Mercury Contamination of the Environment: An Overview

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Presentation Outline:

- Background of the “mercury problem”
- Current understanding and present research directions – example from the Everglades
- Summary comments and relevance to modeling

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Mercury toxicity revealed in the 1950's-60's by severe contamination cases in Japan and Iraq
Minamata, Japan poisoning victim

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Mercury Contamination of Aquatic Resources

	1960s - 1970s	1980s - 1990s
Mercury sources	industrial, direct	multiple, atmospheric
Pollution level	heavy	light to moderate
Affected waters	developed rivers, reservoirs, lakes	remote to developed
Key factors	large mercury inventories	high bioavailability (production of methylmercury)
Problem resolution	reduce direct discharges to surface waters	further reduce emissions, management of mercury-sensitive ecosystems

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From: Wiener, Krabbenhoft and others, 2002

Mercury Pollution

Ecosystem	Hg in game fish (µg/g wet wt)	
	Mean range	Maxima range
Old		
Waters polluted by chlor-alkali plants	1 - 5	2 - 15
New		
Newly flooded reservoirs	0.7 - 3	2 - 6
South Florida wetlands	0.4 - 1.4	2 - 4
Low-alkalinity lakes	0.5 - 0.9	1 - 3

Data for northern pike, walleye, largemouth bass, and smallmouth bass

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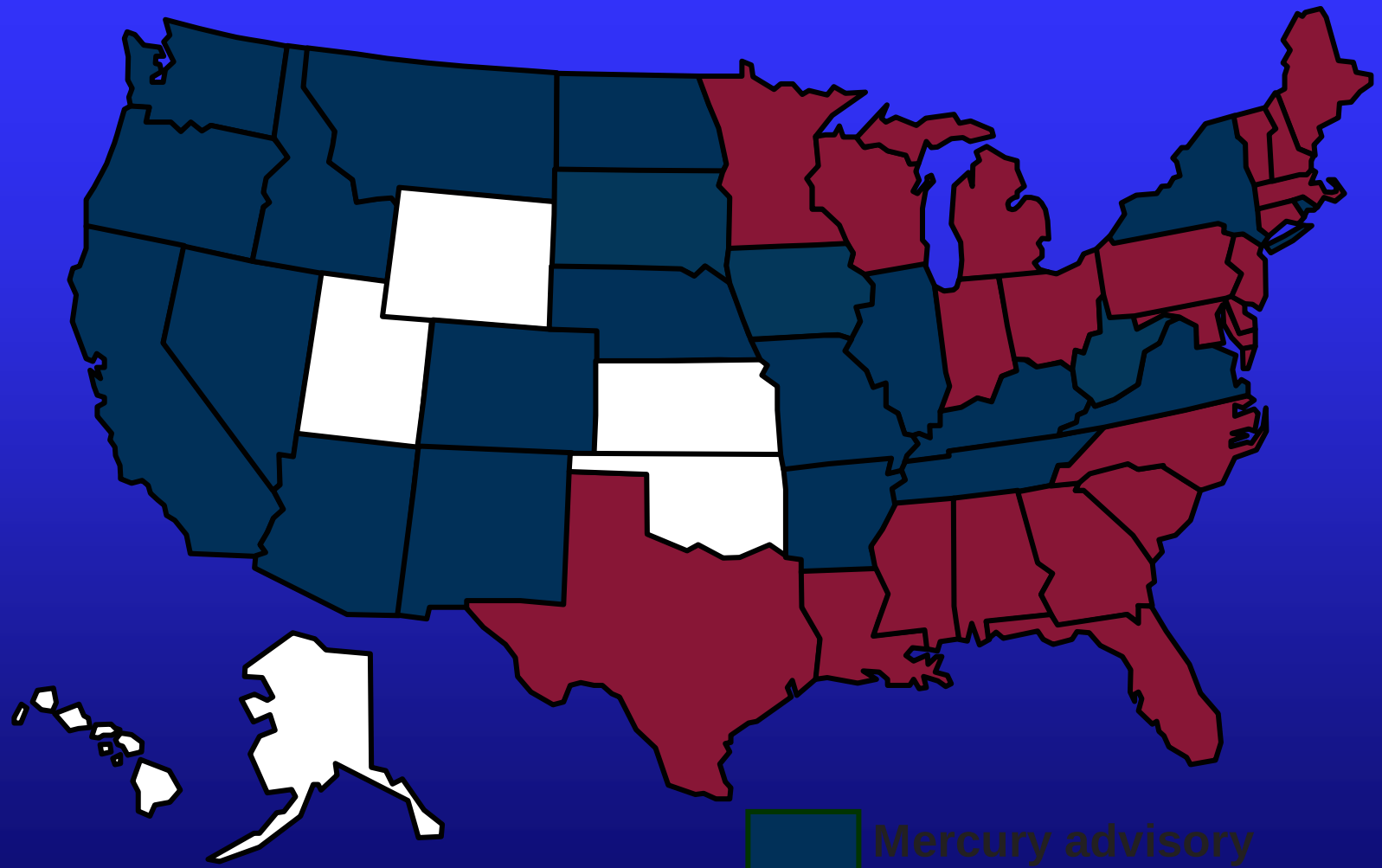
US Map of Fish-Consumption Advisories



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Source: EPA -823-F-03-005

Survival of Mallard and Royal Tern Embryos

This is where the toxicity testing on the Royal Tern and Mallard embryos was shown. The author has not published these results yet, however.

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Source: Gary Heinz, USGS

Embryotoxic thresholds in mallard eggs and diet

Harmful concentrations of mercury in eggs (ppm, wet-weight)	Mercury in diet of adults that produces 0.1 – 0.8 ppm mercury in eggs (ppm, wet-weight)
0.1 – 0.8	~ 0.1

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Source: Gary Heinz, USGS

PATUXENT Wildlife Research Center

Consequences of Mercury (MethylImercury) Contamination of Fish

- Direct health effects on humans and fish-eating wildlife
- Loss or degradation of a consumable resource having socioeconomic, nutritional, cultural, and recreational value
- Socio-cultural damage to people who fish for subsistence

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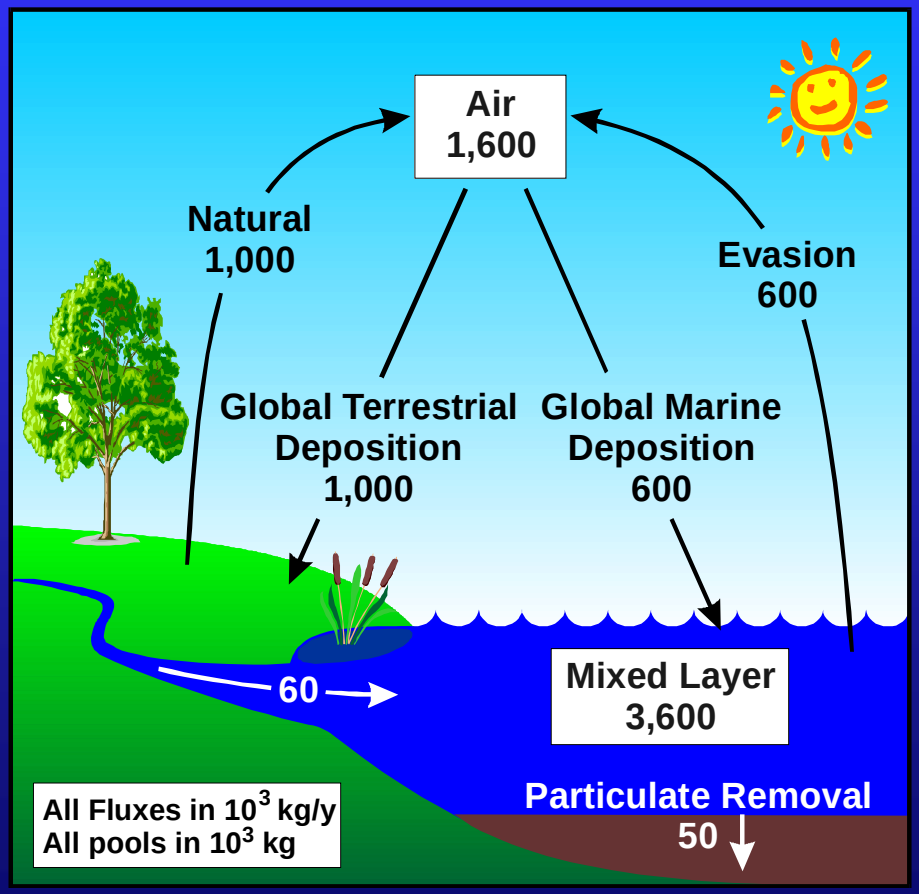
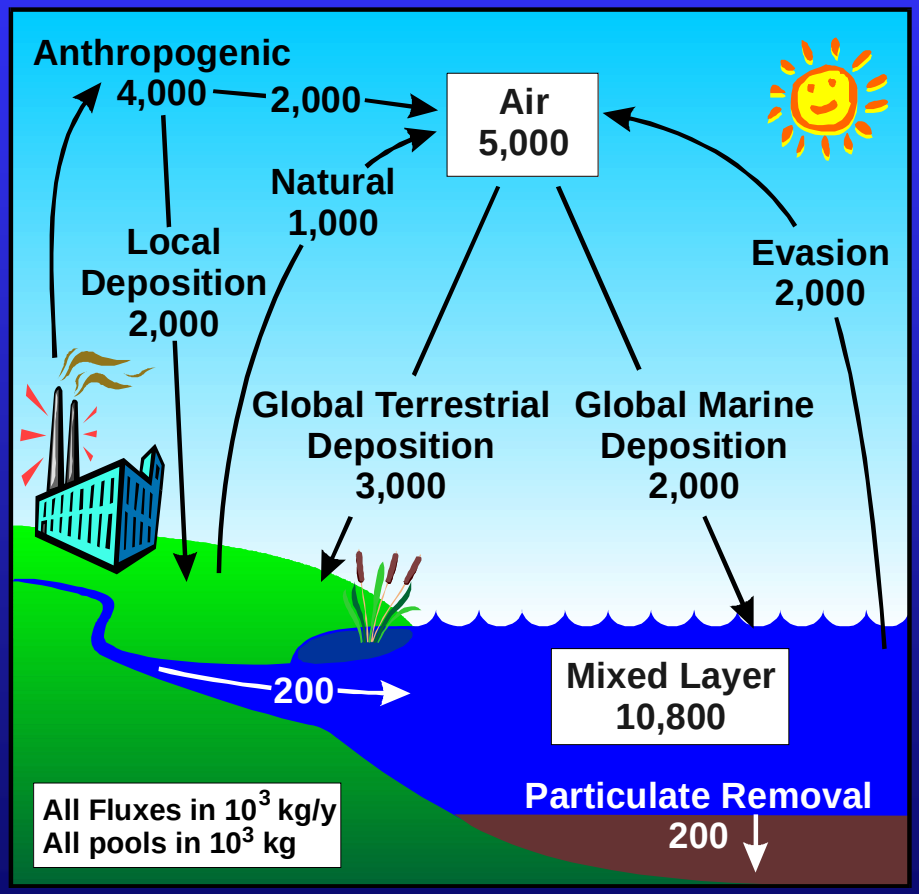
Mercury Then and Now

