Assessing Local Deposition of Mercury Associated with Coal-Fired Power Plants

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Background

- Mercury regulation is on its way.
- EPA has suggested a Cap-and-Trade Program
- Impacts of local deposition are perceived to be an issue of concern for Cap-and-Trade
  - Secretary McGinty (PA – DEP) “Unlike most pollutants, mercury is highly toxic and does not disperse easily, creating “hot spots” of contamination.” July 04
  - Secretary Cipriano (IL – EPA) “Specifically, we are concerned that local "hot spots" of elevated mercury may result or worsen, especially if the required reduction levels are not sufficiently strict.” Feb 04

Background

- Modeling studies suggest some increased local deposition, however, few measurement studies.
- Local deposition of reactive gaseous mercury and any particulate mercury is expected during precipitation events. Elemental mercury enters the global cycle.
- Data are needed to asses local impacts.

Approach

- Select a coal-fired power plant for analysis.
- Perform deposition modeling based on plant specific parameters and meteorological conditions.
- Design soil and vegetation sampling program to look for excess deposition within 10 Km of the plant and determine the validity of modeling.
- Examine data for correlation with model predictions and look for hot spots.

Coal-Fired Power Plant

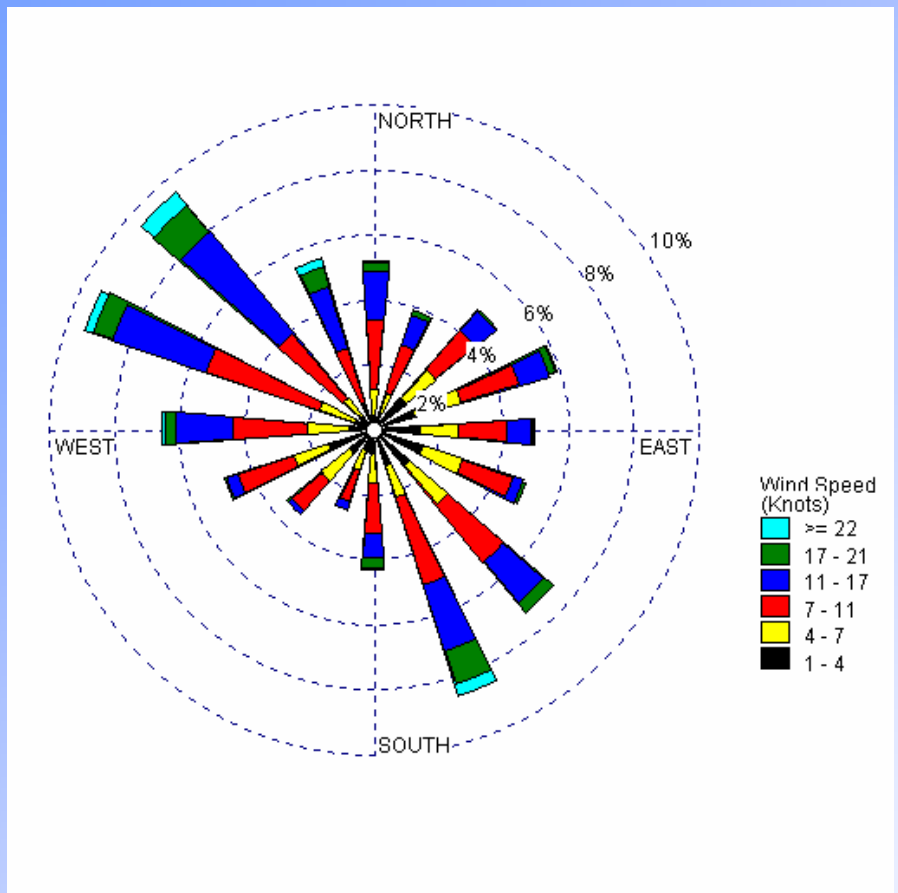
- A large sized power plant in the Midwest was selected for study.
- Annual emissions of Hg 340 kg/yr
- Fraction of Hg(+2) = 0.18 (61kg/yr of Hg(+2))
- Large stack height (200 m), lower deposition locally.

