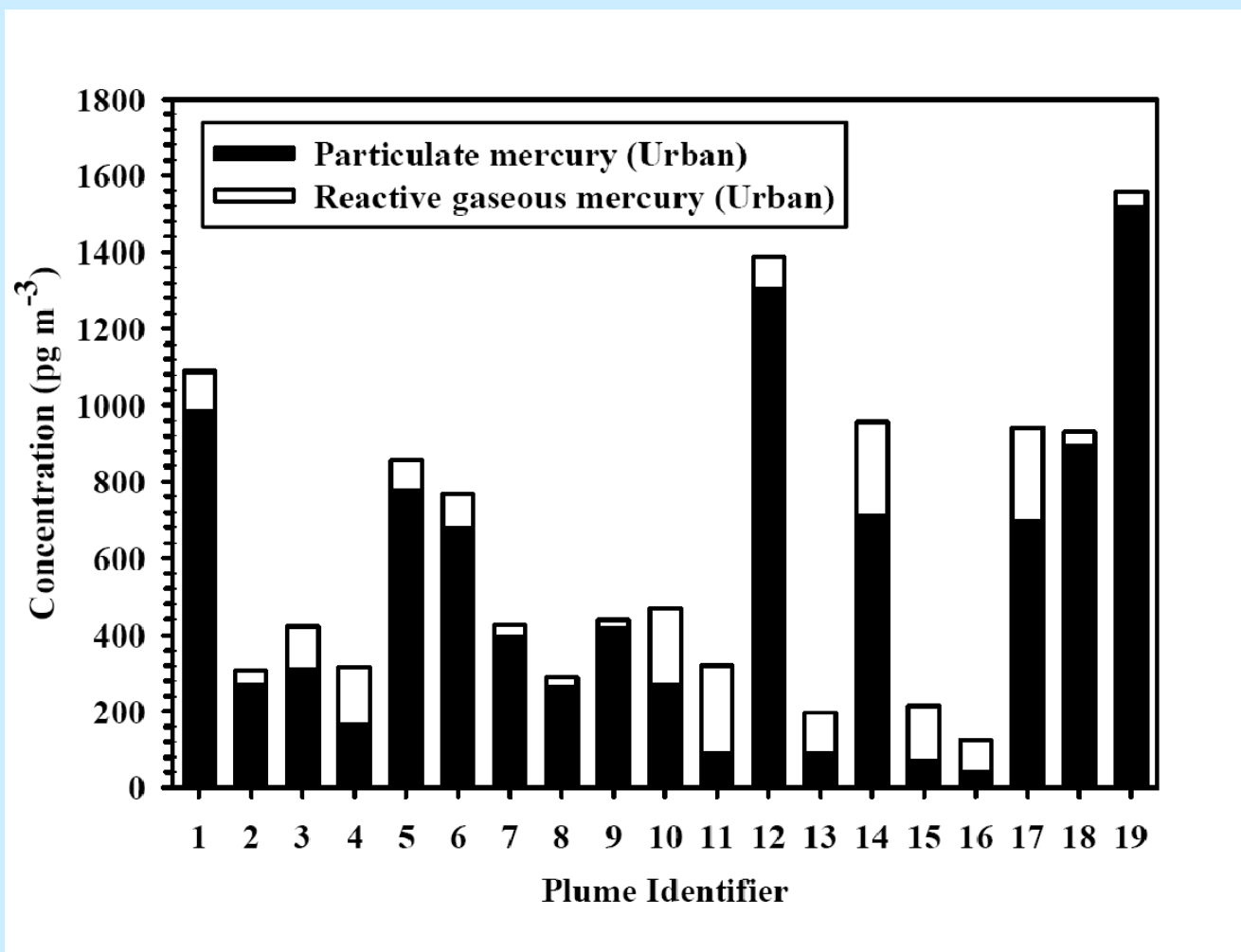
1-hr composite samples are collected for pHg and RGM