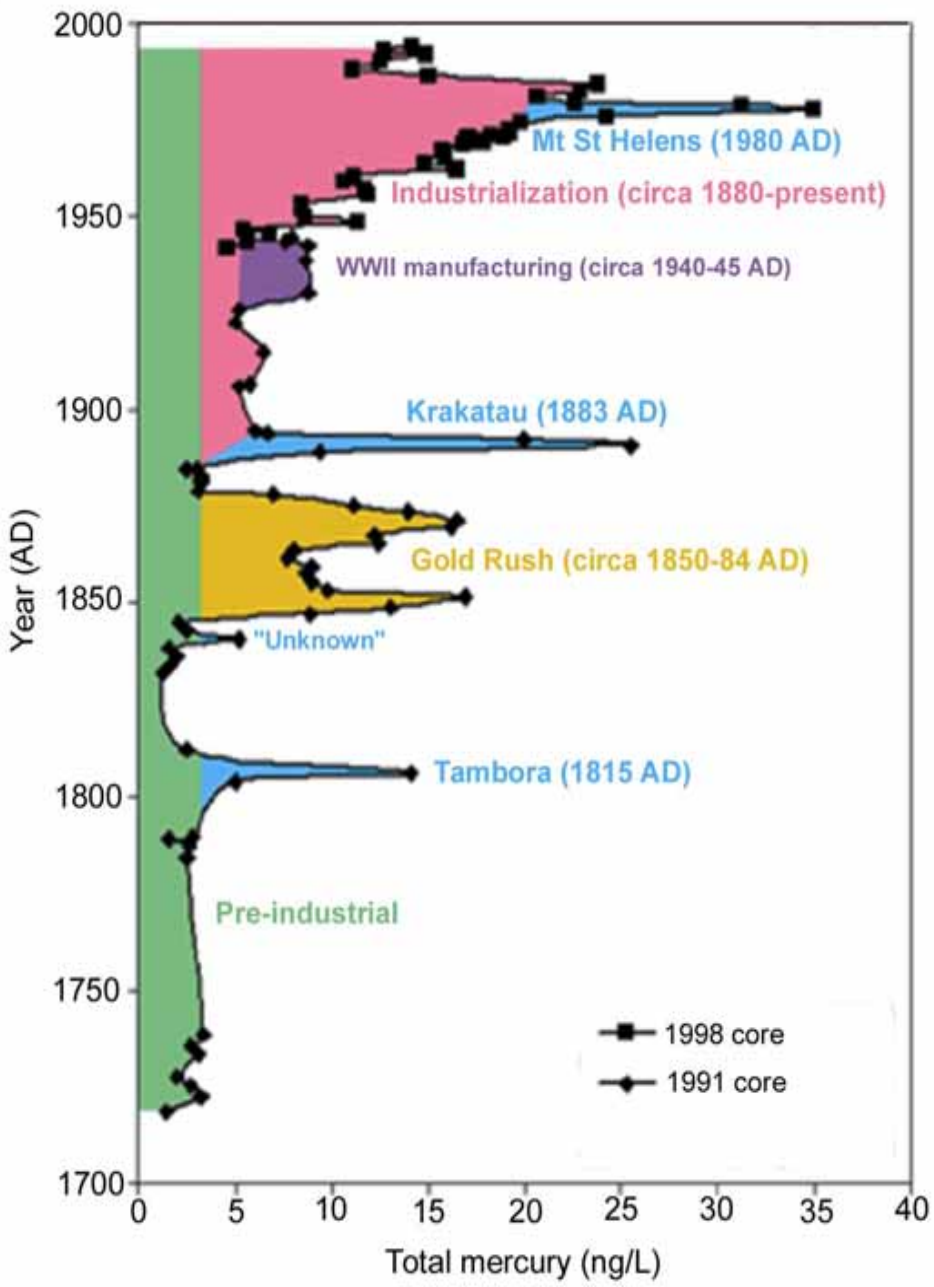
Pre-industrial



Current



Mason et al. 1994



Lessons from the Freemont Glacier:

270-year record

Large changes in mercury deposition

Regional-to-global scale impacts from varying Hg sources.

