Global source-receptor relationships for mercury under present and year 2050 anthropogenic emissions scenarios

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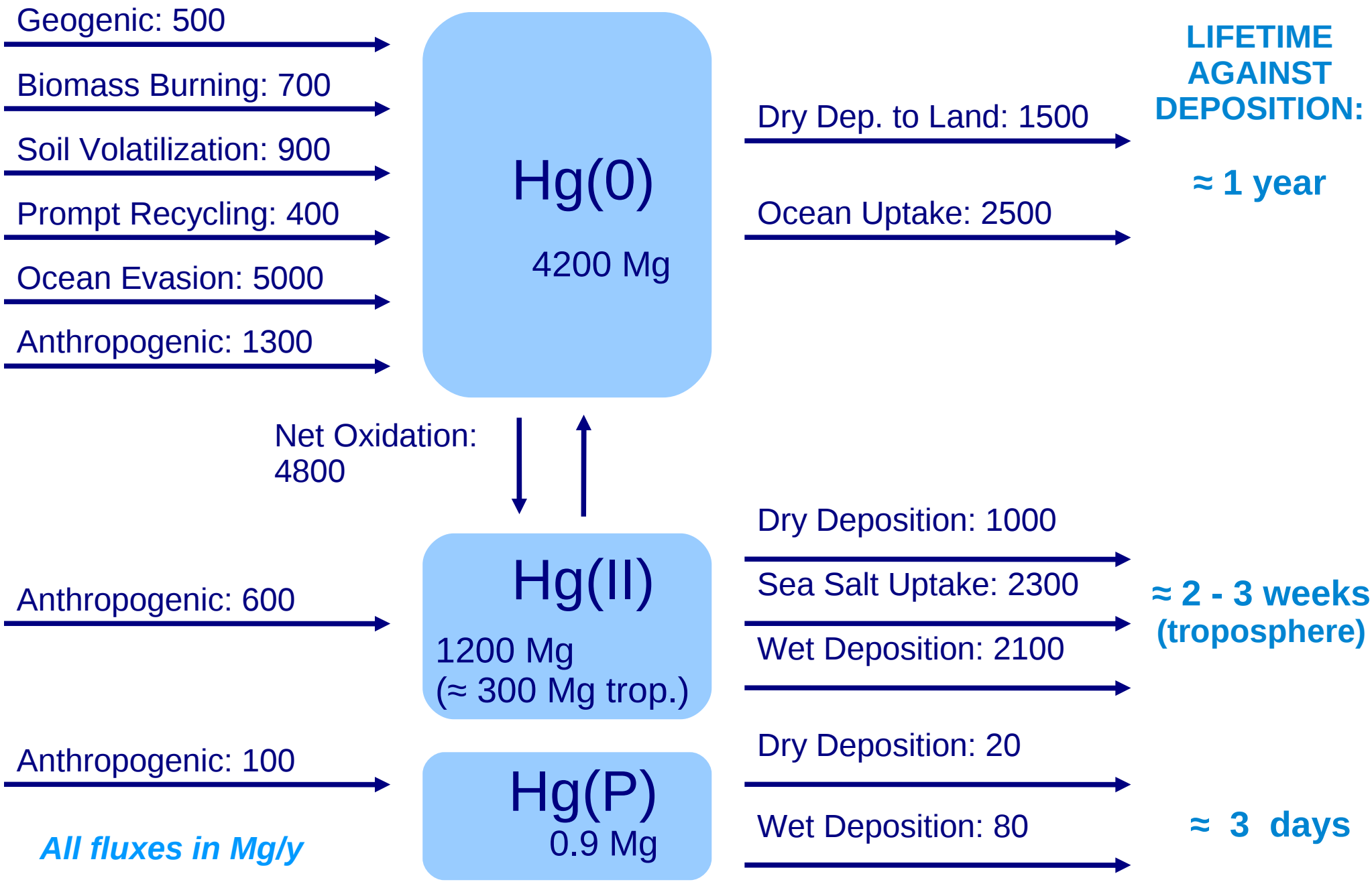
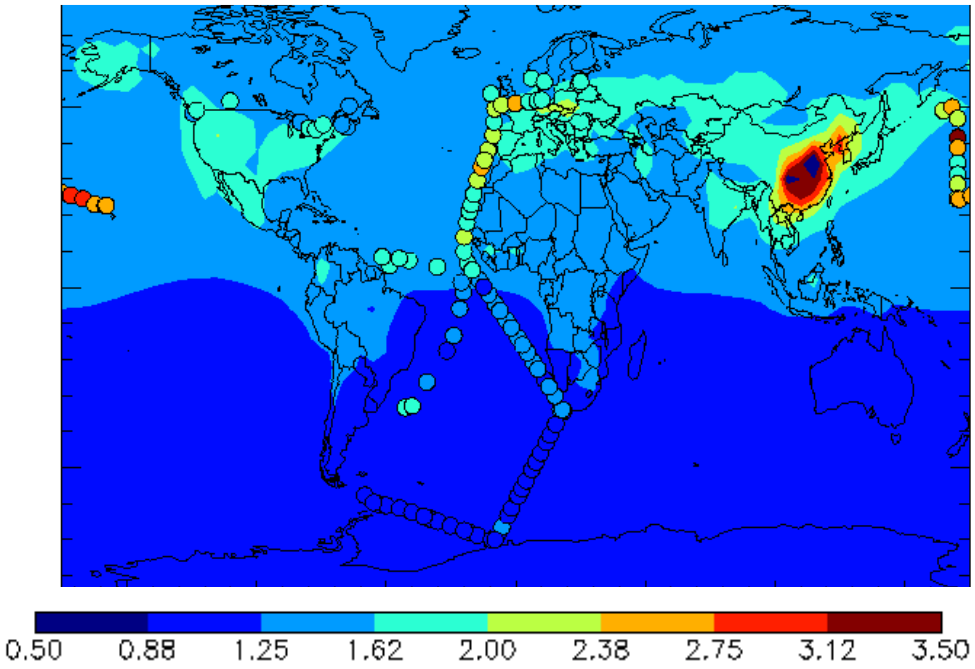
The cycling of mercury in the environment is highly dependent on the speciation of Hg