Deposition Modeling

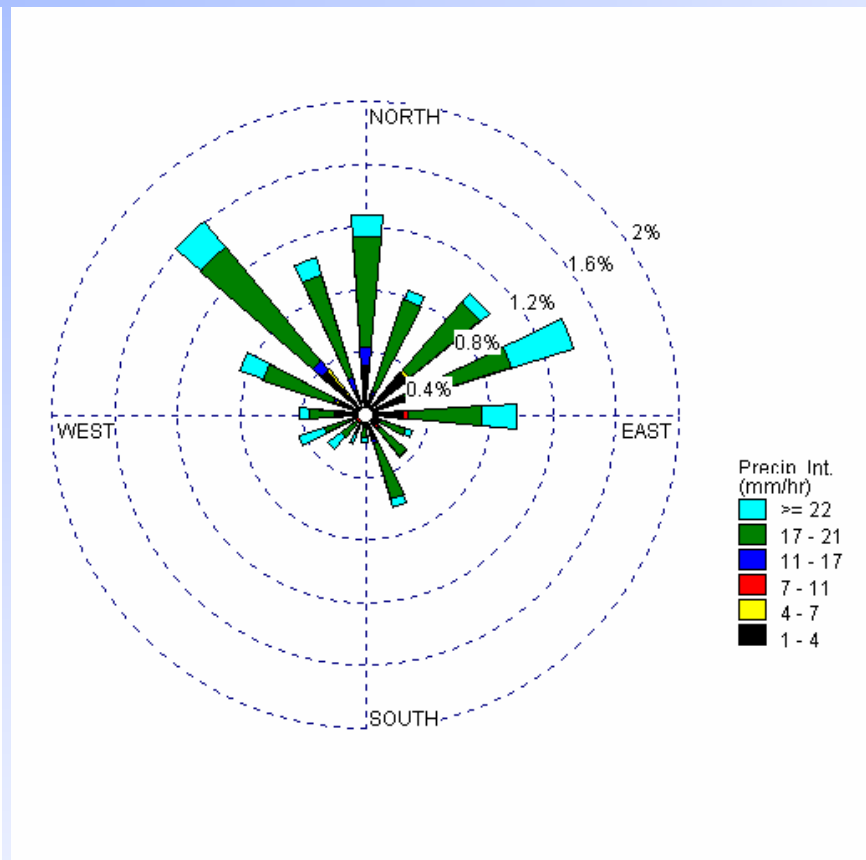
- Use plant specific parameters (emission rates, stack height, etc.).
- Examine meteorological records over 10 year period. Select most representative year.
- Model deposition over the course of 1 year.