70% of Hg accumulation over the past 100 years resulting from man's activities

Distinct decline last 10 years

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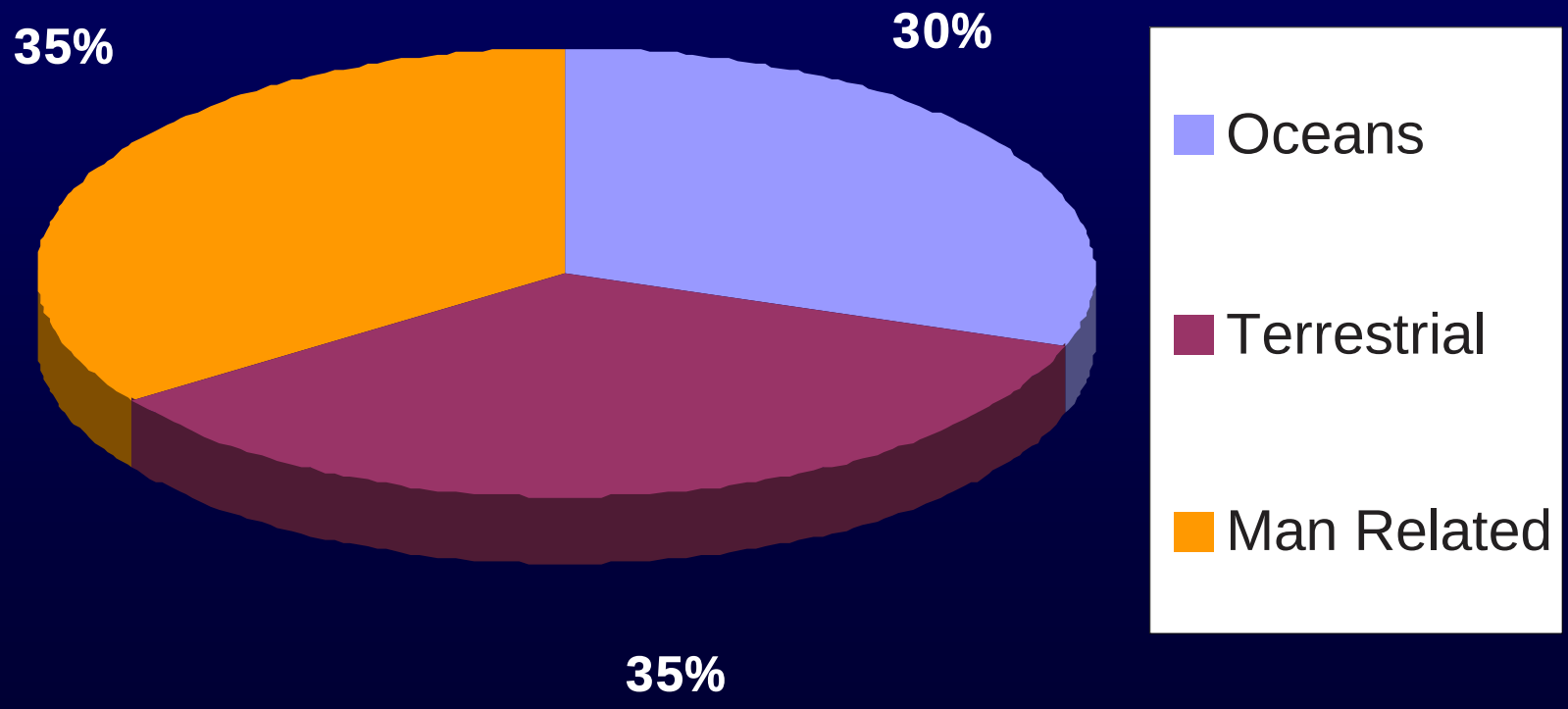
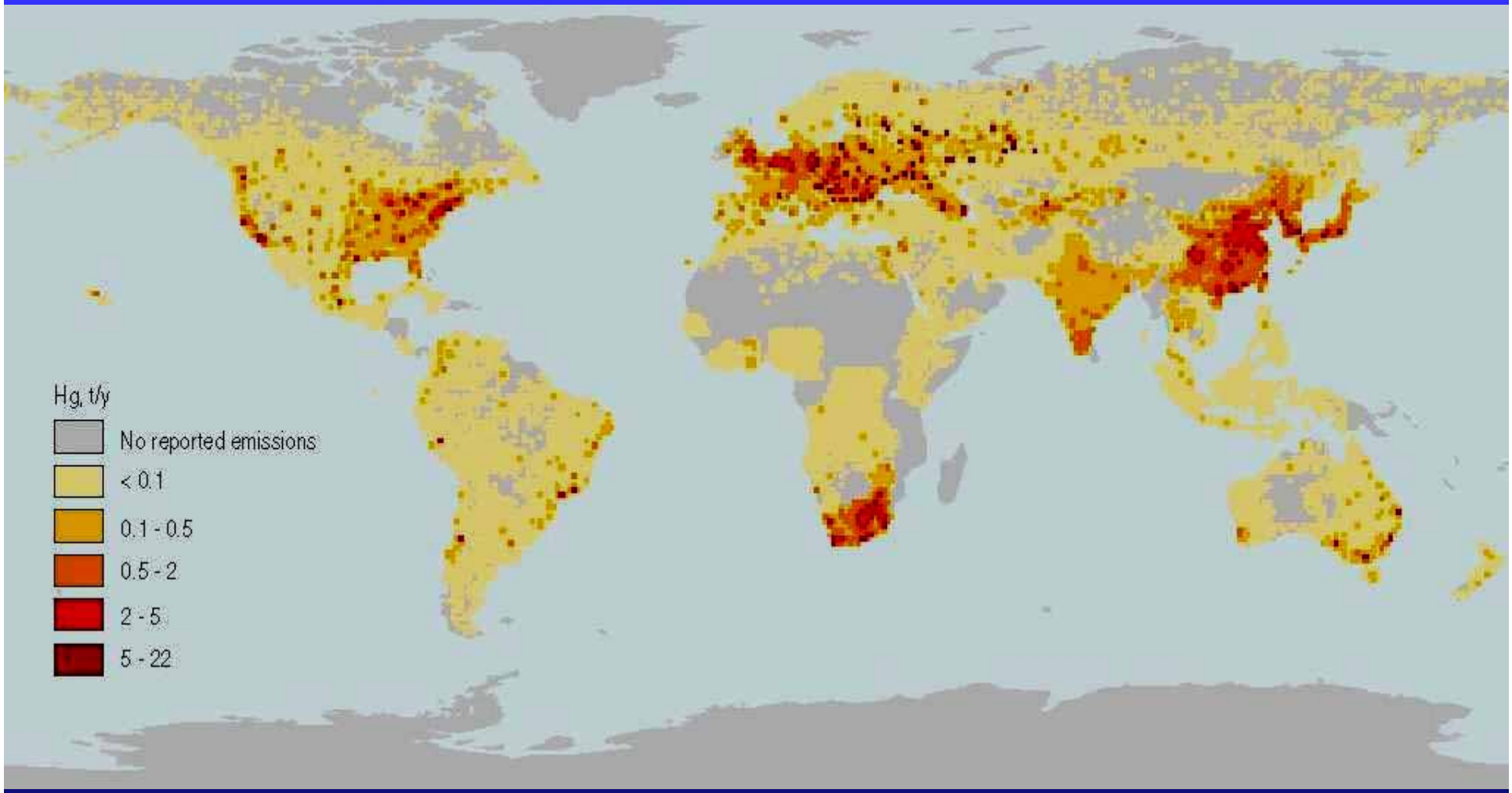
Where does the come from?

Global Atmospheric Mercury Emissions (percent of 7260 tons per year)



Source: EERC Rept., v. 9, no. 1, 2003

