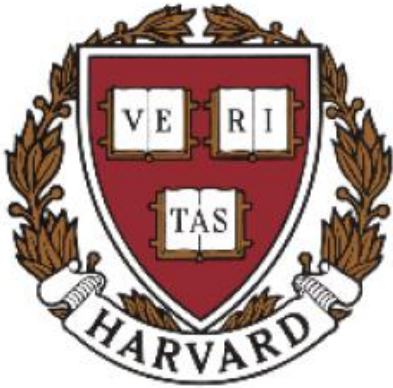


# Historical accumulation of anthropogenic mercury in soils

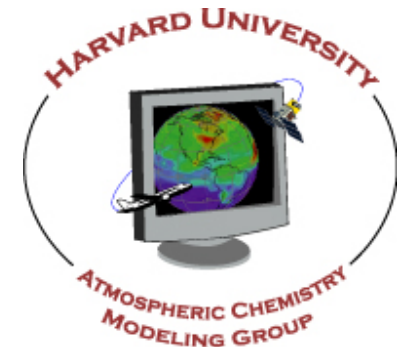
*Simulated with the GEOS-Chem coupled atmosphere-ocean-land model*



Harvard University  
Earth & Planetary Sciences  
PhD Candidate  
corbitt@seas.harvard.edu

**Elizabeth (Bess)  
Sturges Corbitt**

**10<sup>th</sup> ICMGP  
July 26<sup>th</sup>, 2011**

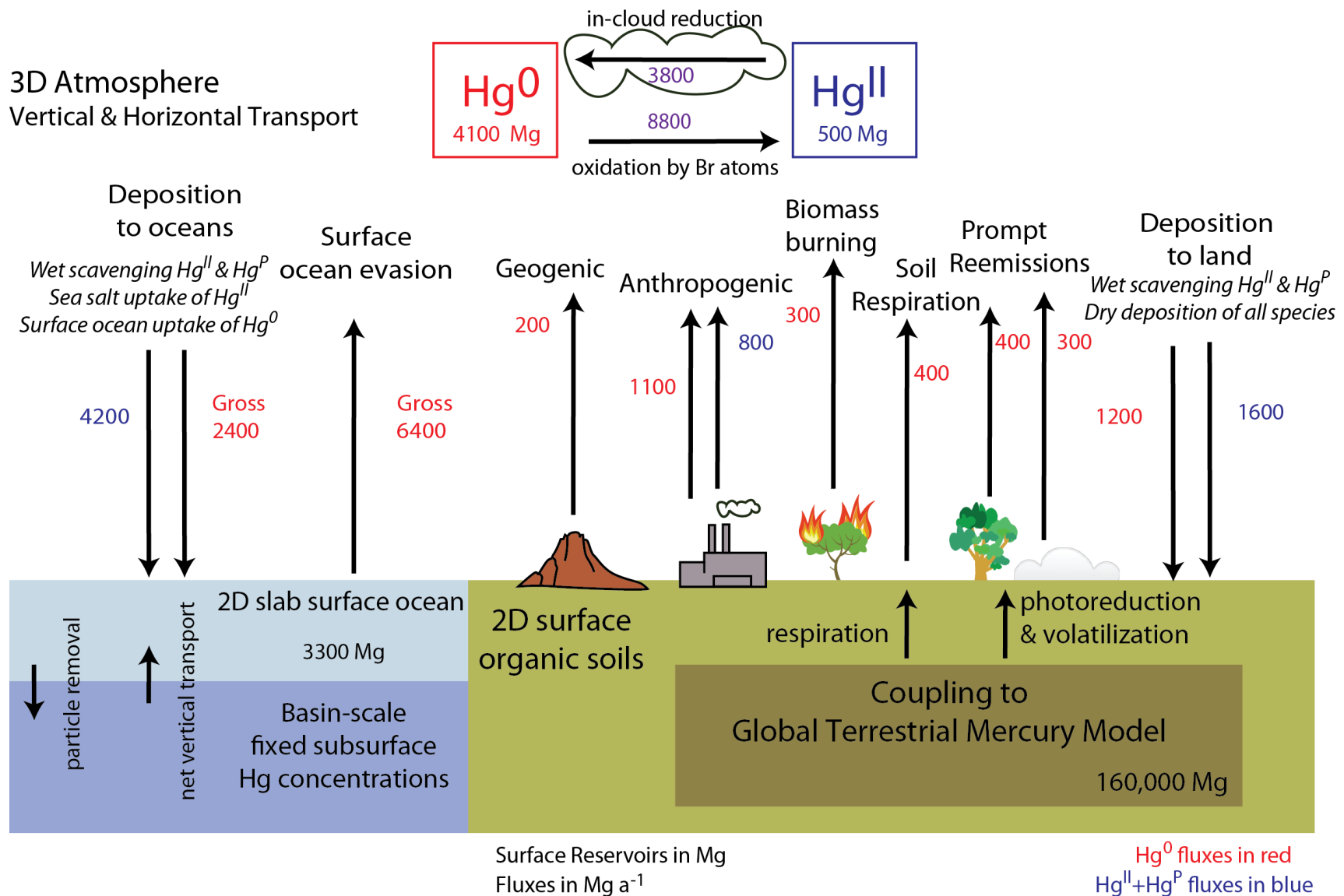


Funding from NSF

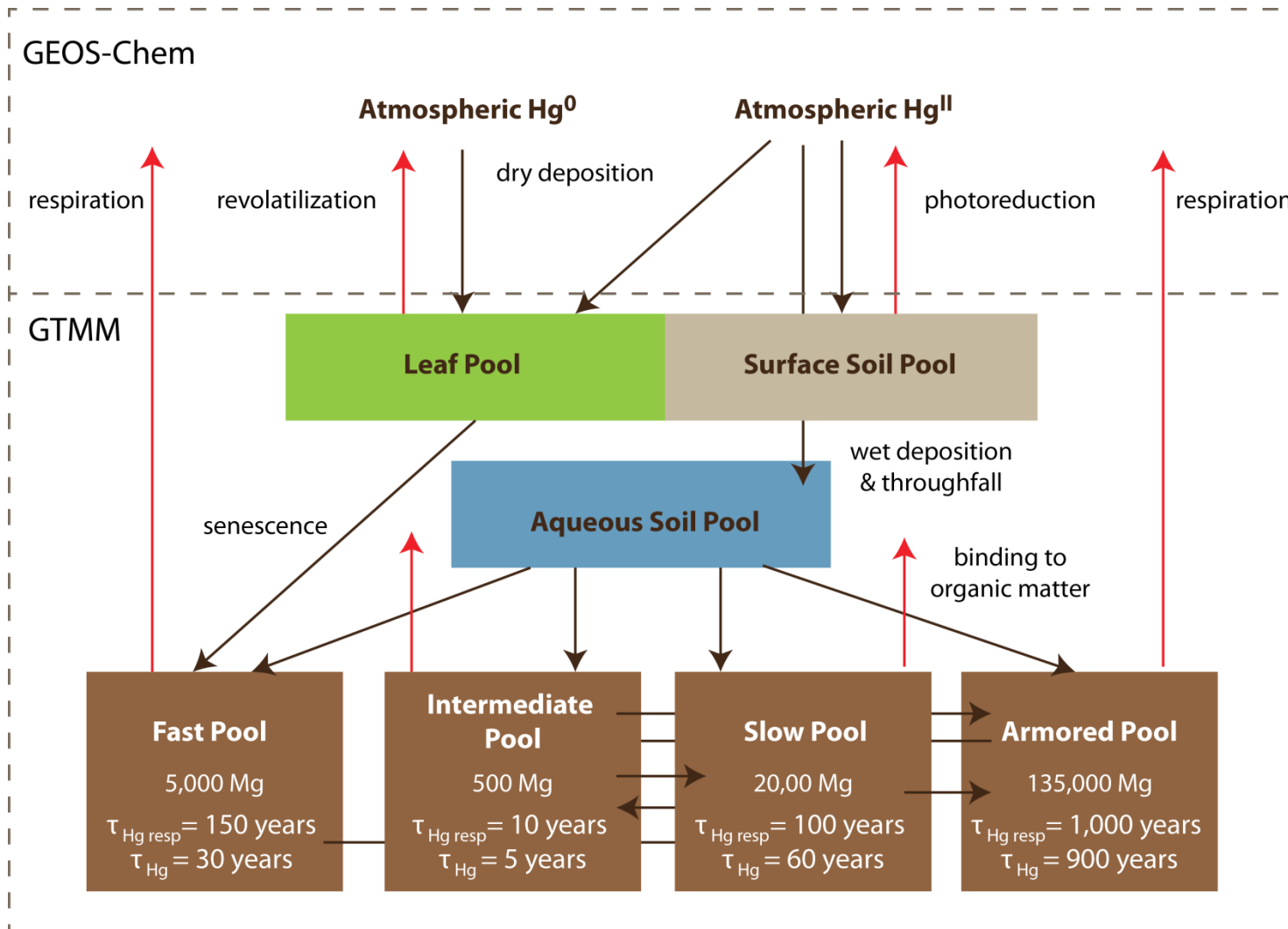