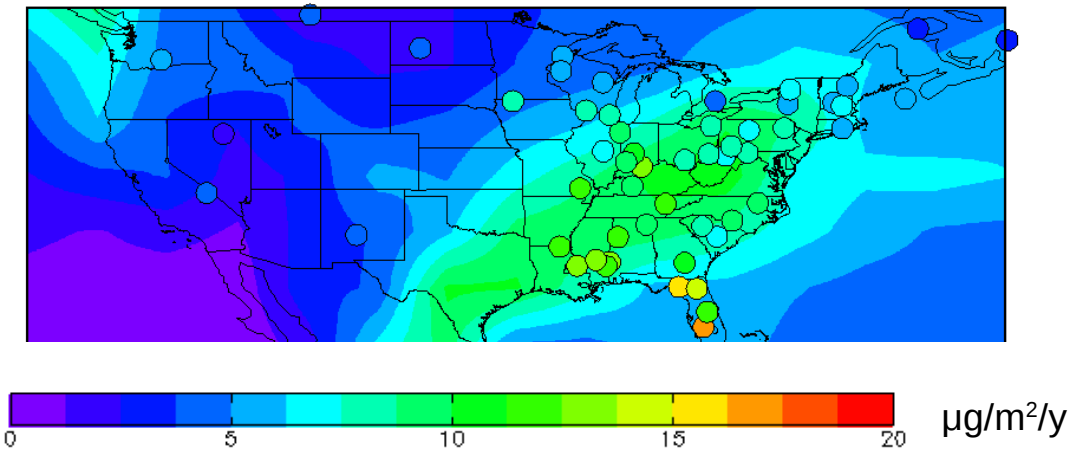


Mercury sources, transport, and deposition are sensitive to model processes

Total Gaseous Mercury Concentration at Surface: Model and Observations



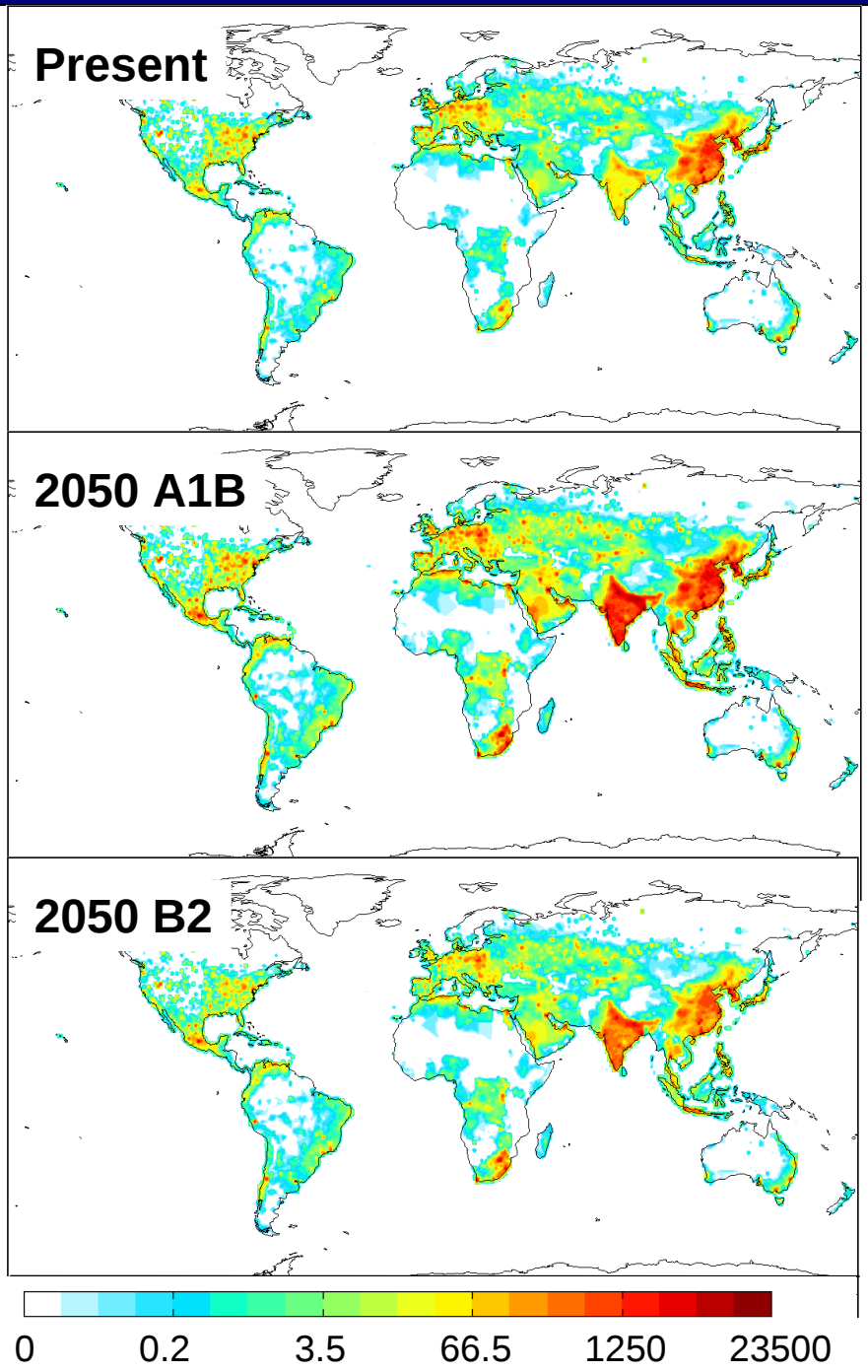
Hg Wet Deposition to the United States: Model and Mercury Deposition Network



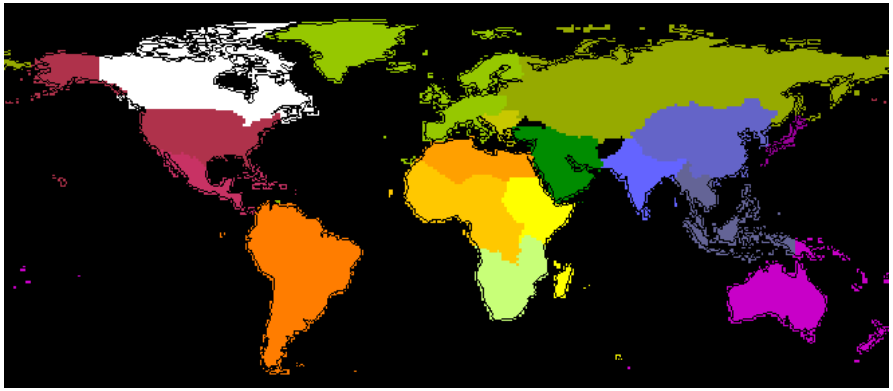
Use of Br as the dominant oxidant of Hg(0) improves the modeled latitudinal pattern of surface total gaseous mercury, bringing down concentrations at high latitudes.

Modeled wet deposition compared to the Mercury Deposition Network exhibits similar East-West and North-South trends, but the model underestimates the highest deposition near the Gulf of Mexico.