Spatial distribution of global emissions of mercury to air



Source: UNEP Global Mercury Assessment, 2002, using J. Pacyna 1995 data, as presented by AMAP (1998).

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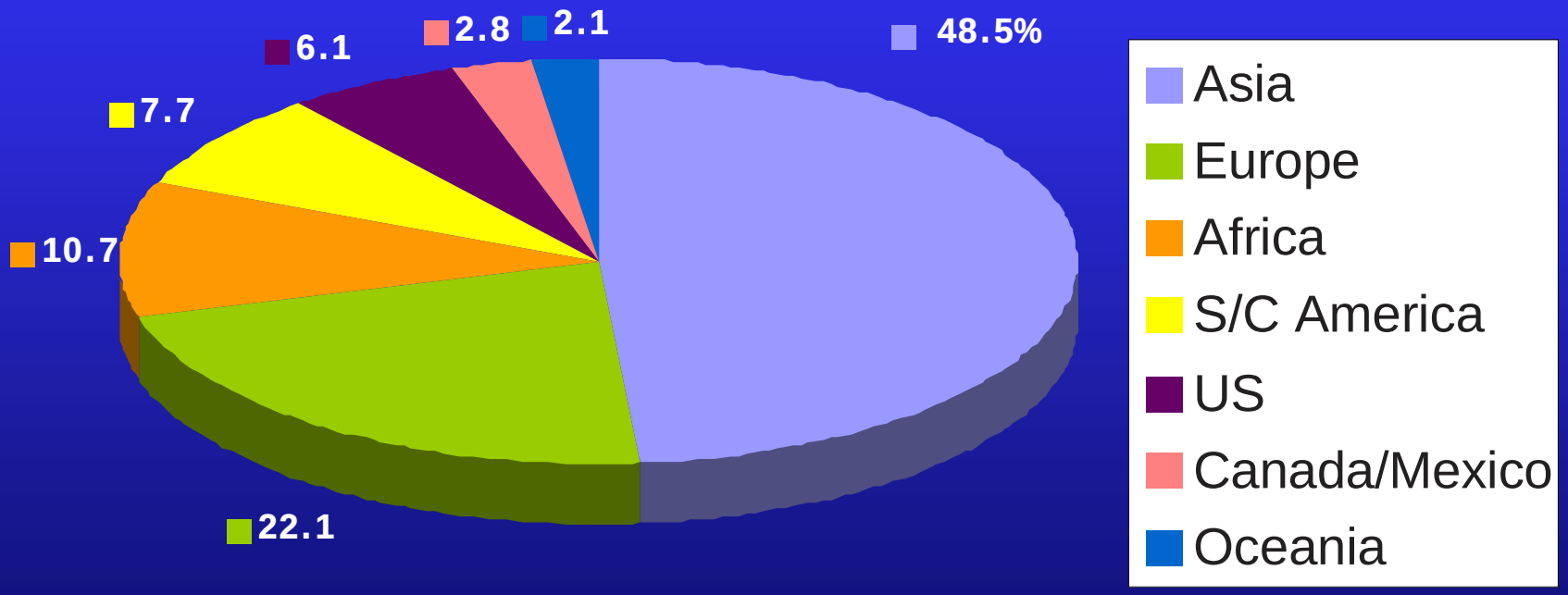
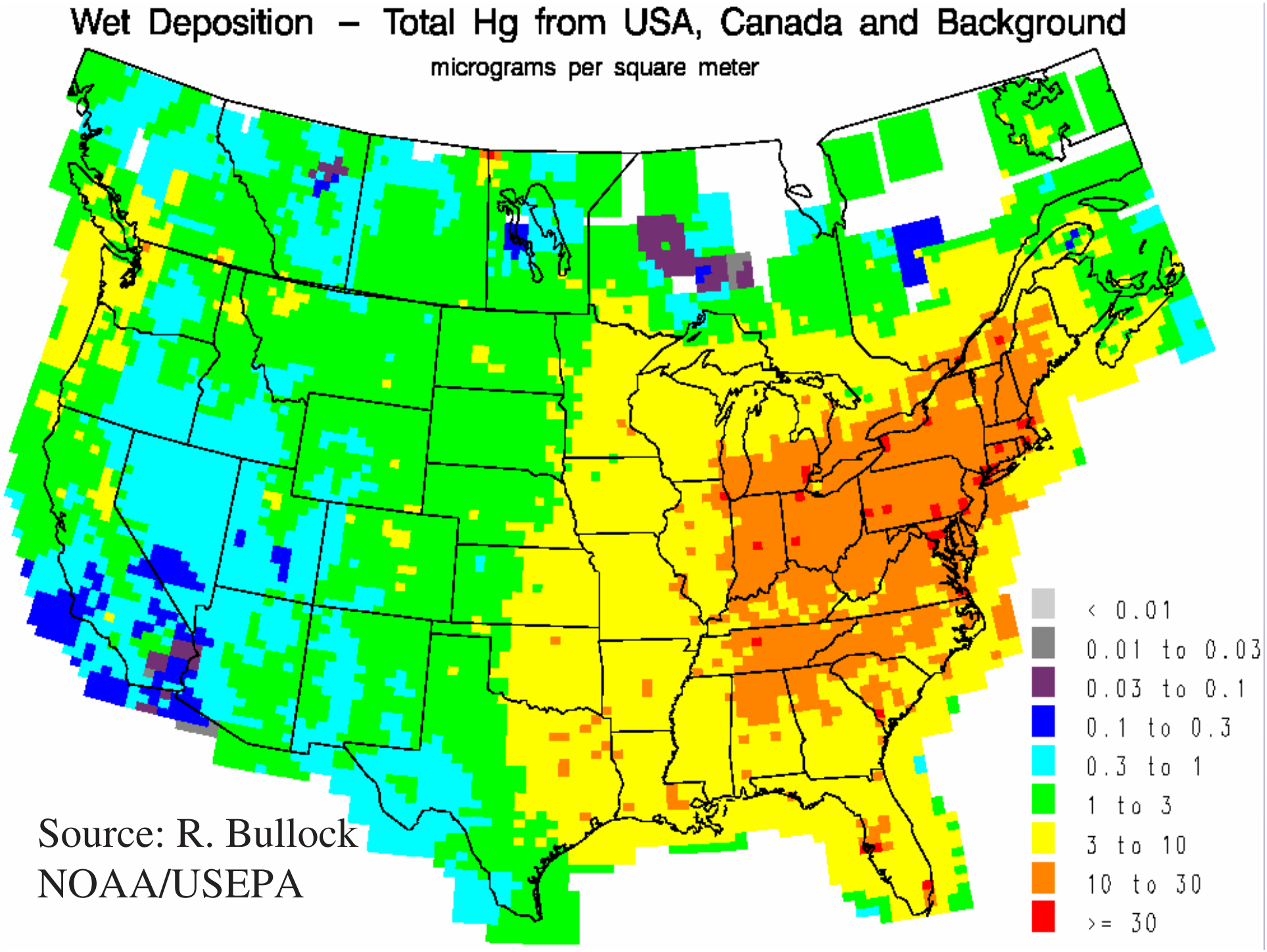
Regional Atmospheric Mercury Emissions (percent of total man-related emissions)