Co-authors: Nicole V. Smith-Downey<sup>1</sup>, Daniel J. Jacob<sup>2</sup>, Claire C. Carouge<sup>3</sup>, Christopher D. Holmes<sup>4</sup>, Hannah M. Horowitz<sup>2</sup>, Helen M. Amos<sup>2</sup>, David G. Streets<sup>5</sup>, Elsie M. Sunderland<sup>2,6</sup>

(1) Earth System Sciences, LLC; (2) Harvard University; (3) University of New South Wales; (4) University of California, Irvine; (5) Argonne NL; (6) Harvard University School of Public Health

# GEOS-Chem global mercury model



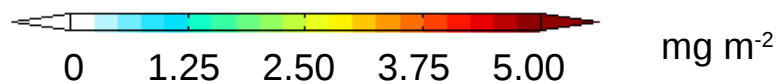
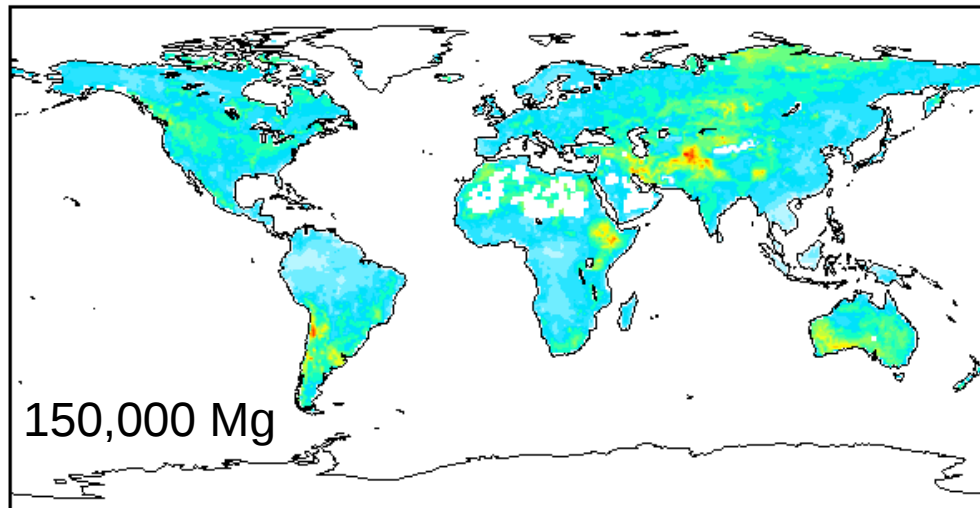
# Global Terrestrial Mercury Model



