Assessing Local Risks from Mercury Emissions from Coal-Fired Power Plants through Soil Sampling

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ABSTRACT

Mercury (Hg) emissions from coal fired plants will be limited by regulations enforced by the US Environmental Protection Agency (USEPA). However, there is still debate over whether the limits should be on a plant specific basis or a nationwide basis. The nationwide basis allows a Cap and Trade program similar to that for other air pollutants. If Cap and Trade is allowed, there is a potential for mercury 'hot-spots' around coal-fired power plants. Modeling suggests that increased mercury deposition close to the plant (within 10 – 15 Km) may occur due to wet deposition. Interpretation of literature (Lipfert, 2004) on mercury deposition and soil characterization near a 1200 MW Midwest power plant suggest small increases over background deposition. The intent of this program is to collect data to prove or disprove the existence of 'hot-spots'. This work focuses on characterizing the increase in local deposition in the vicinity of coal-fired power plants through measurement of soil mercury levels near a coal-fired power plant. Our previous study at another power plant did not find evidence of hot-spots.

Approach

a) Select Coal-fired power plant for analysis
b) Perform deposition modeling based on plant parameters.
c) Design soil and vegetation sampling program
d) Examine data for hot spots' and correlation with modeling

A) Coal-Fired Power Plant

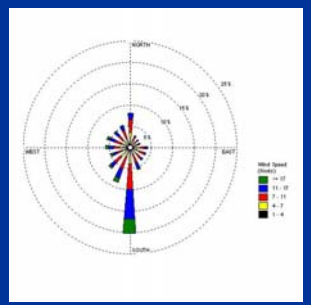
Mid-sized power plant (1200 MW) in the Midwest selected. 15 miles to the NNW, a small coal-fired power plant also exists.
Both included in deposition modeling.

Mid-sized Plant:
- Annual Hg emissions 161 kg/yr.
- Fraction of Hg(+2) =0.2 (32 kg/yr).
- Stack Height – 187 m

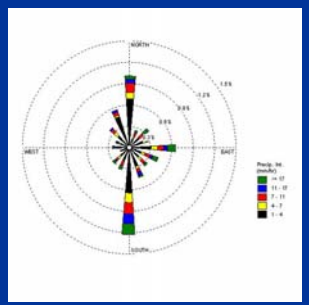
Small Plant:
- Annual Hg emissions = 11 kg/yr
- Fraction of Hg(+2) = 0.2 (2.2 kg/yr)
- Stack Height (13,5 m).

B) Deposition Modeling

Used 5-year average for meteorological data
Modeled wet and dry deposition.
Wet deposition localized near plant. High rates of deposition during precipitation events.
Dry deposition maximum away from the plant but < 10% of expected background deposition.
Wet deposition dominates the deposition rates pattern.



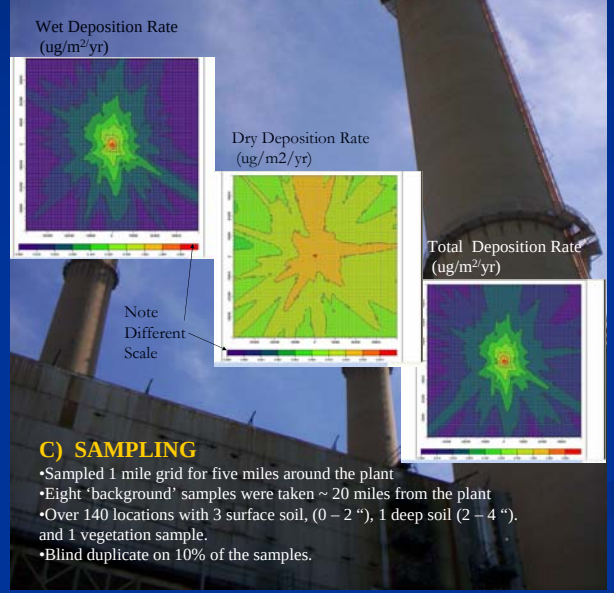
Wind rose (from)



Rain rose (from)

DEPOSITION MODELING RESULTS

Modeled Wet, Dry, and Total Deposition
Wet deposition above expected background near the plant (within 5 km).
Dry Deposition maximum away from the plant j((10 – 20 Km) and predicted to be much lower than background deposition rates
Total deposition rate dominated by Wet deposition rates

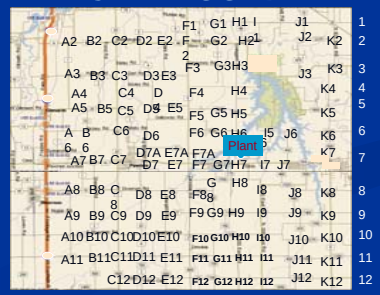


C) SAMPLING

•Sampled 1 mile grid for five miles around the plant
•Eight 'background' samples were taken ~ 20 miles from the plant
•Over 140 locations with 3 surface soil, (0 – 2 "), 1 deep soil (2 – 4 ").
and 1 vegetation sample.
•Blind duplicate on 10% of the samples.

Sampling Crew

SAMPLING GRID

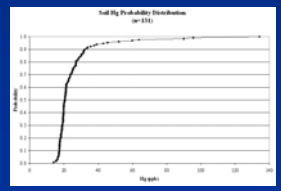


Hg ANALYSIS

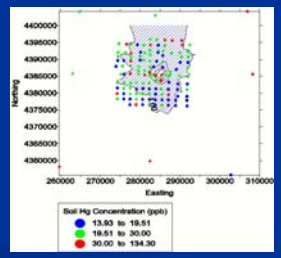
- Samples sent to BNL for analysis.
- Samples analyzed on Direct Mercury Analyzer
- Samples analyzed in duplicate
- Over 1400 samples analyzed.
- QA: 10% blind duplicates and 10% standards.

D) DATA INTERPRETATION

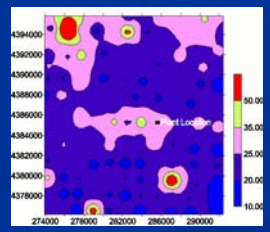
Soil



Data Distribution
132 locations (3 at each location, duplicate analysis)
Average 25 ppb.
Median 21 ppb Standard deviation 15 ppb.
Min 14 ppb.; Max 134 ppb.
6 locations with concentrations > 2* average

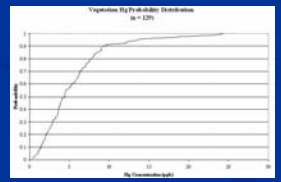


Predicted deposition and soil Hg concentration. Poor match between prediction and soil data. High variability in soil data is not present in predicted deposition

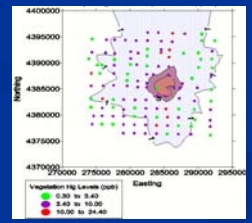


Soil Hg contour map based on measured data. Above average concentrations (pink) W and N the plant. Modeling predicts peaks near plant going to the orth, Note large variability in soil data.

Vegetation



Data Distribution
132 locations (3 at each location, duplicate analysis)
Average 5 ppb.
Median 4 ppb.
Standard deviation 4 ppb.
Min 1 ppb.; Max 24 4 ppb.



Predicted deposition and measured Hg vegetation concentration.

Poor correlation between predicted deposition and vegetation Hg levels.

CONCLUSIONS

No statistically significant evidence of 'hot spots' in soil and vegetation.
Several soil samples had elevated levels of Hg. These were east and north of the Plant and did not match modeled deposition pattern.
Soil and vegetation Hg concentrations are not consistent with expected (modeled) deposition pattern.