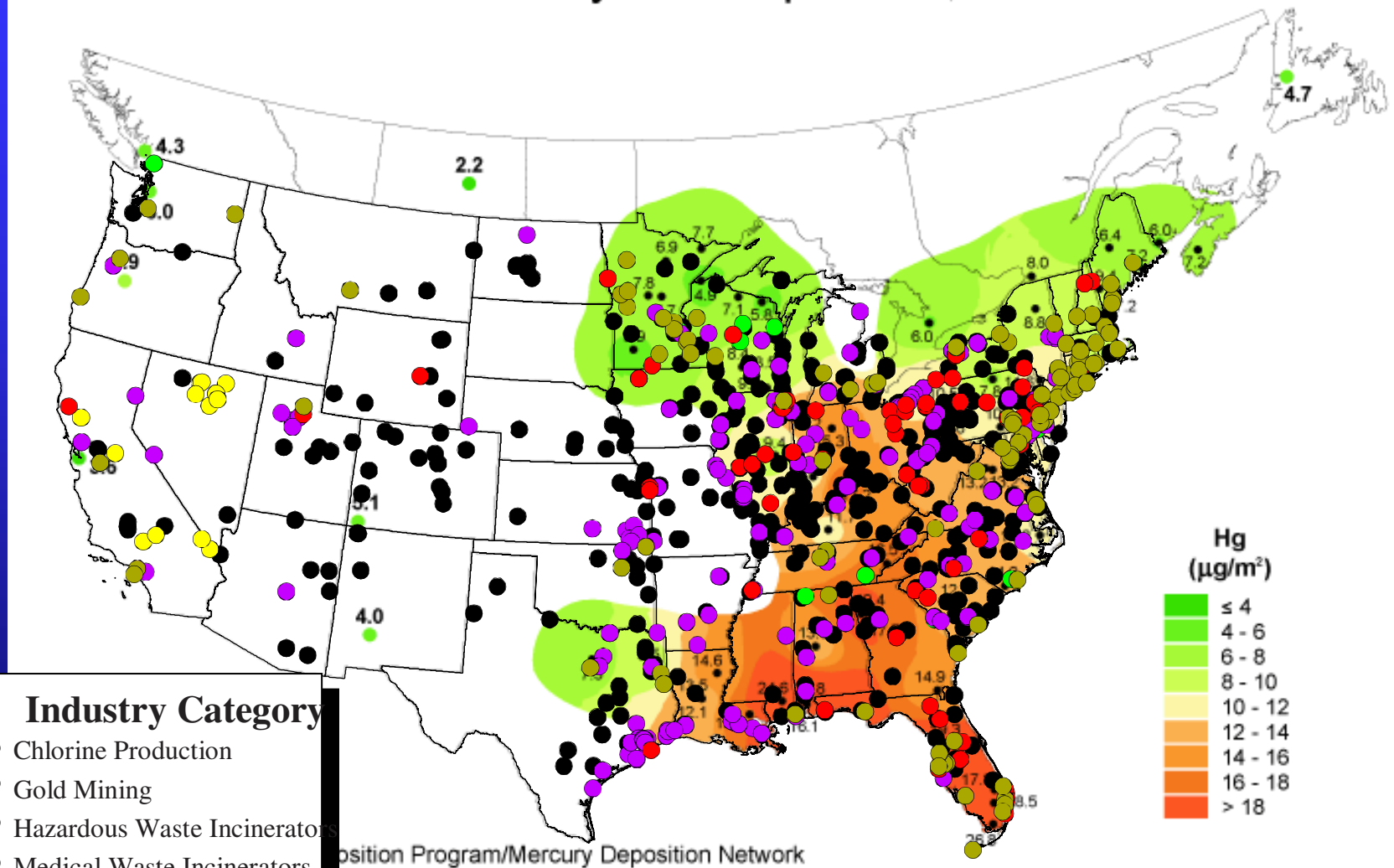


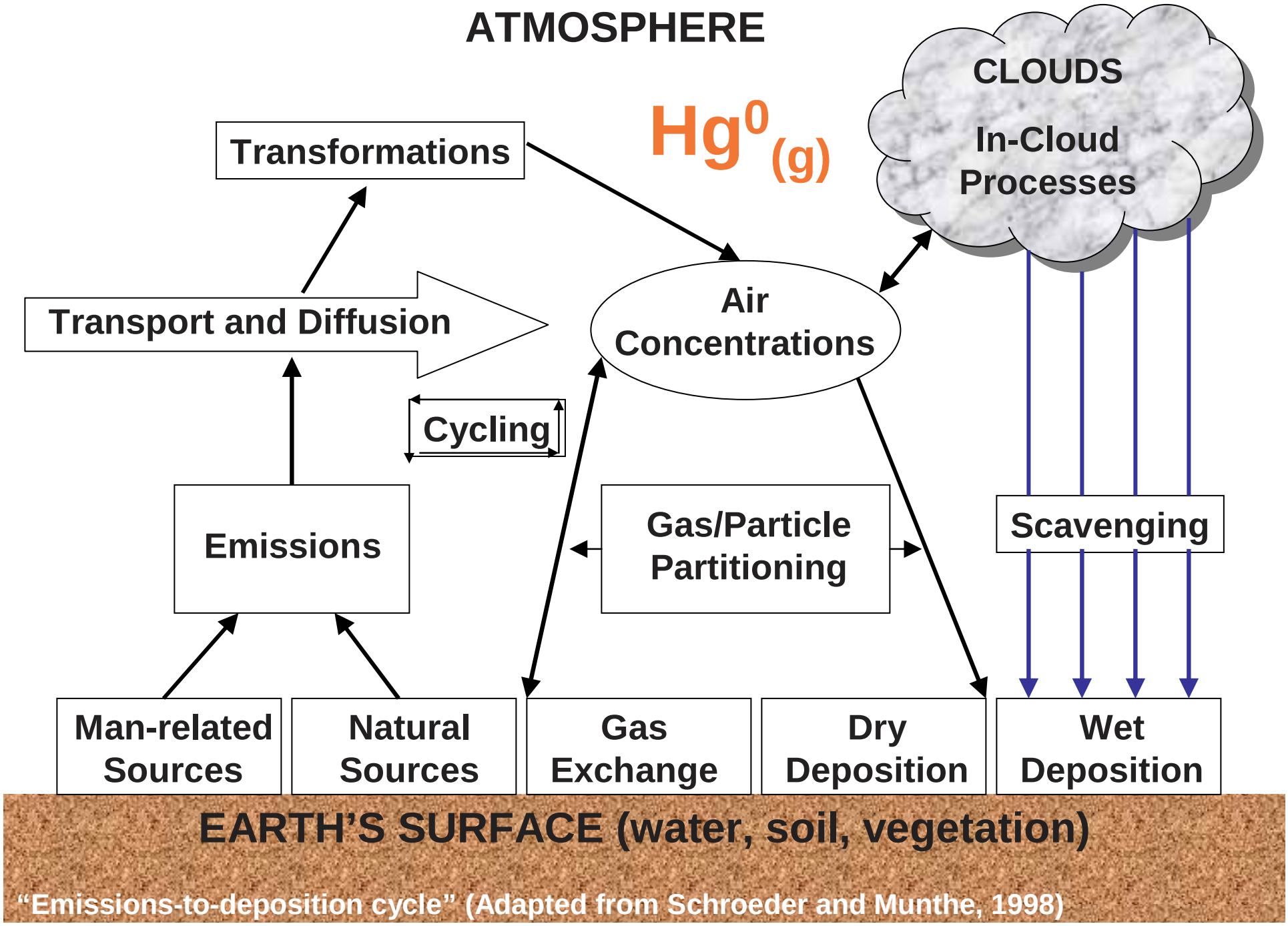
Source: EERC Rept., v. 9, no. 1, 2003



Source: R. Bullock
NOAA/USEPA

Total Mercury Wet Deposition, 2003





"Emissions-to-deposition cycle" (Adapted from Schroeder and Munthe, 1998)

How important is atmospheric deposition (or atm. mercury load reductions), at sites of historical point source mercury contamination?

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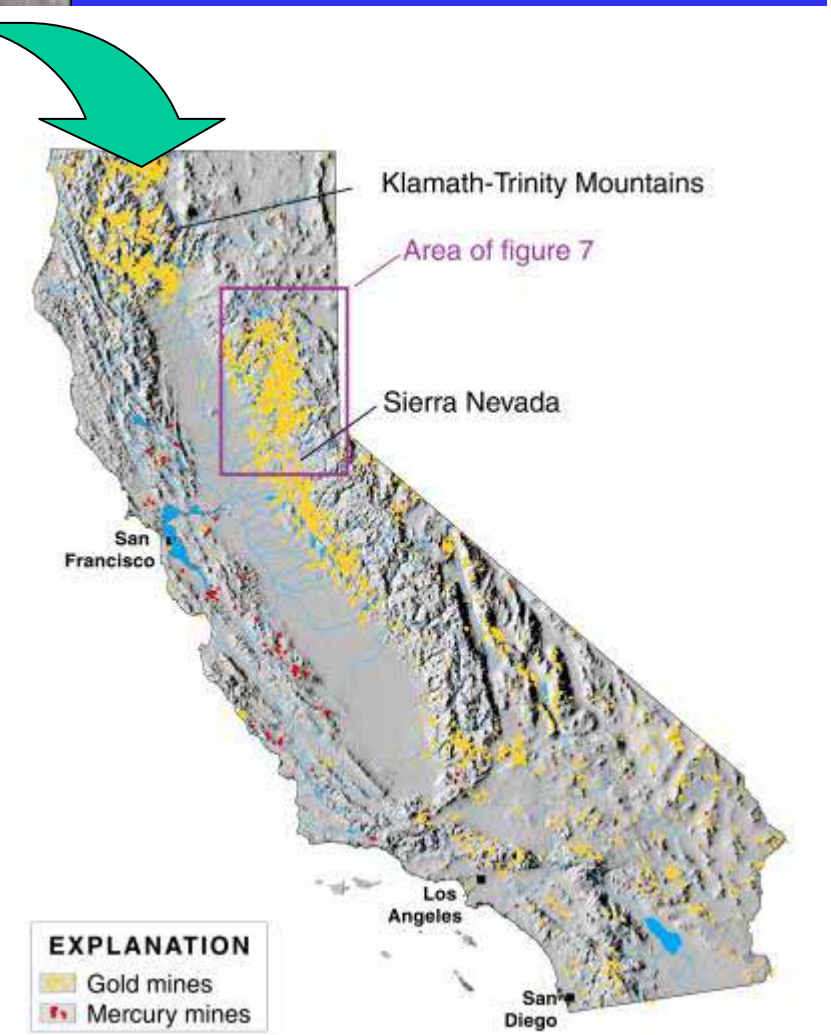
California Mercury Production

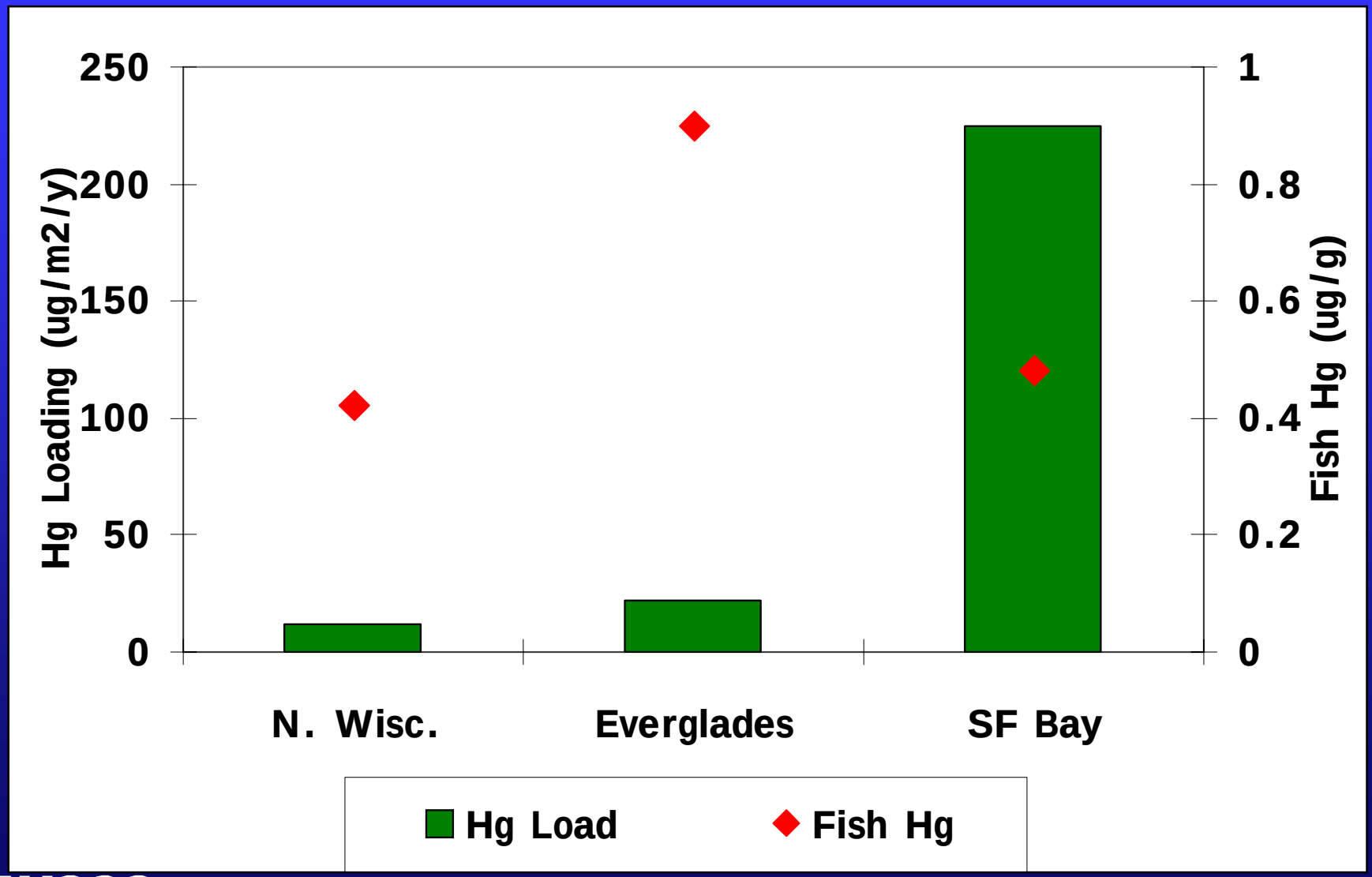
Historical mercury problems: California example