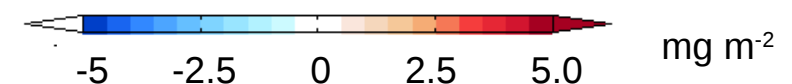
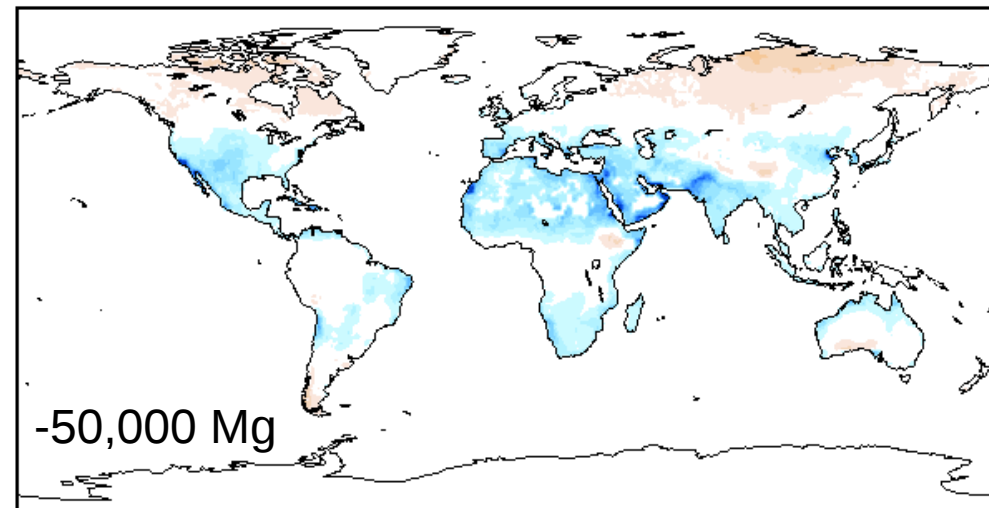
- Terrestrial mercury model based on the CASA biogeochemical carbon model
- GEOS-Chem atmosphere model run with preindustrial and historical industrial & mining emissions
- Monthly deposition fluxes input to surface pools to drive GTMM
- Deposited mercury that is not quickly revolatilized is partitioned to soil pools based on carbon mass
- Fraction of mercury released to atmosphere during respiration

# Preindustrial soil Hg distribution

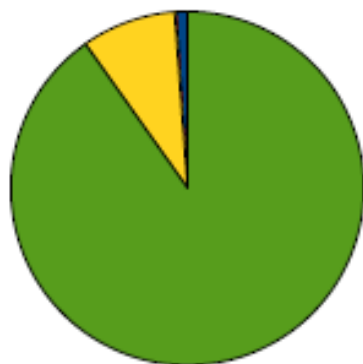
Preindustrial Soil Hg Distribution: Br Ox.



Soil Hg: Br Ox. – OH/O<sub>3</sub> Ox. Models



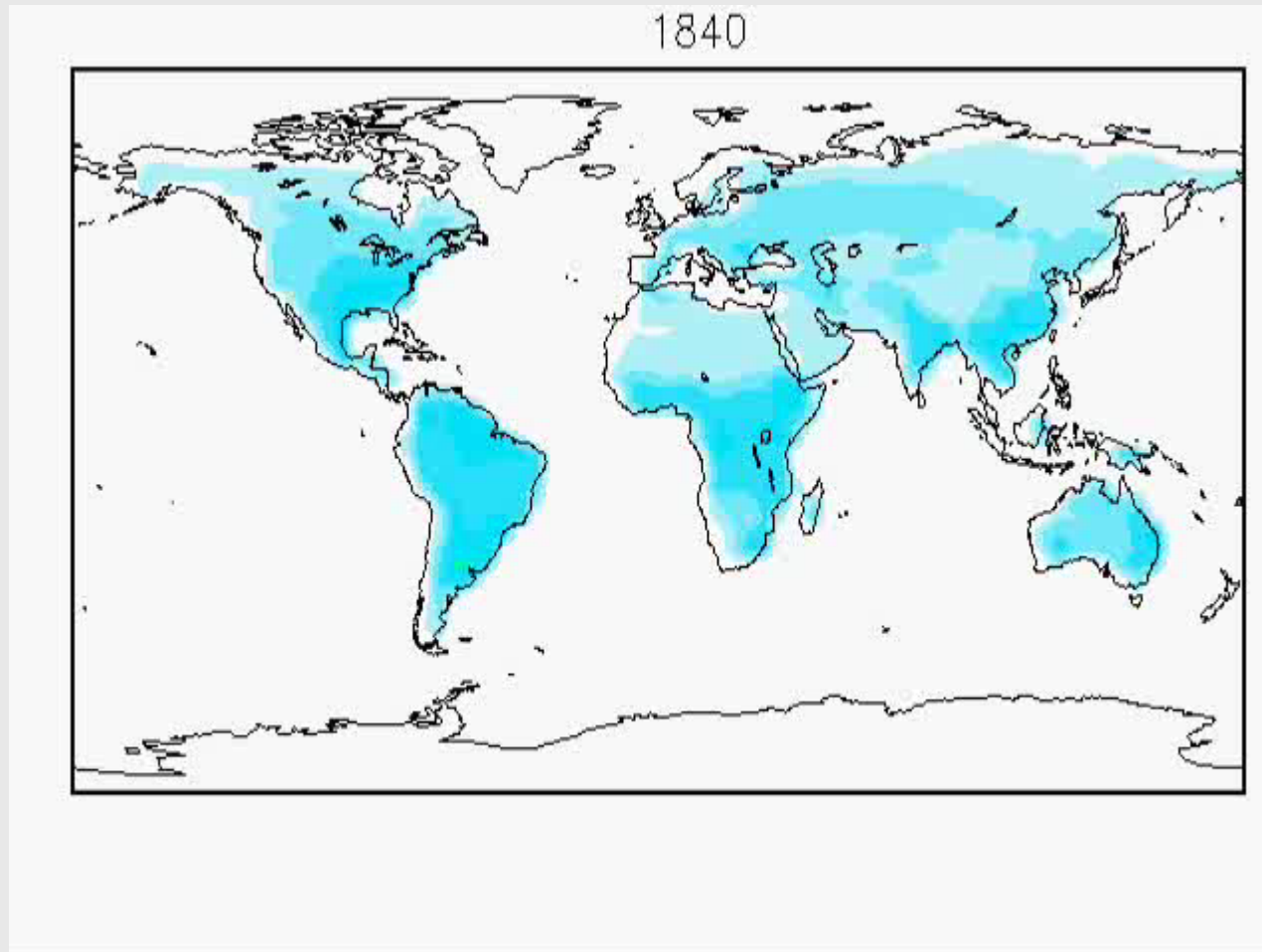
Preindustrial Soil Hg by Pool



■ Fast  
■ Intermediate  
■ Slow  
■ Armored

- In steady-state, preindustrial conditions, mercury accumulates in the most long-lived, recalcitrant pools
- Shift in oxidation of Hg<sup>0</sup> → deposition of Hg<sup>II</sup> → soil Hg accumulation to higher latitudes in the simulation with oxidation by Br