Tracking anthropogenic emissions



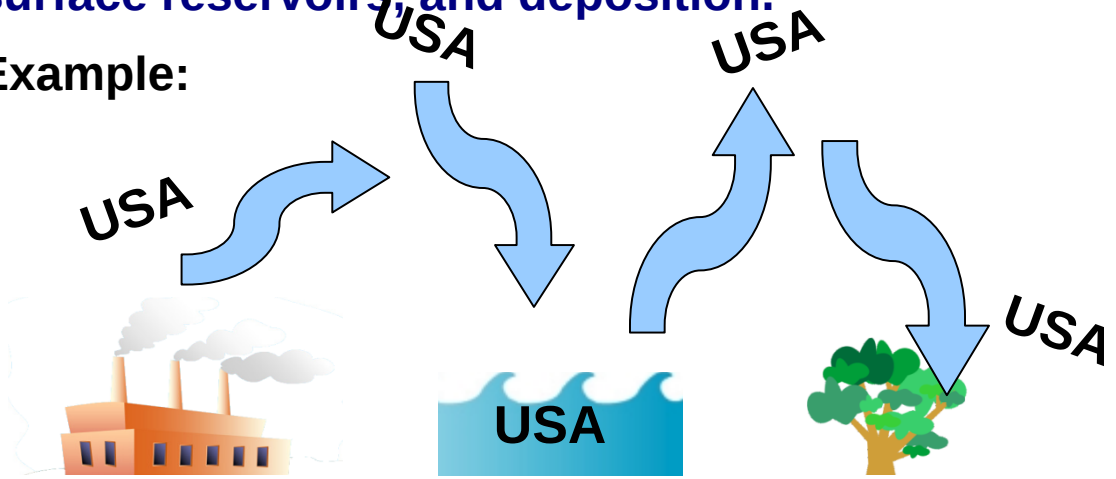
Definition of Regions



Hg anthro. emissions from each 1x1 grid box (GEIA 2000) are scaled to the total regional emissions from *Streets et al. 2009*.

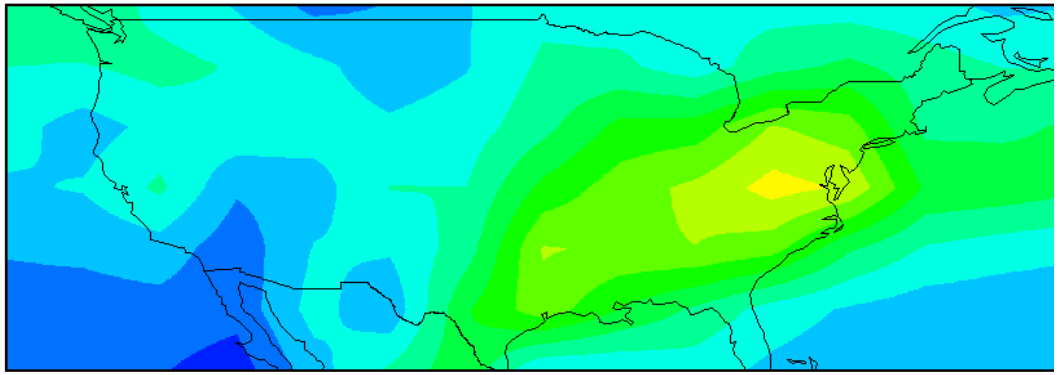
Hg emissions are "tagged" by origin and traced through chemistry, transport, cycling in the surface reservoirs, and deposition.

Example:

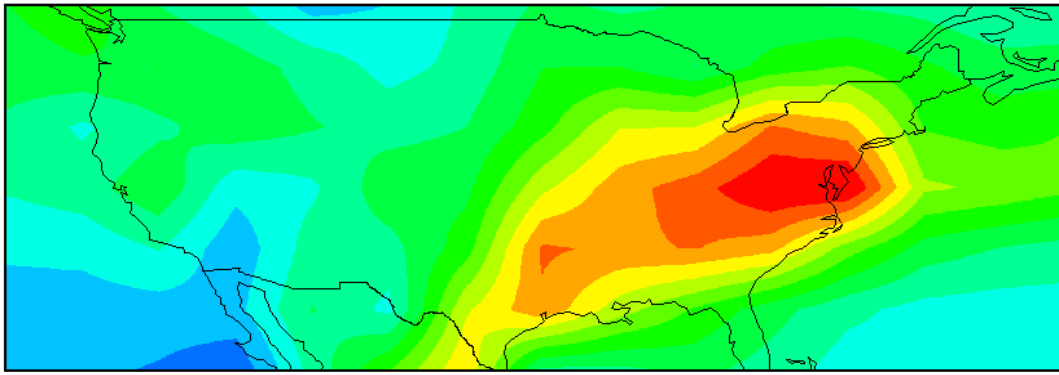


Increased deposition of mercury to the US in a high growth scenario with little pollution controls

Deposition: 2006 Anthro Emissions

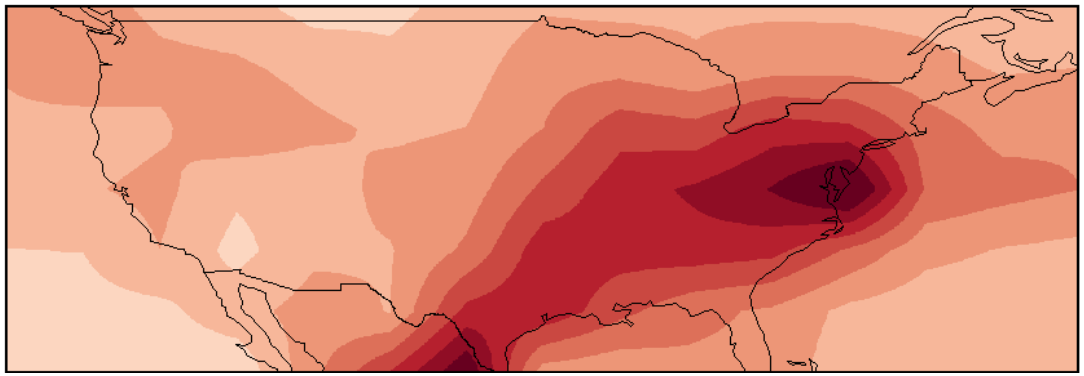


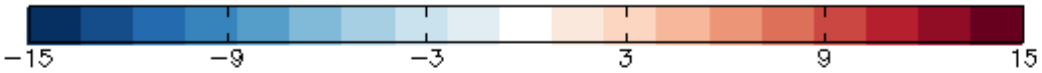
Deposition: 2050 A1B Anthro Emissions



µg/m²/y

Absolute Difference Dep: 2050 A1B - 2006





µg/m²/y

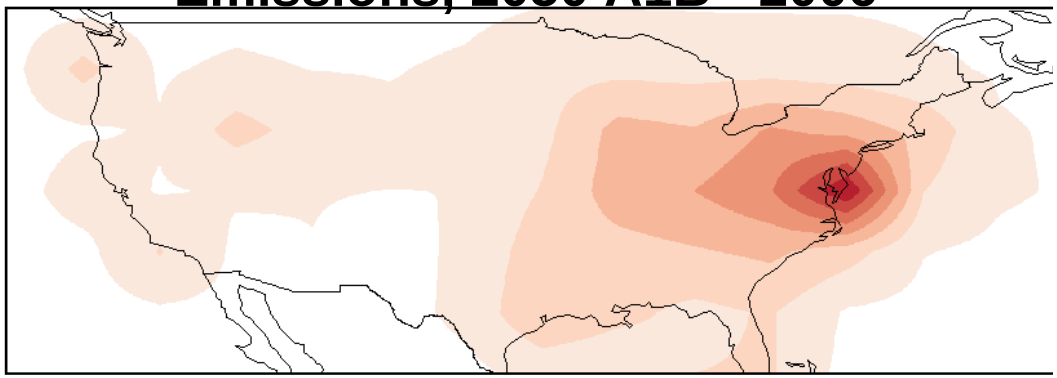
A1B scenario is the most pessimistic scenario for total global emissions of Hg.