Legacy of historical mercury uses that 150 years later are now sources



Figures from C. Alpers

Relating Sources and Loading to Bioaccumulation – Bioavailability is the Key



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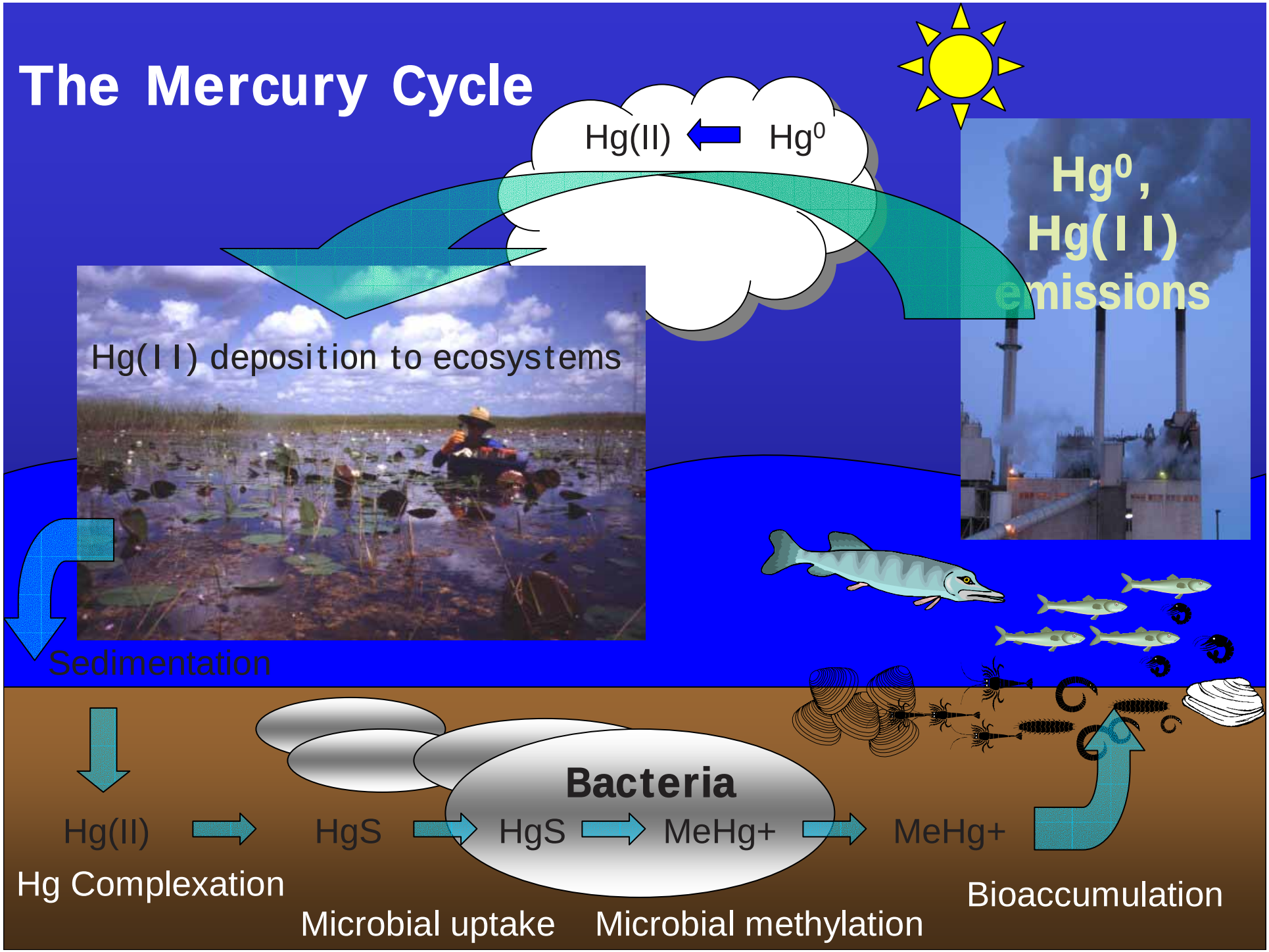
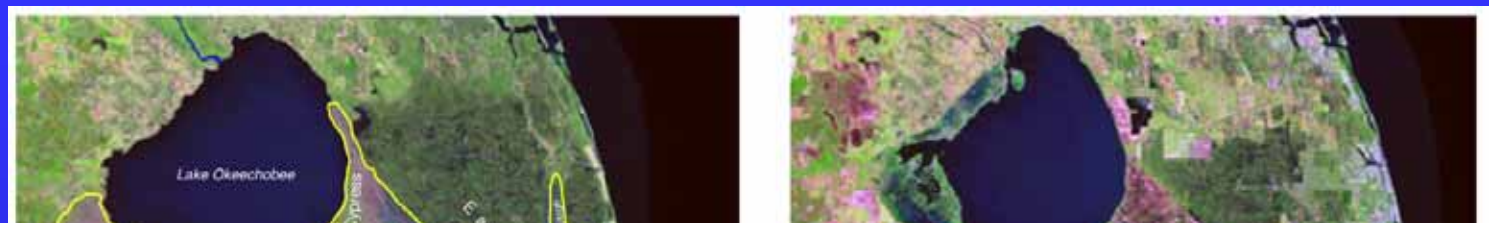
The Mercury Cycle



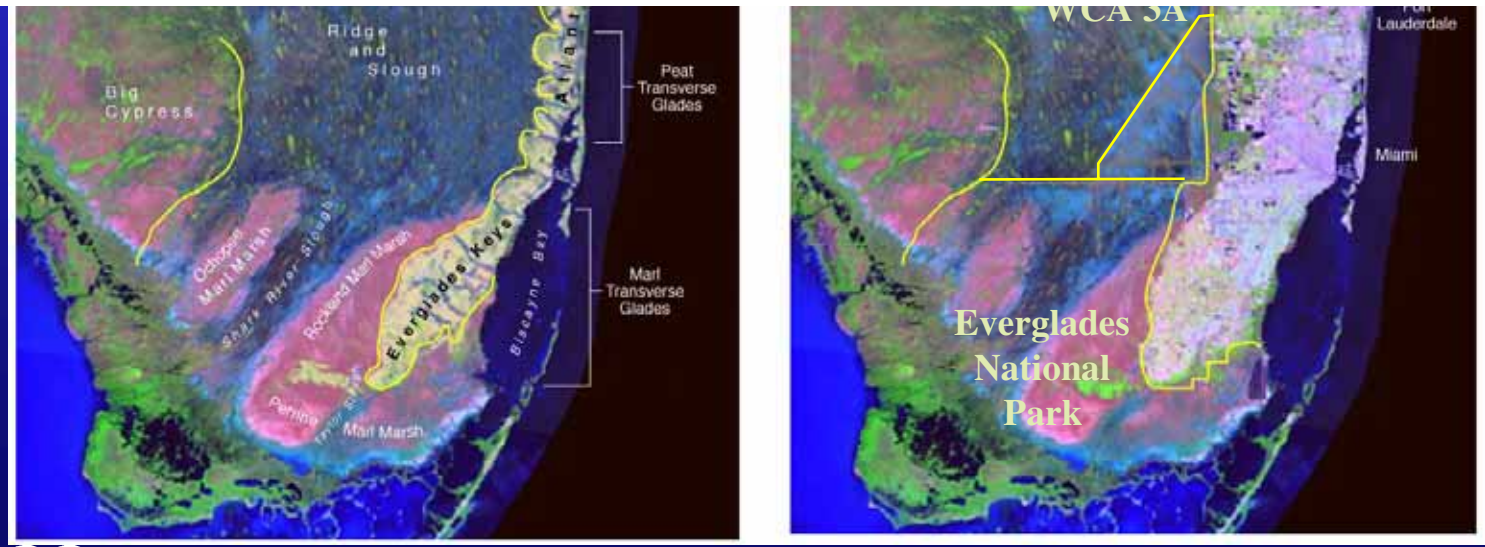
The Aquatic Cycling of Mercury in the Evergaldes Project 95 - present

Florida Everglades: Then and Now

Pre 1900's **Current**



The Future? $8 billion in restoration efforts will tell the next chapter of the story