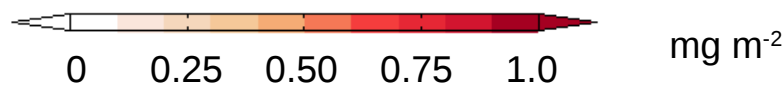
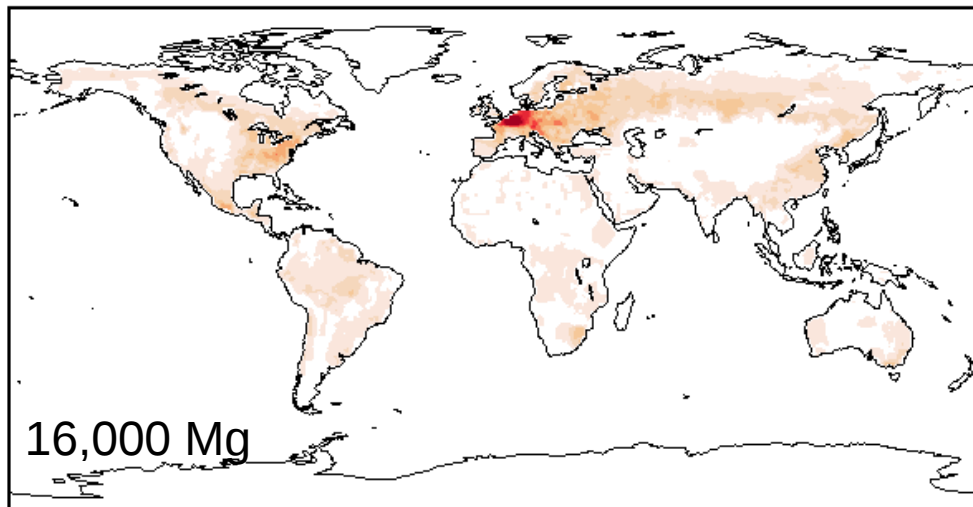
# Total Gross Mercury Deposition to Land 1840-2000



Regionally Resolved Historical Emissions  
& Hg<sup>0</sup> Oxidation by Br

# Enhancement of soil Hg due to anthropogenic emissions since 1840

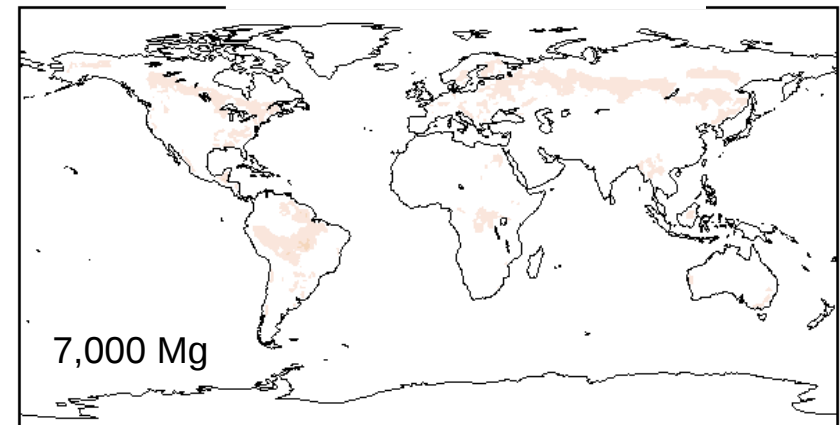
Hg<sup>0</sup> Oxidation by Br  
& Regionally Resolved Historical Emissions



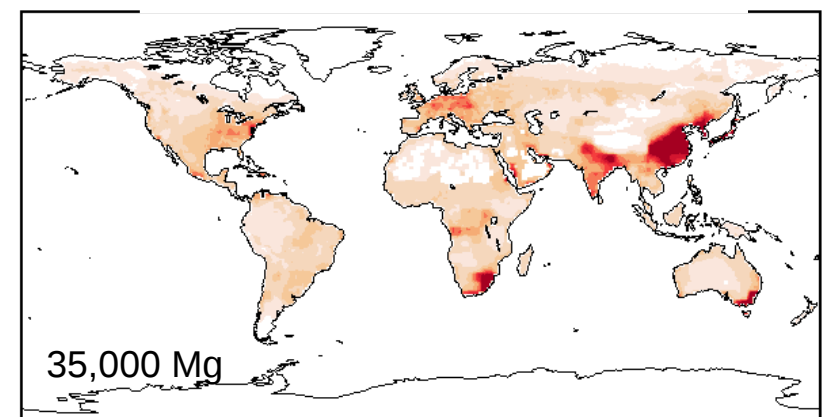
- Soil accumulation of anthropogenic mercury 1840-2000: 16,000 Mg (7% of emitted Hg)
- Sensitive to magnitude and spatial distribution of deposition