United States total Hg emissions increase by 38% overall in this scenario. Emissions of short-lived Hg(II) increases by 52%.

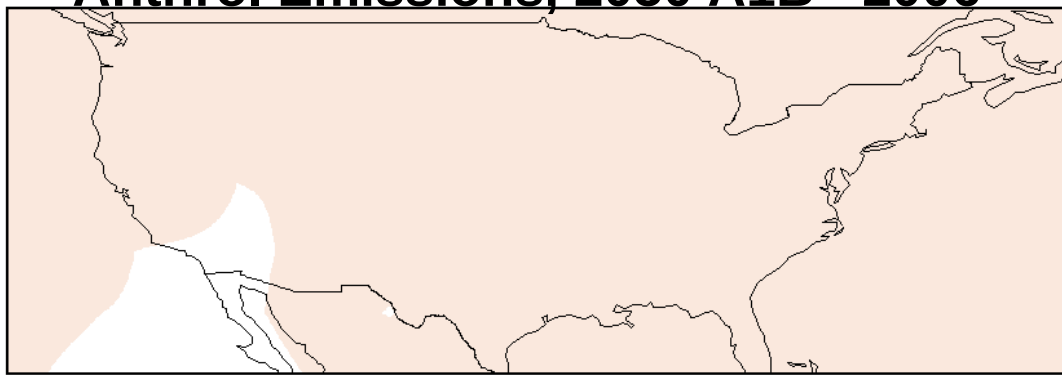
Central American total Hg emissions increase by 240%, Hg(II) by 430%.

Increase in Hg deposition to the US due to greater US emissions and global atmospheric background