MCMA 2006 Mercury Plumes



Distribution of Reactive Mercury

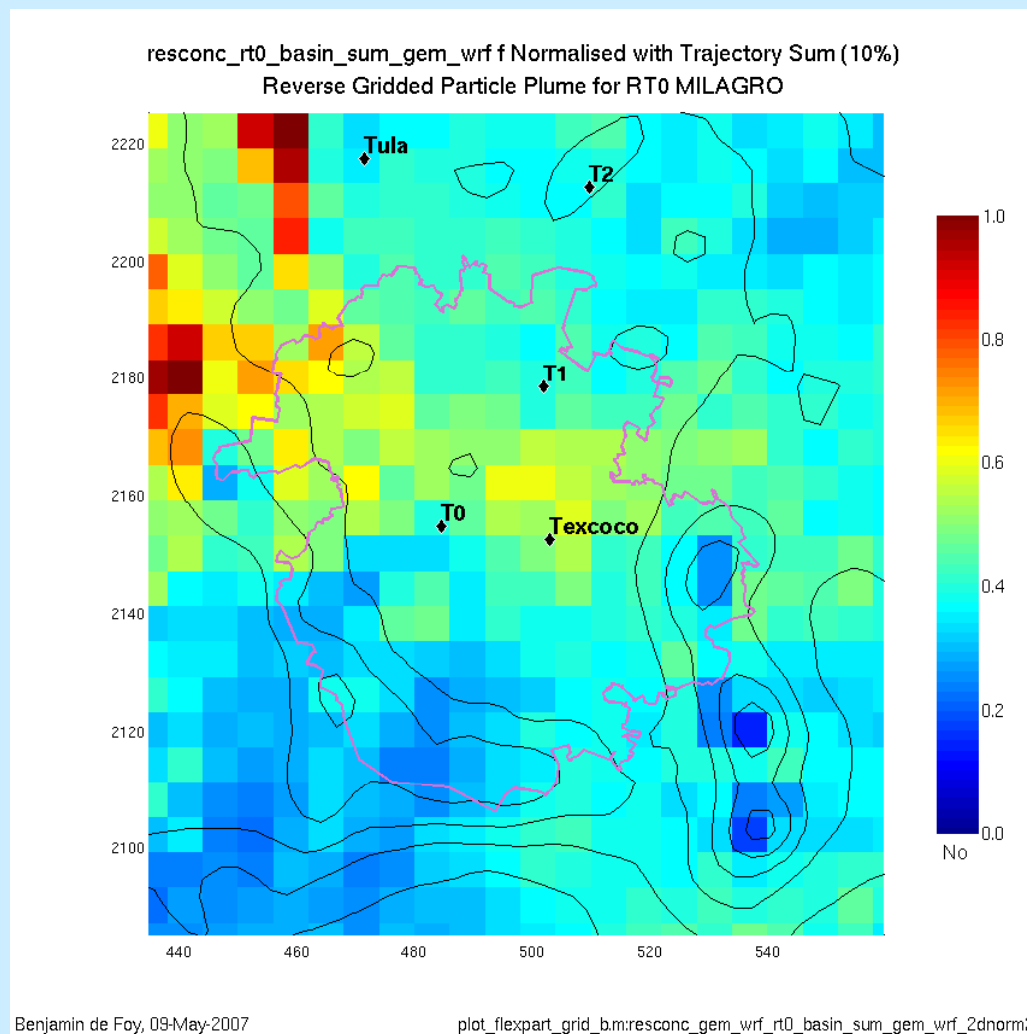


Concentration Field Analysis

- Prof. Ben de Foy will cover in more detail
- Modeling approach that fully exploits high time resolution measurements
- Uses a probabilistic approach to merge back trajectory or high time resolution measurements
- Performed on elemental mercury, RGM and particulate mercury measurements