Historical Emissions Scaled to North American Industry

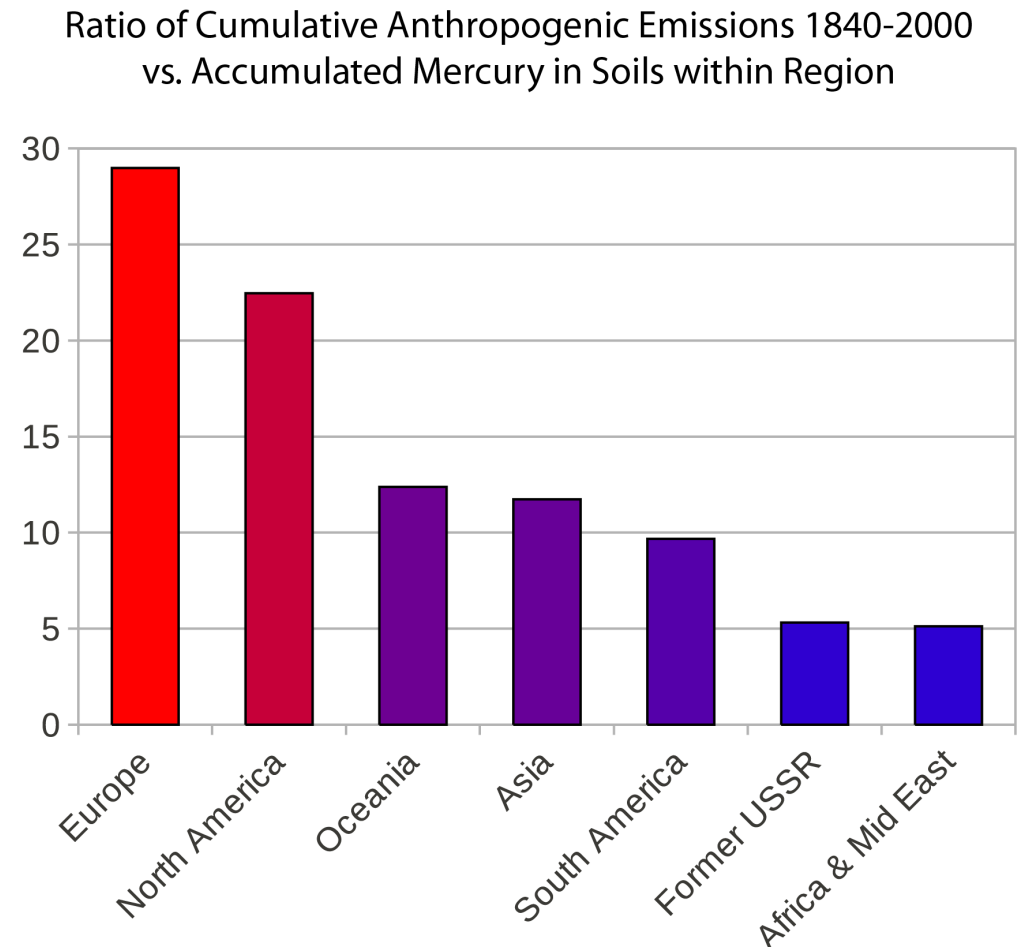
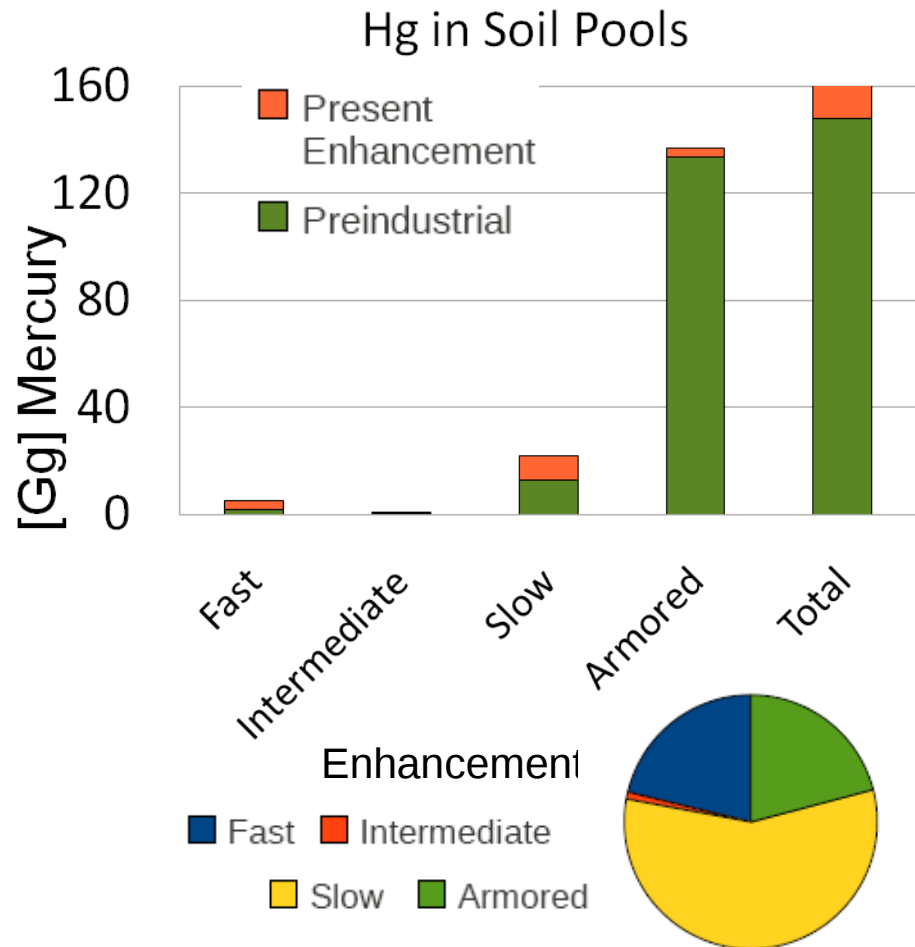
Hg<sup>0</sup> Oxidation by Br