Difference in Dep. from USA Anthro. Emissions, 2050 A1B - 2006

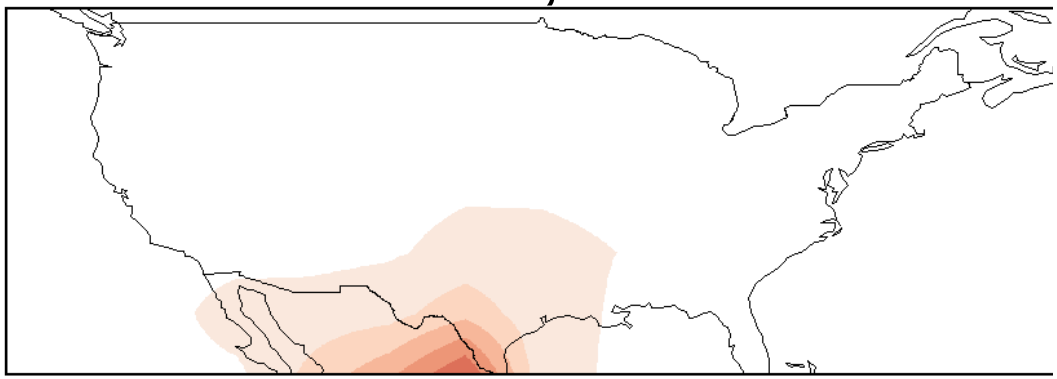


Difference in Dep. from East Asia Anthro. Emissions, 2050 A1B - 2006

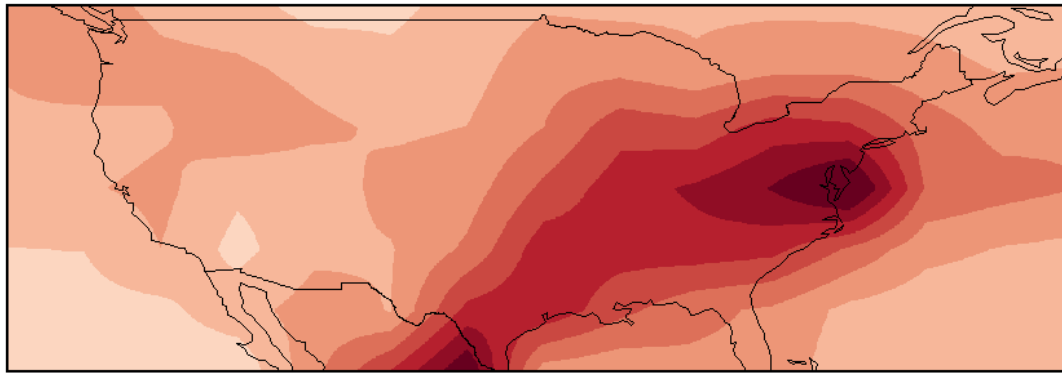


μg/m²/y

Difference in Dep. from C. American Anthro. Emissions, 2050 A1B - 2006



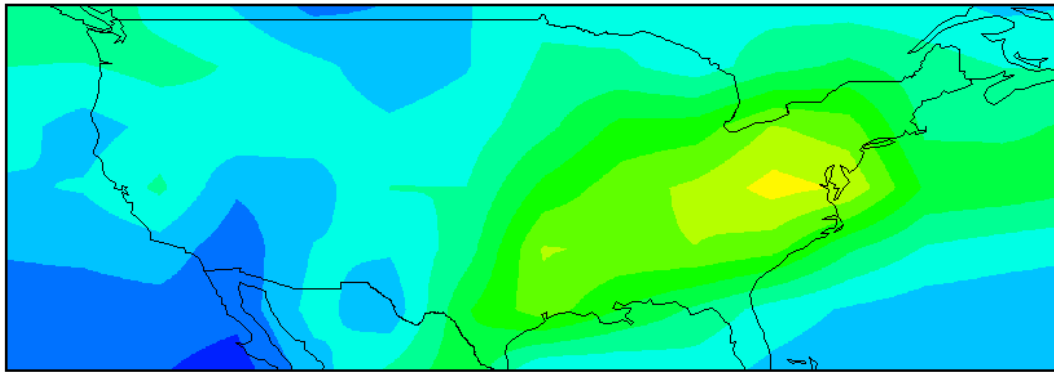
Total Difference Dep: 2050 A1B - 2006



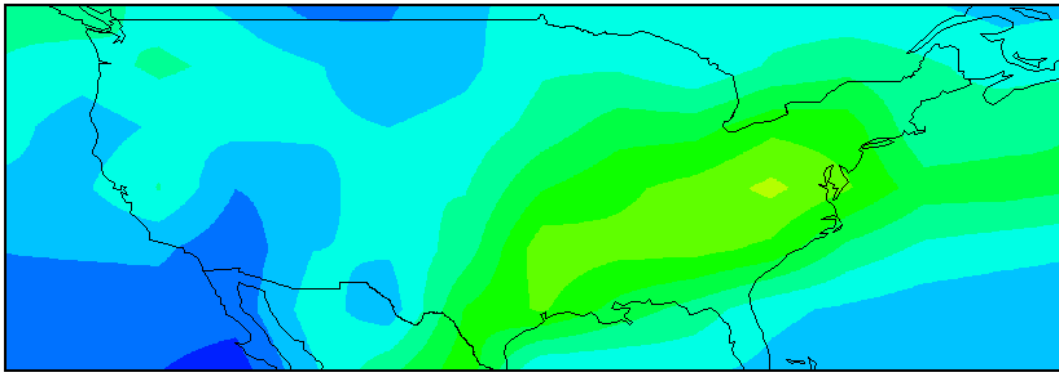
Increase in deposition in the US in the A1B scenario is due mostly to domestic increases in anthro. emissions. Greater global emissions of Hg(0) increase the well-mixed atm. background of Hg(0), increasing dry deposition to the United States.

Decreased mercury deposition to the US is possible in scenarios with commitment to emissions reductions

Deposition: 2006 Anthro Emissions

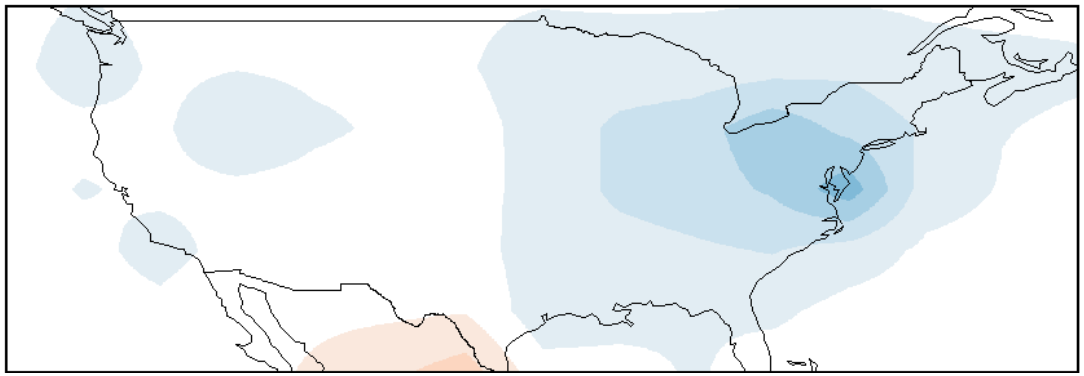


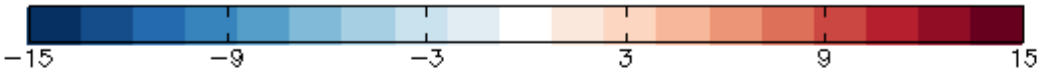
Deposition: 2050 B2 Anthro Emissions



μg/m²/y

Absolute Difference Dep: 2050 B2 - 2006





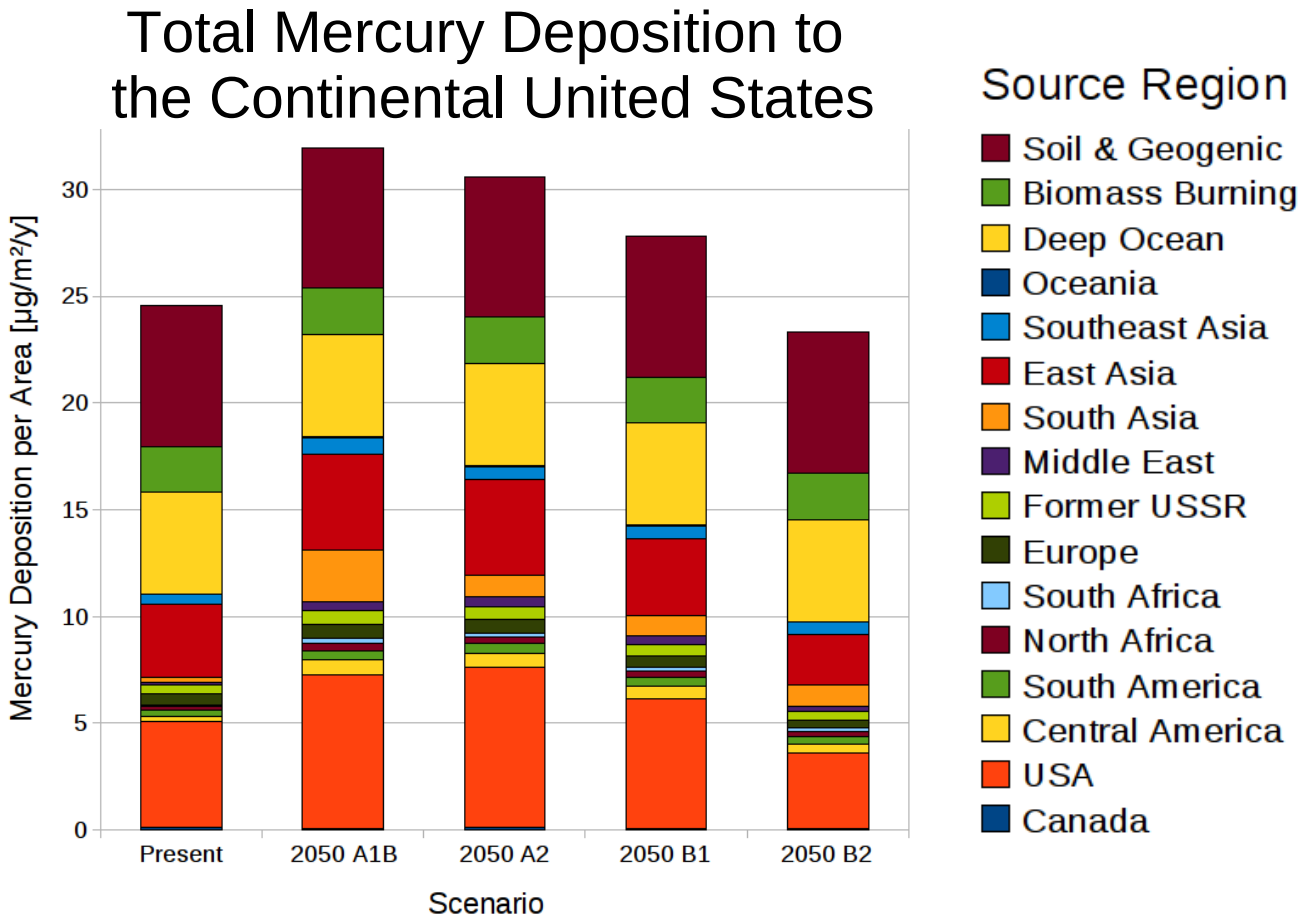
μg/m²/y

B2 is a more optimistic scenario for total global emissions of mercury.