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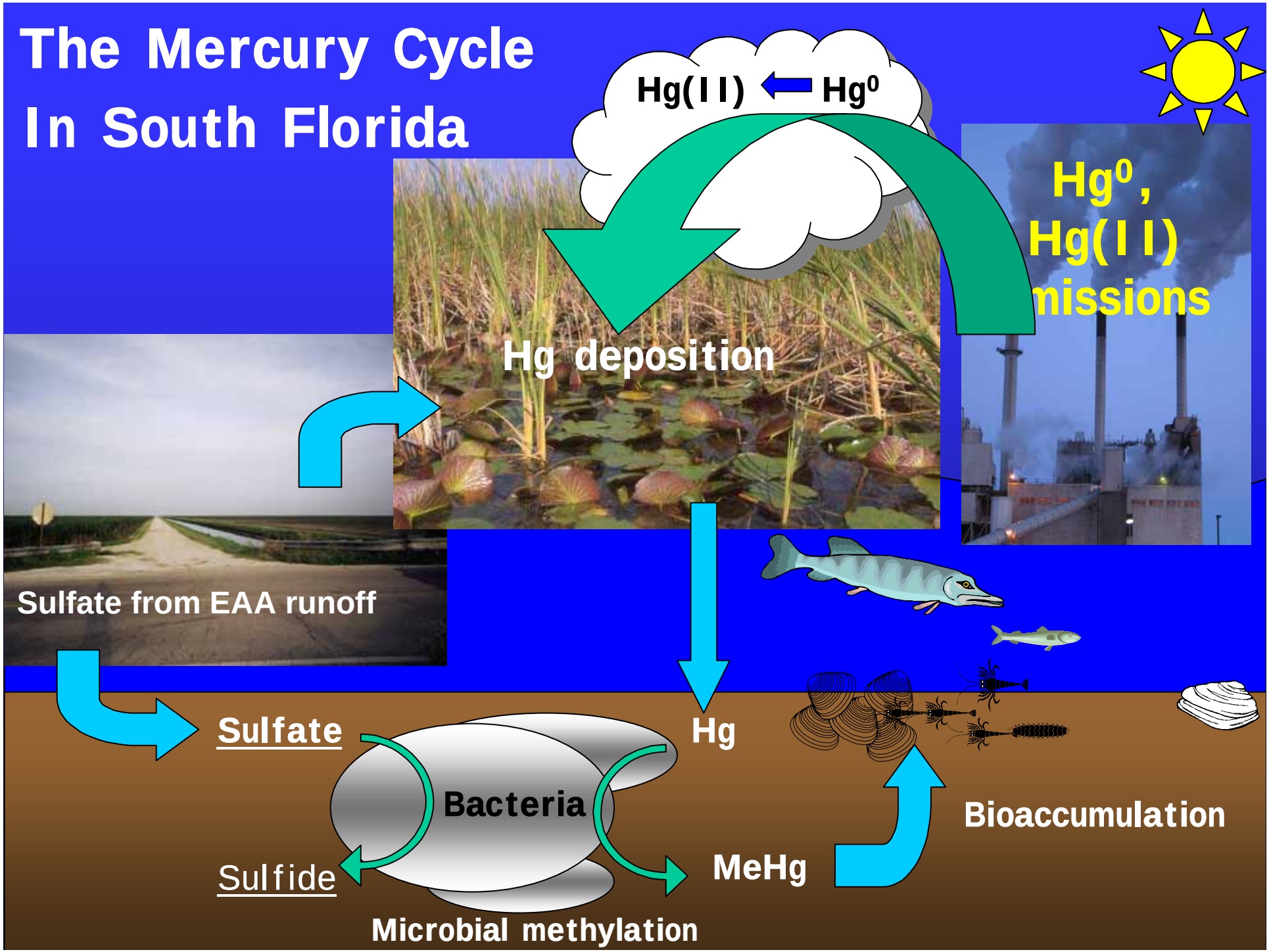
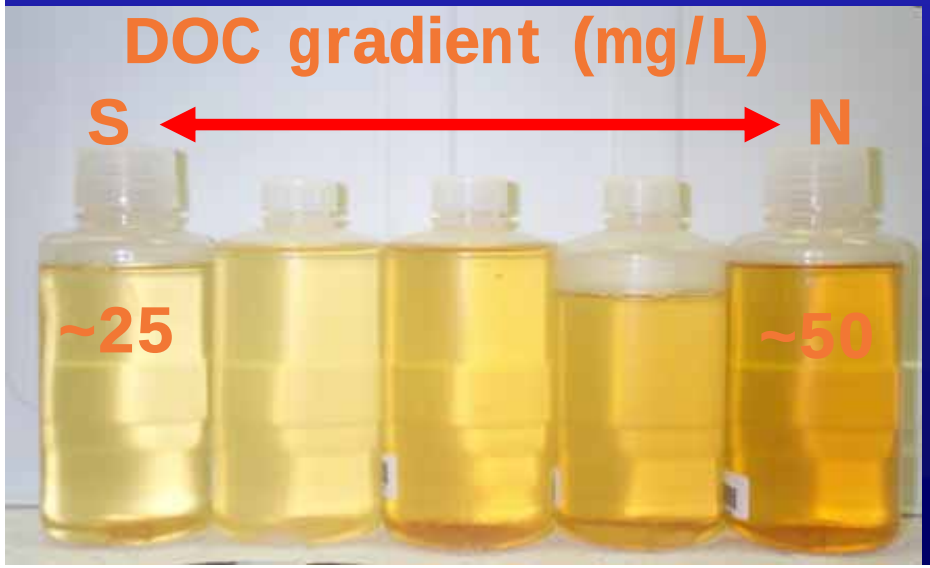
The Mercury Cycle In South Florida

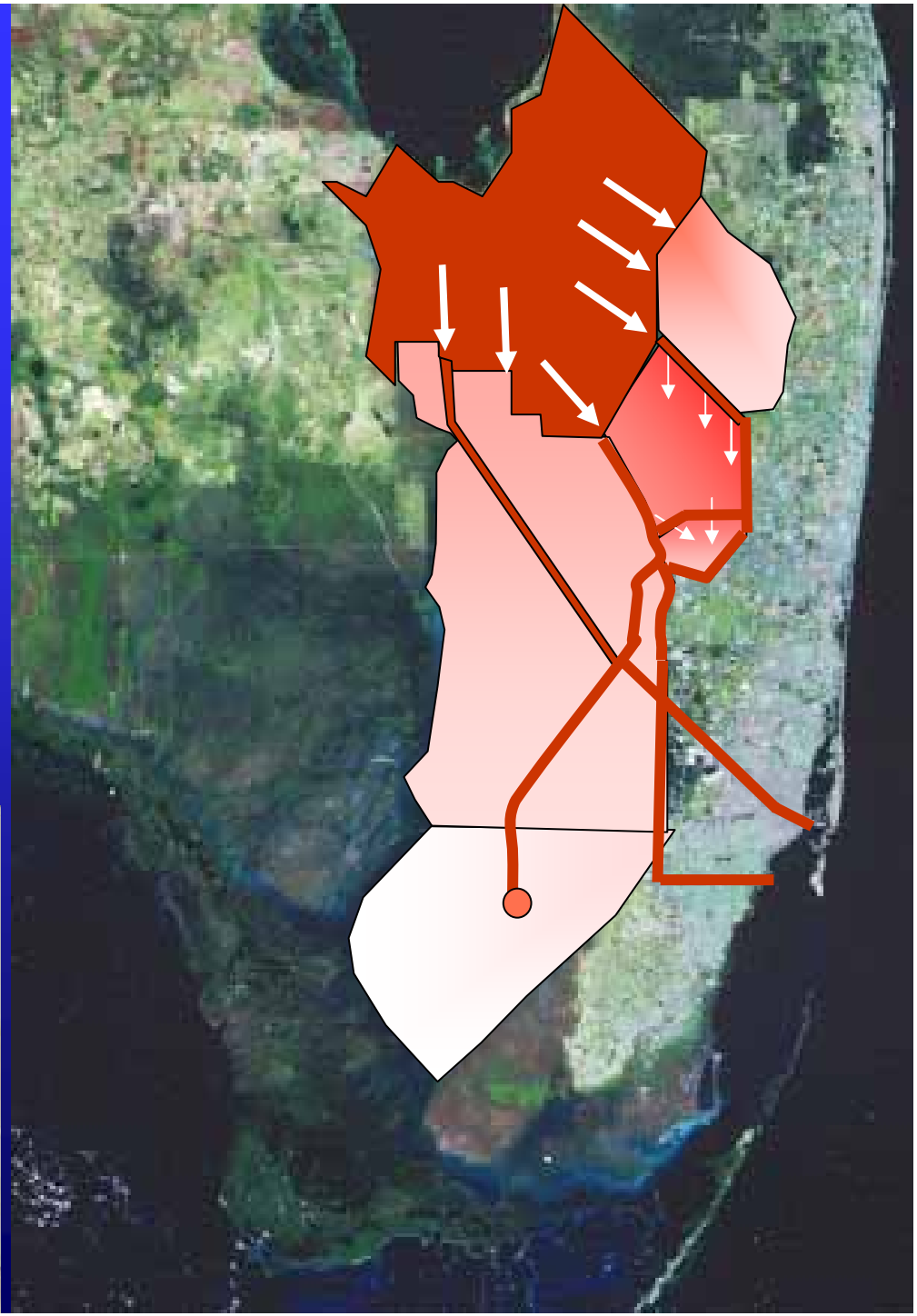


Ecosystem Scale QW Gradients:

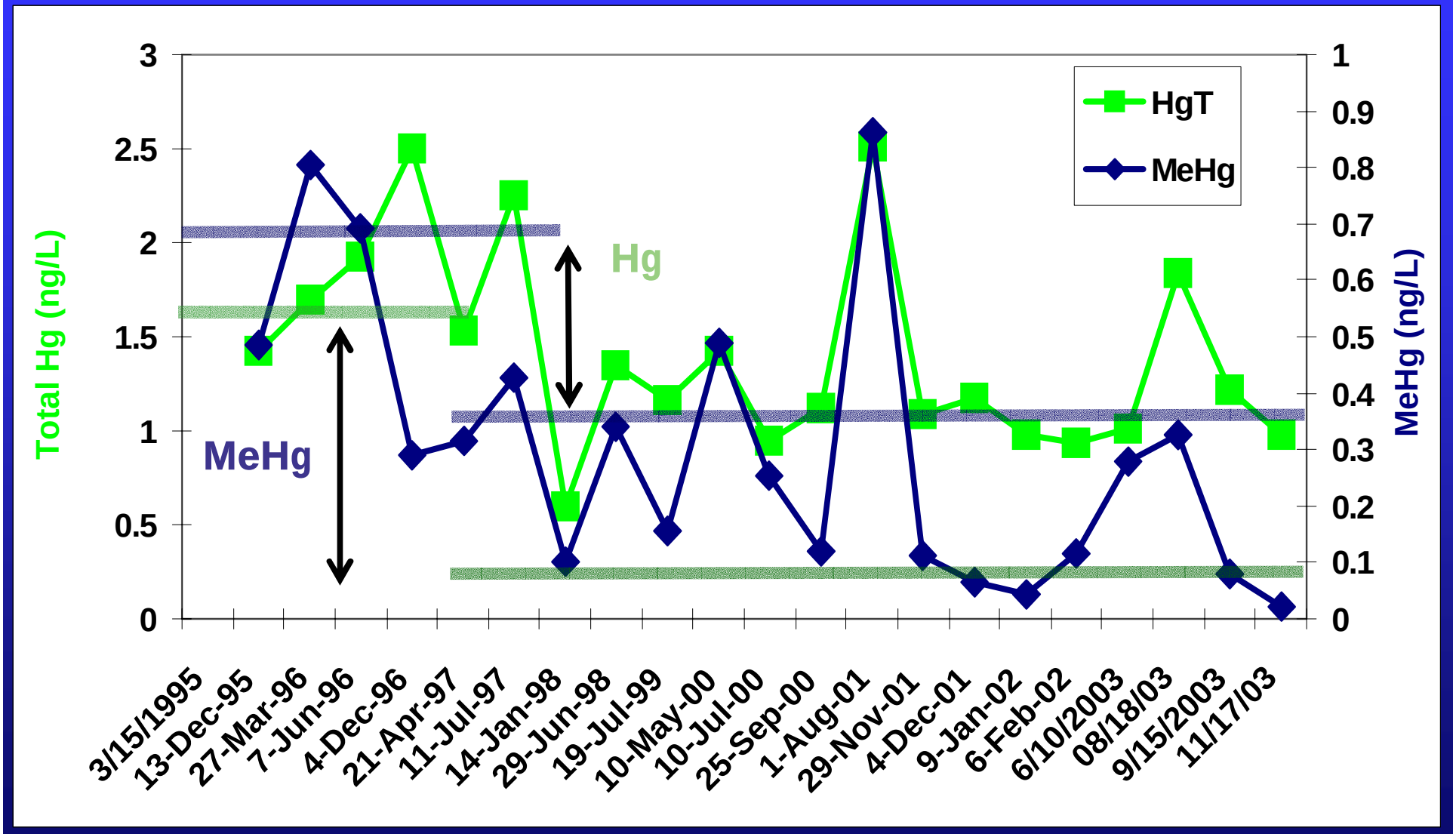
SO_4 & DOC Loading from the EAA

- > 100's mg/L
- ~50-150 mg/L
- ~2-10 mg/L
- >0.5 -2 mg/L





Total Hg and Methyl Hg Time Series



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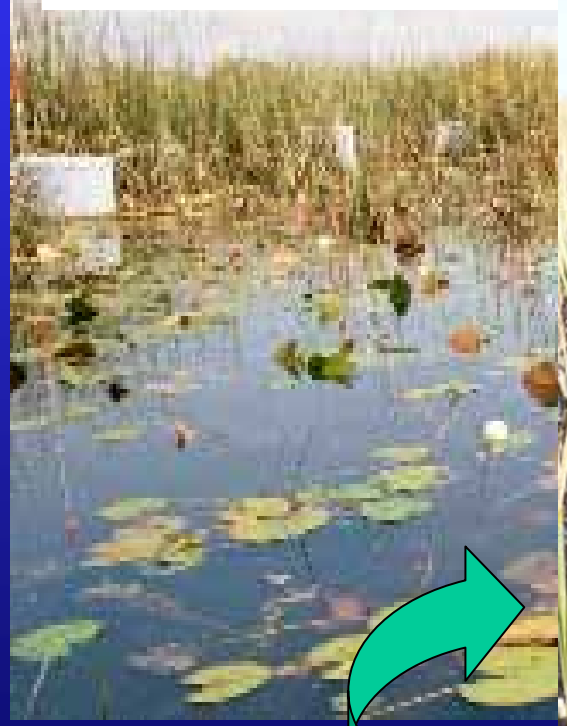
Linked hydrologic and MeHg Production Cycle

Inundation: net methylation & bioaccumulation (June-February)



Rewetting, O/A shift, onset of methylation (April-May)

Dry down and internal SO4 & labile C production (March)

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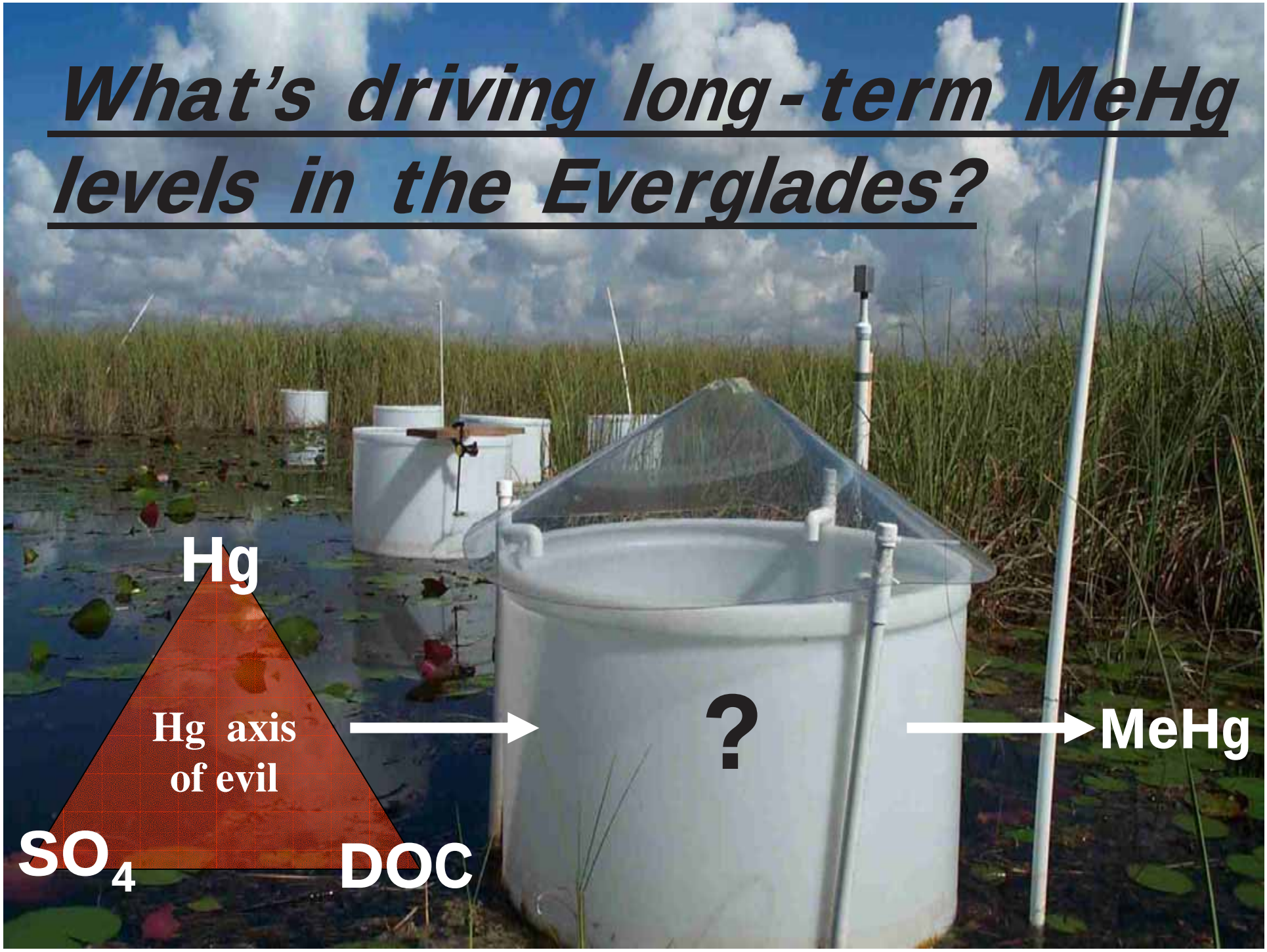
What's driving long-term MeHg levels in the Everglades?



The Mercury Problem (summary):

- Substantial problem potentially affecting aquatic ecosystems across the globe
- Many factors have controlling effects: Hg loading rate, water chemistry (S,C, & Hg), hydrology (wetting & drying, watershed inputs, floods), disturbances (fire, dredging, global warming) and land management (wetland restoration & construction, reservoir construction, erosion, mining, mine restoration, fire, land-use changes) → It's not just Hg loading!
- New discoveries (e.g., new vs. old Hg) are continually challenging researchers and model developers to provide an accurate and predictive tools.

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Present needs:

- Ecosystem recovery (response times and magnitude) to changes in Hg loading (new vs old Hg behavior, watershed influences)
- Freshwater → Marine ecosystem connections
- Bioavailability (reactivity) of various mercury pools
- Human & wildlife toxicology
- Science integration and science-policy linking

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An Invitation to the Eighth International Conference on Mercury as a Global Pollutant

August 6-11, 2006
Madison, Wisconsin, USA

Complete information at:

www.mercury2006.org