Hg<sup>0</sup> Oxidation by OH & O<sub>3</sub>



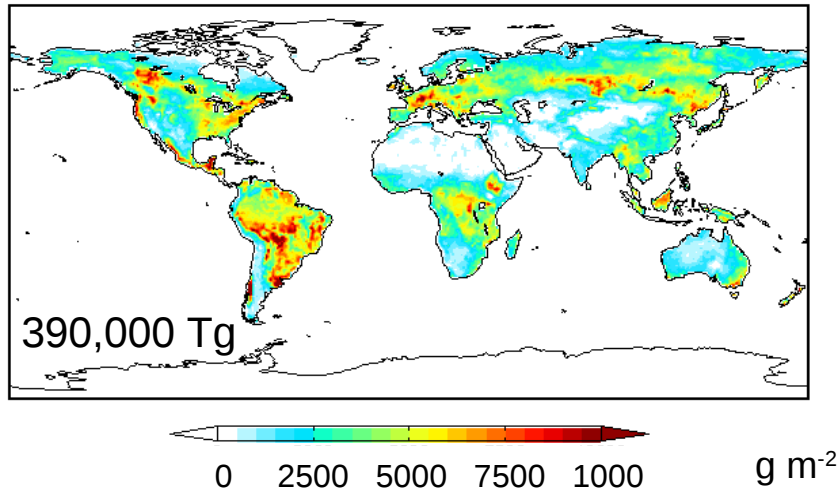
# Fate of anthropogenic mercury in soils



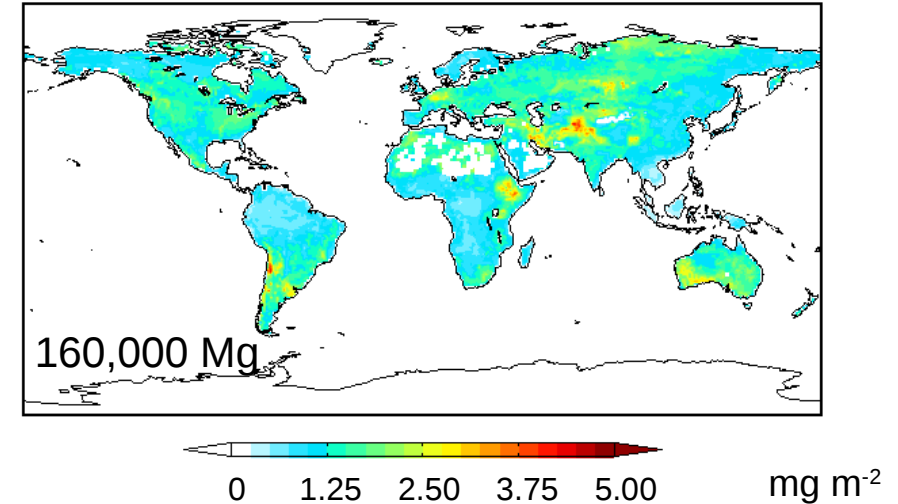
- Greatest magnitude of anthropogenic mercury accumulation in slow & armored pools, while greatest relative enhancement in fast pool.
- Most emissions over time period from Europe and North America, while deposition and accumulation is more distributed.