Most improvement in deposition to the US comes from domestic emissions reductions, exhibited by the decreases close to sources.

United States emissions are reduced 31%; global emissions up 15%.

Mercury deposition to the United States: a mix of domestic and foreign sources



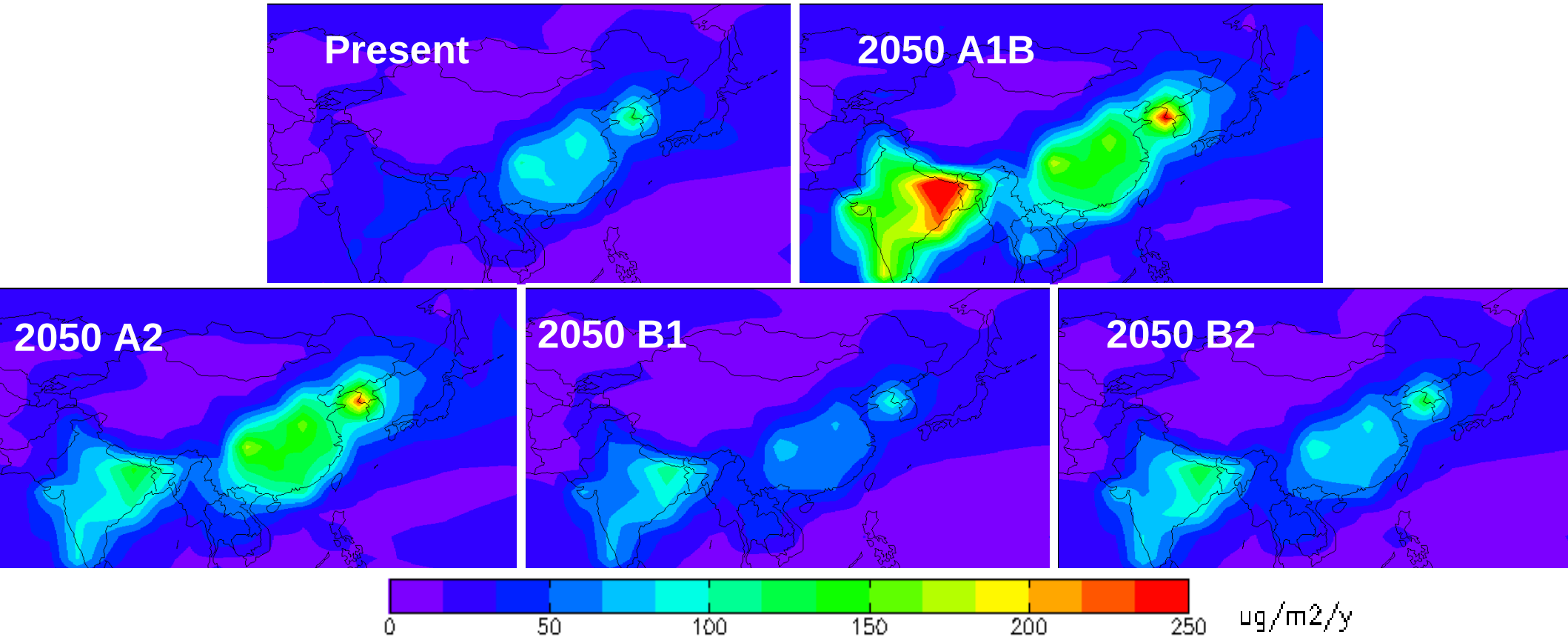
Approx. 20% of deposition of mercury to the United States in the present day is from its own anthropogenic emissions.

Changes in US emissions in the future scenarios may result in direct deposition changes to the region on average ranging from of -1 µg/m²/y to +2.5 µg/m²/y. Overall deposition to the region ranges on average from -1 µg/m²/y to +6.5 µg/m²/y.

Possible future mercury deposition to Asia strongly determined by domestic emissions

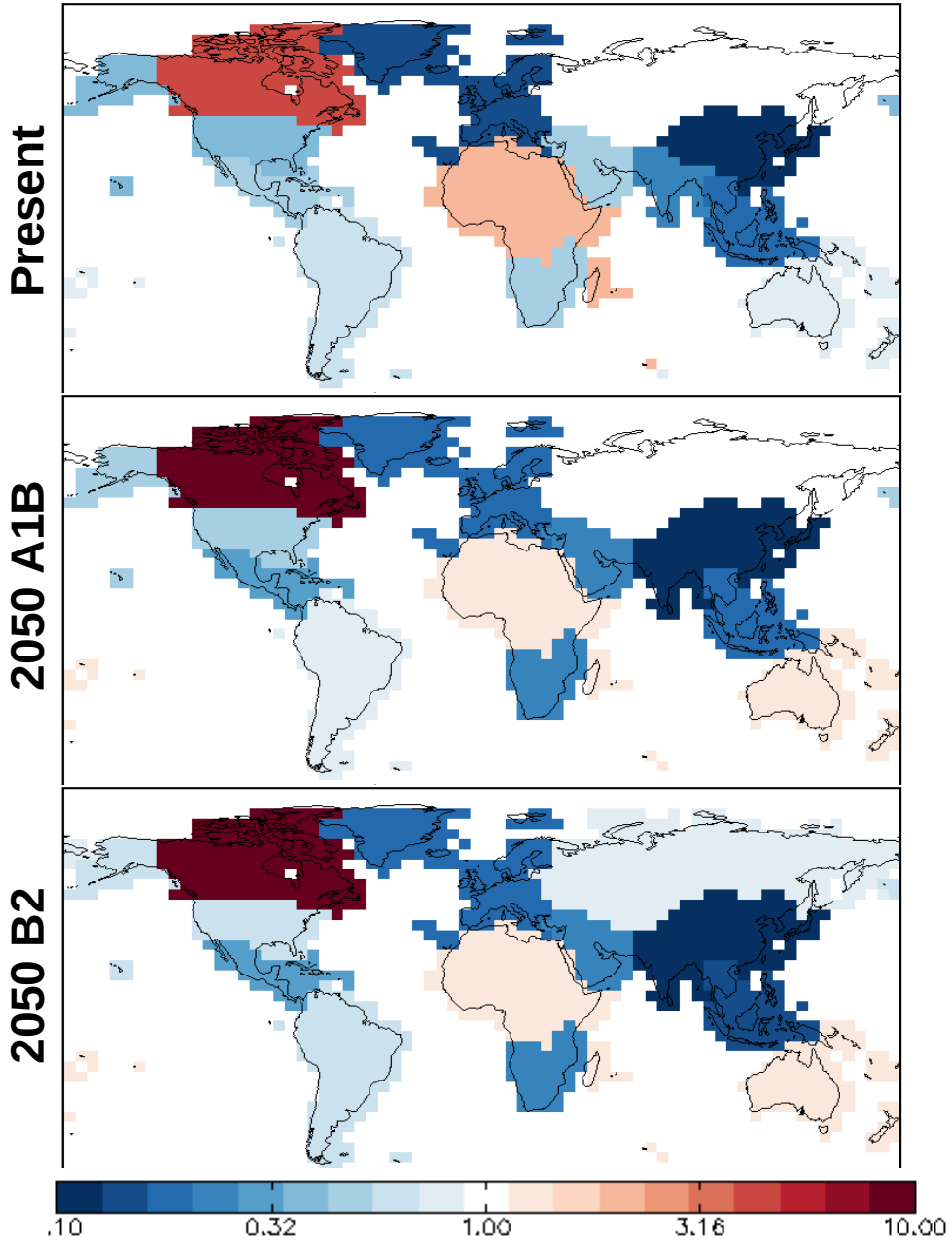
Mercury deposition to Asia varies greatly depending on the scenario, especially in South Asia.