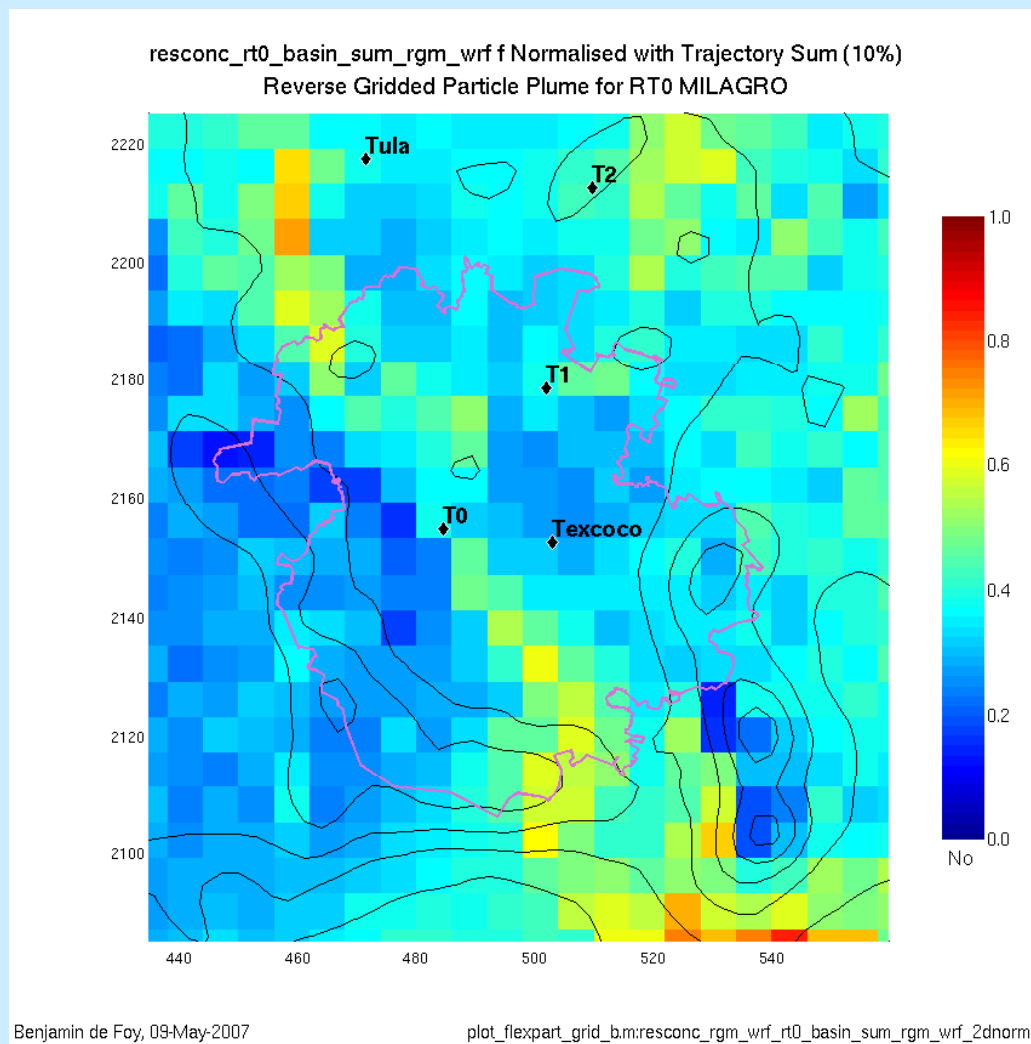
CFA Mapping of Elemental Hg



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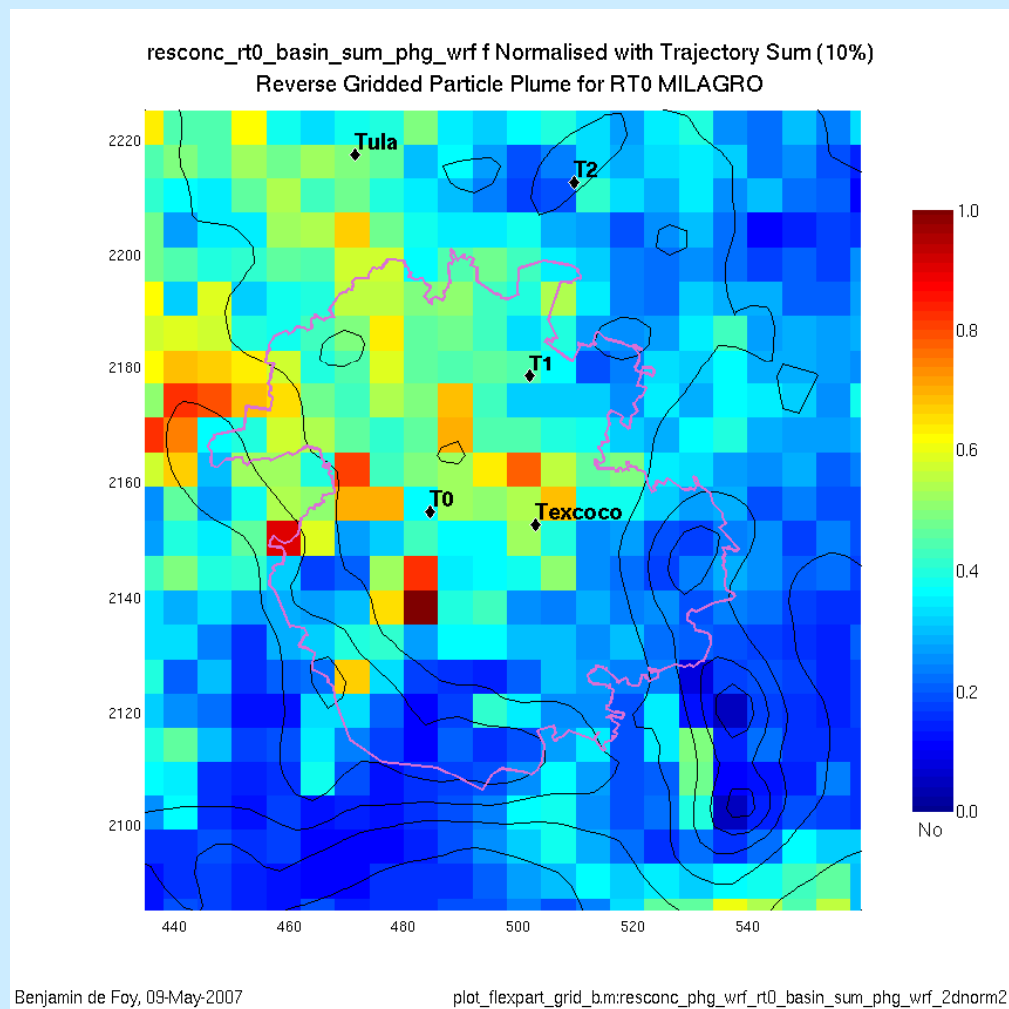
CFA Mapping of RGM



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CFA Mapping of Particulate Hg



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Recommendations and Conclusions

- Relatively high concentrations of elemental and reactive mercury in atmosphere of Mexico City
- Local source impacts are important for elemental mercury
- Data provides insight into sources and demonstrates feasibility of approach
- Longer sampling times are needed for a more complete analysis



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