# Mercury accumulation relative to carbon stocks

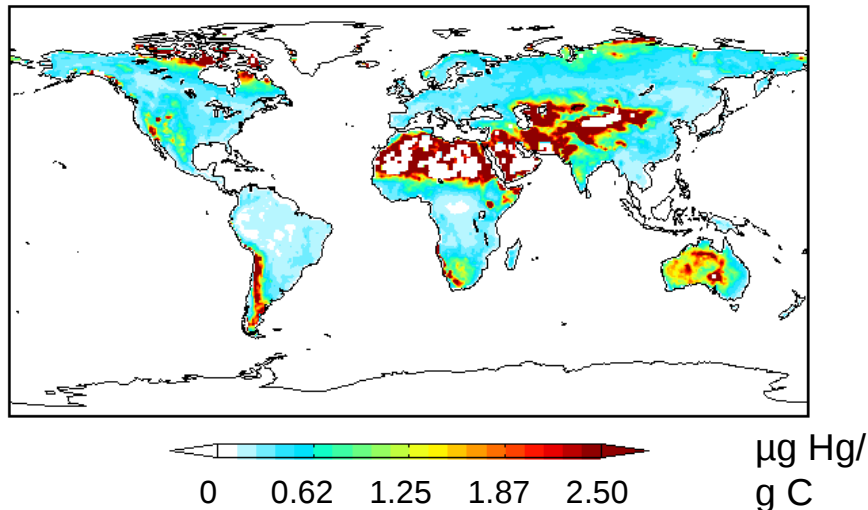
Soil Carbon



Present-Day Soil Hg

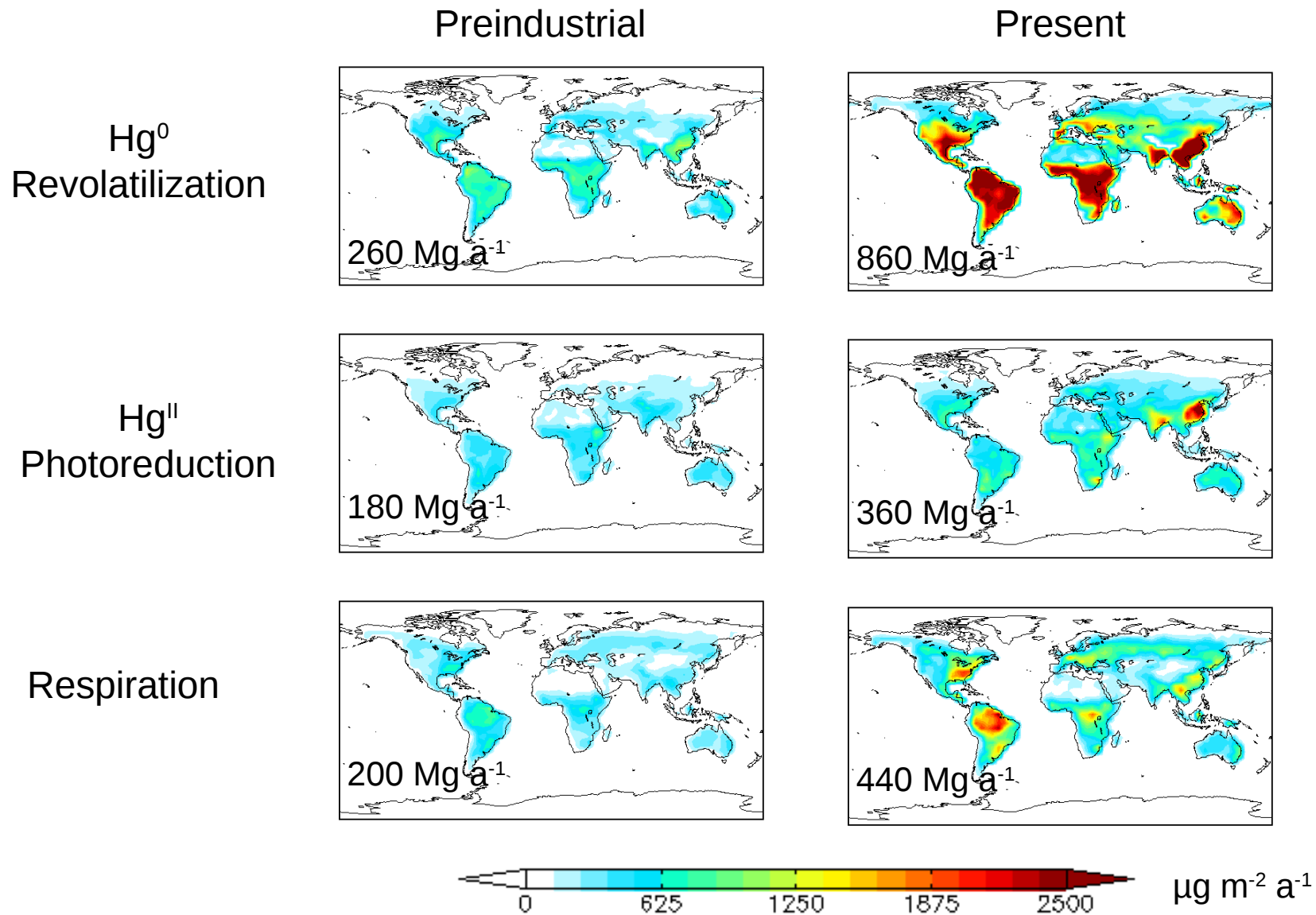


Soil Hg:C

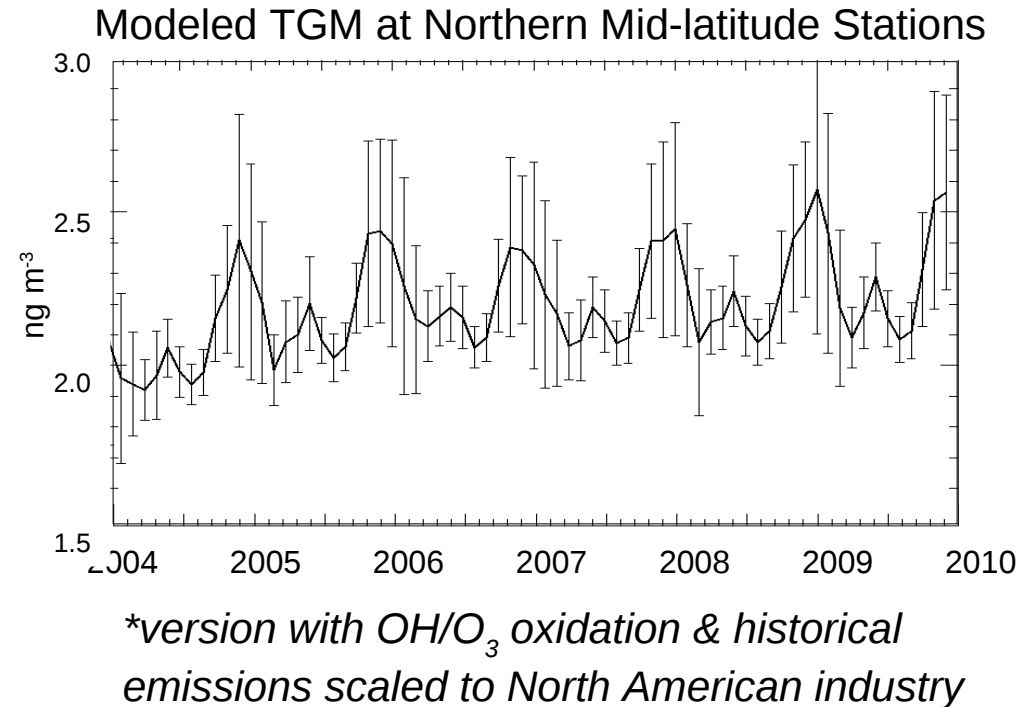
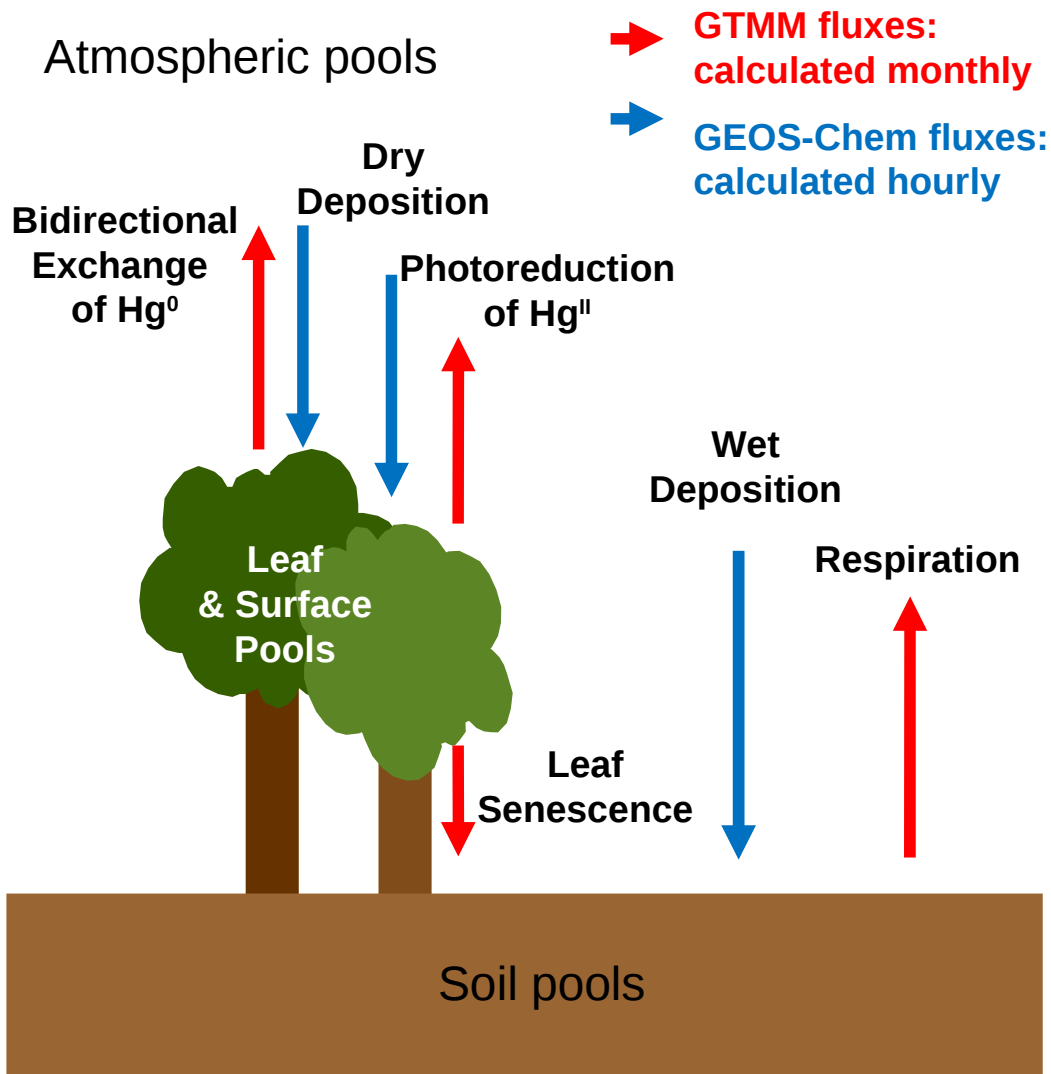