A majority of the mercury emitted in the 2050 scenarios is short-lived Hg(II) and deposits close to its source. Domestic sources dominate the regional deposition.

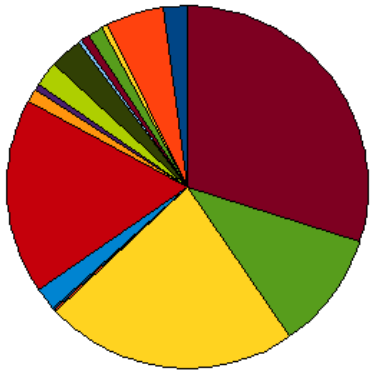


Regional disparities in domestic versus foreign sources of deposited mercury

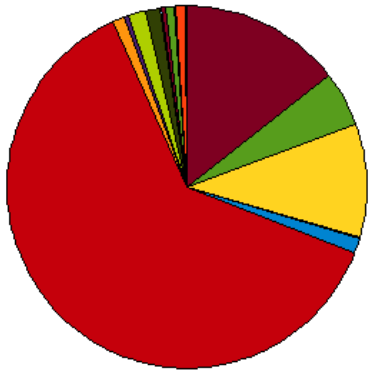
Ratio of Foreign Anthro. Emissions Imported as Deposition to Region's Anthro. Emissions



Present Day Deposition to Canada, by Source



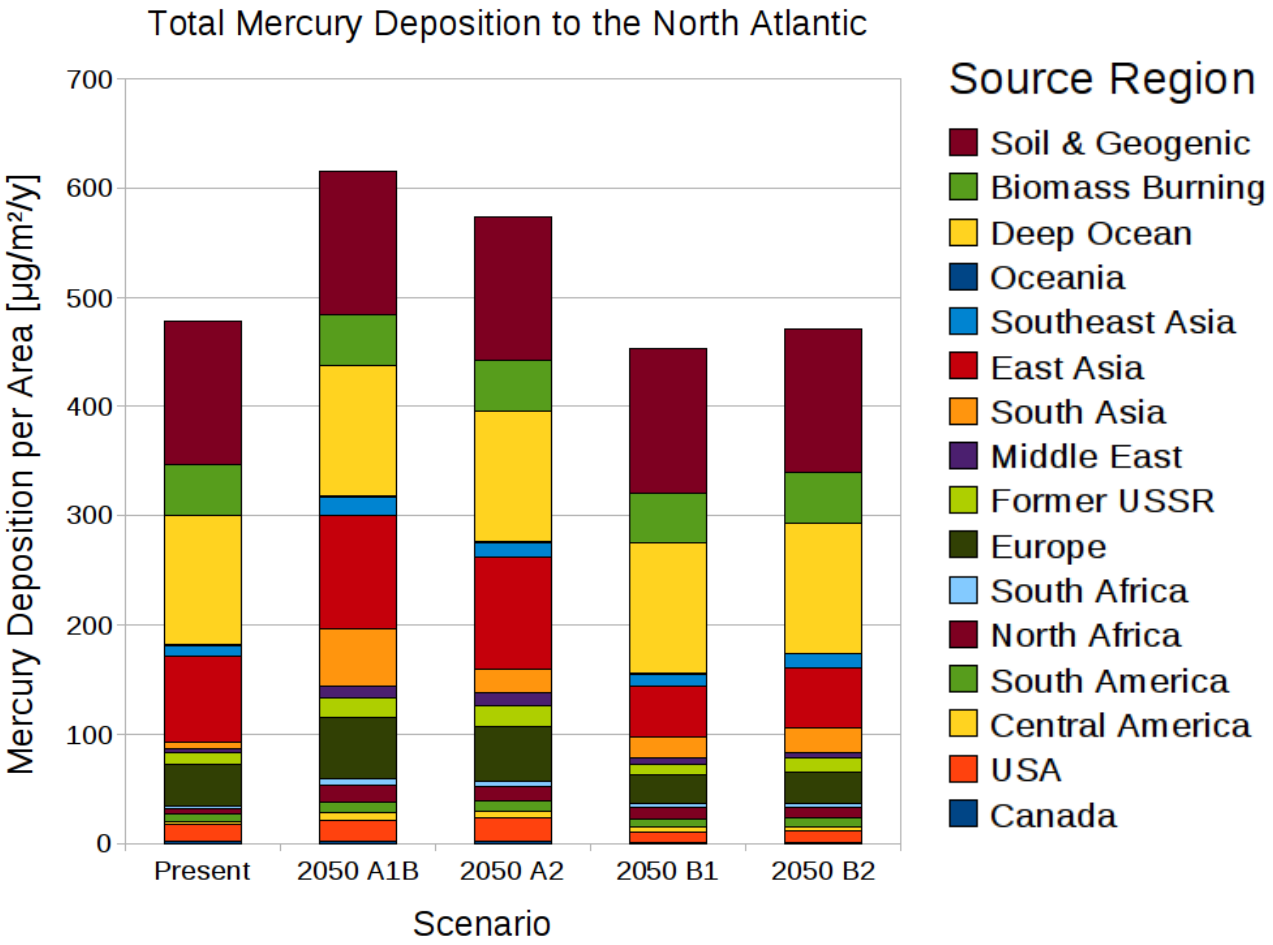
Present Day Deposition to East Asia, by Source



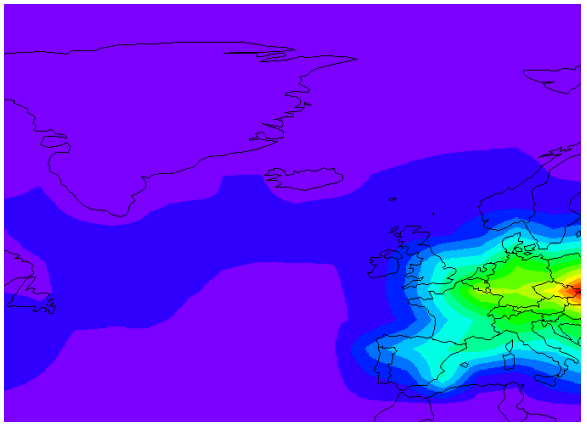
A region like Canada has little control over the mercury deposition it receives and must rely on reductions from others for any gains.

On the other extreme, deposition to a region like East Asia is dominated by mercury emitted within its own borders. Domestic pollution policy will be very important.

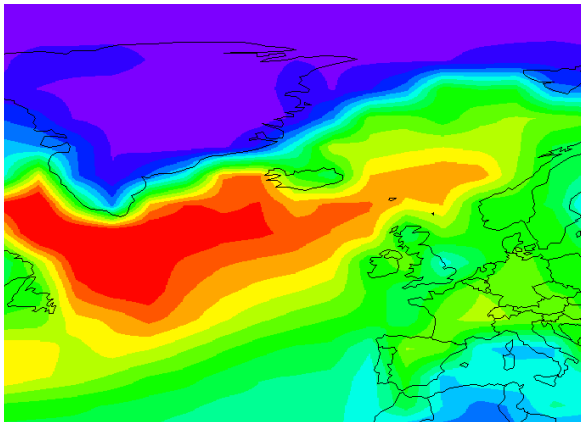
Deposition to the open ocean: Case study in the North Atlantic

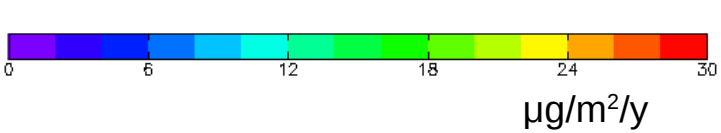


Present Day Total Mercury Deposition from Europe, Canada, and the USA:



Present Day Total Mercury Deposition from All Other Sources:



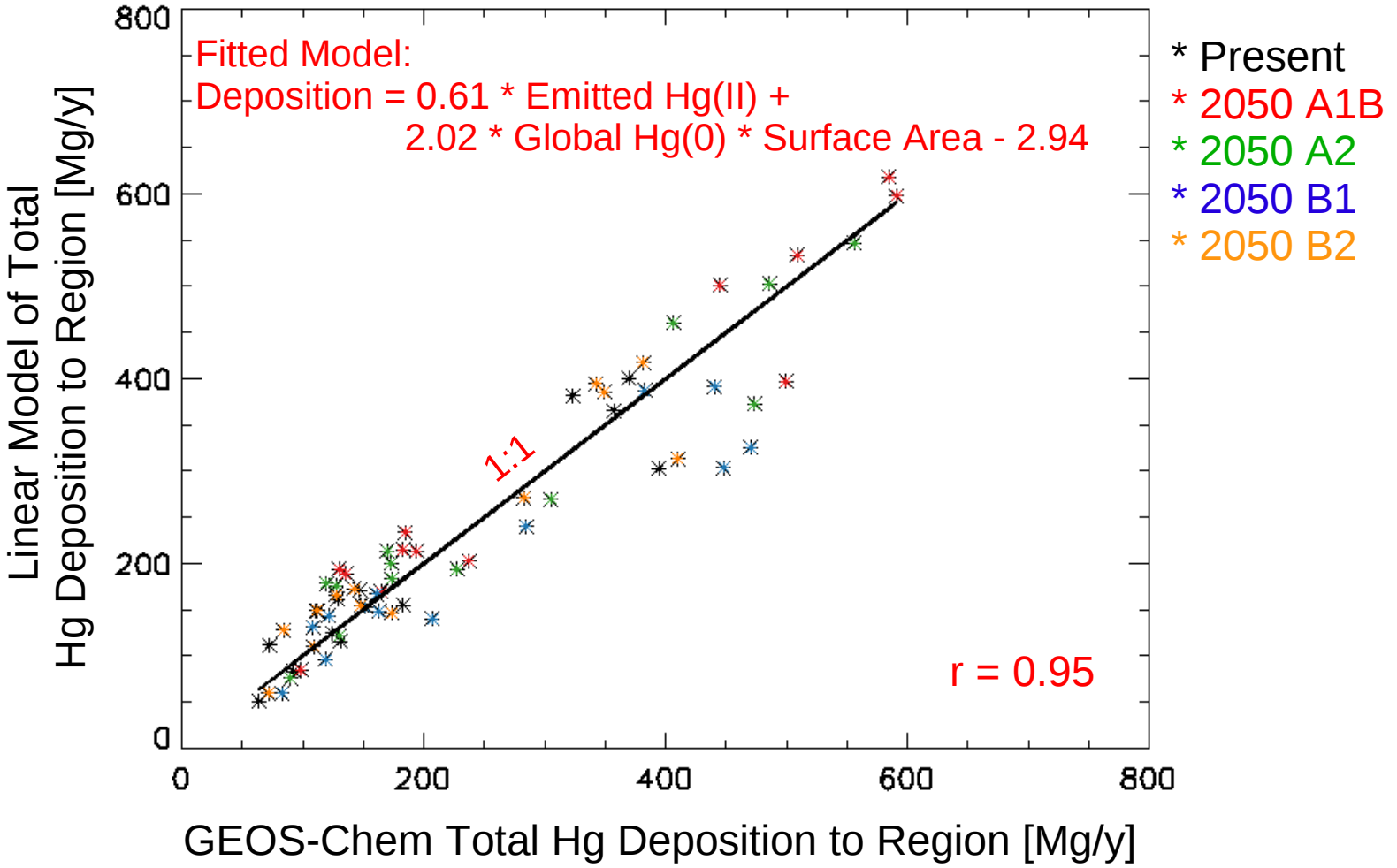


Seafood is a major pathway for human exposure to MeHg. Tracking atmospheric mercury from anthro. sources to deposition to the ocean makes one connection in the chain linking emissions to exposure.

38% of modeled deposition to the North Atlantic in the present day is due to recent anthro. emissions.

Regional Deposition: Function of Both Local Emissions and the Global Hg Background

Total Hg Deposition by Region, Fit to a Linear Model



The amount of total mercury deposition a region receives may be reasonably modeled as the sum of a fraction of the short-lived Hg(II) it emits plus a component of the global atmospheric burden of Hg(0) scaled by the relative surface area of the region.