- Where mercury deposition is moderate or high but carbon turnover is slow, mercury accumulates.
- If the fraction of mercury released during decomposition were greater, the distribution of mercury would more closely resemble that of carbon. (*Smith-Downey et al. 2010*)

# Terrestrial emissions

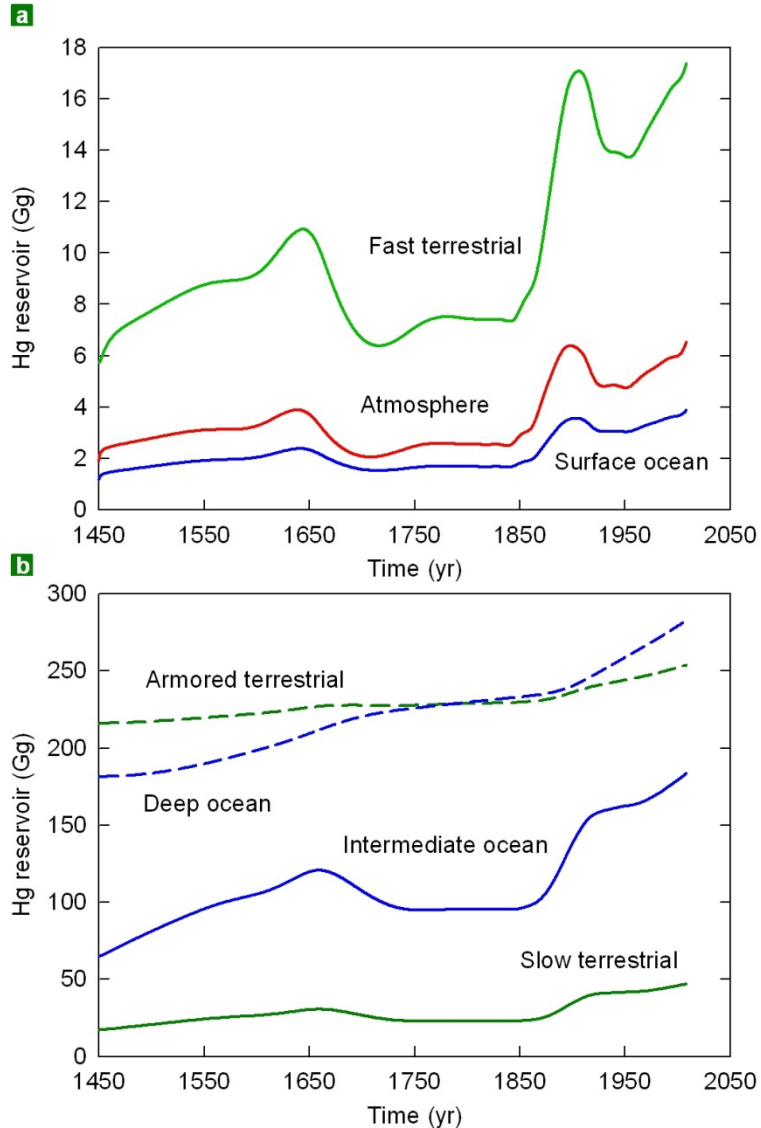


# Coupled atmosphere-terrestrial model



- Capacity for long-term coupled runs to study historical accumulation of anthropogenic mercury in soils, response to climate change

# Timescales of anthropogenic mercury accumulation



- Fast terrestrial, atmosphere, and surface ocean respond most quickly to changes in emissions
- Longer-lived reservoirs record cumulative emissions
- Biggest long-term sink for anthropogenic mercury in the deep ocean
- Armored soil pool of comparable magnitude to deep ocean mercury reservoir, but less relative increase in mercury storage