Wind and Rain Rose

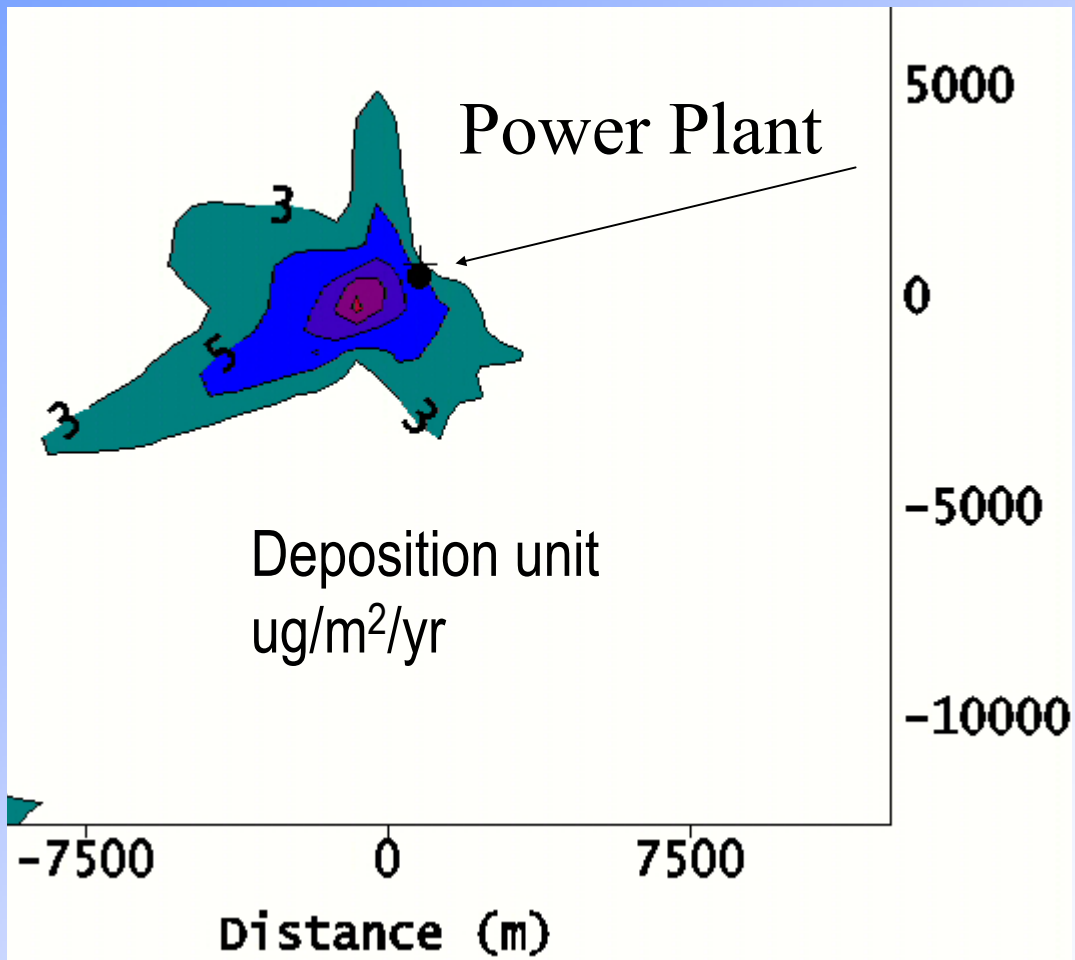
Wind Rose



Rain Rose

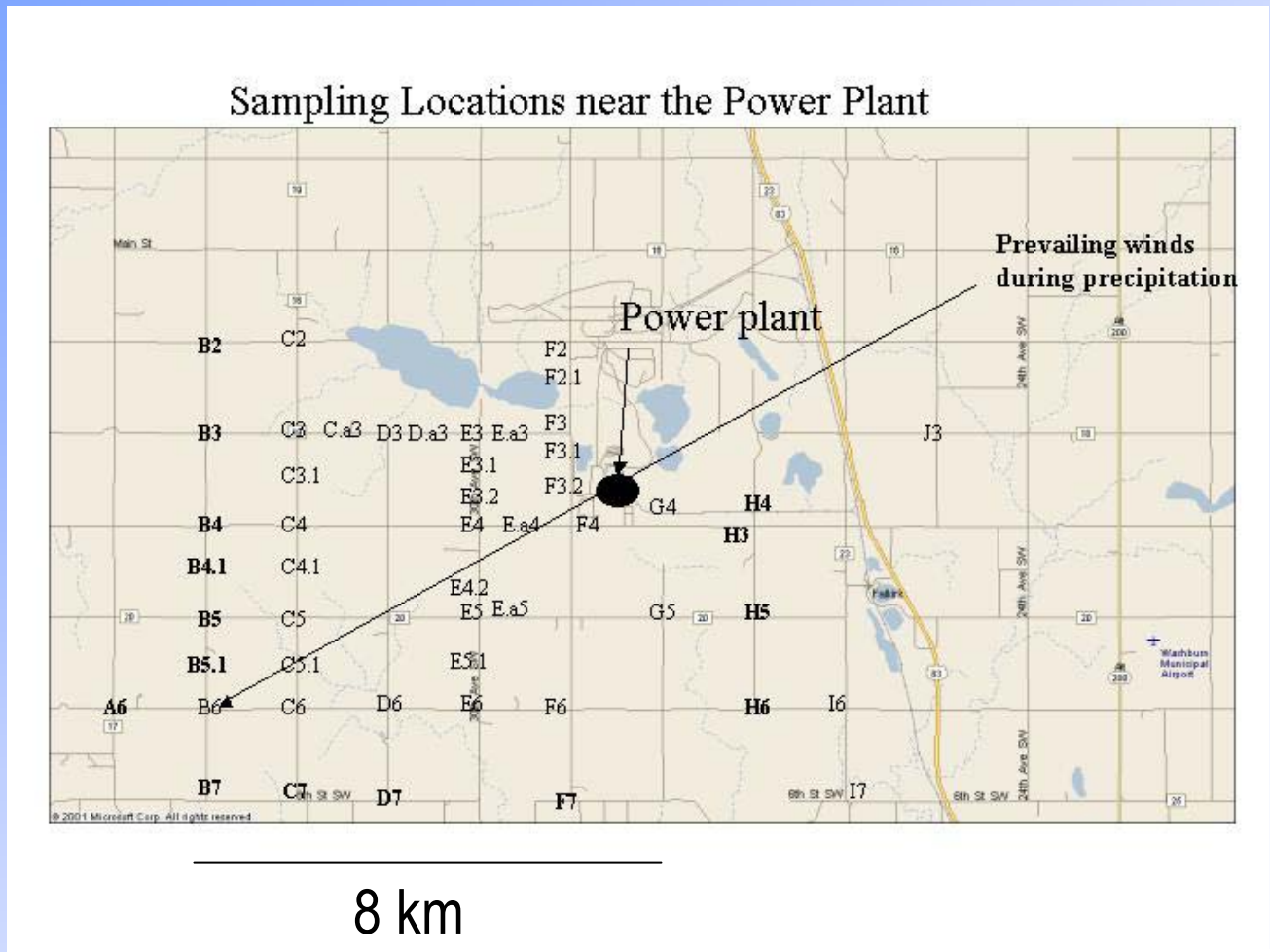


Deposition Modeling Results



Background wet deposition of 5 – 10 ug/m^2/yr

Final Sampling Grid



Sampling

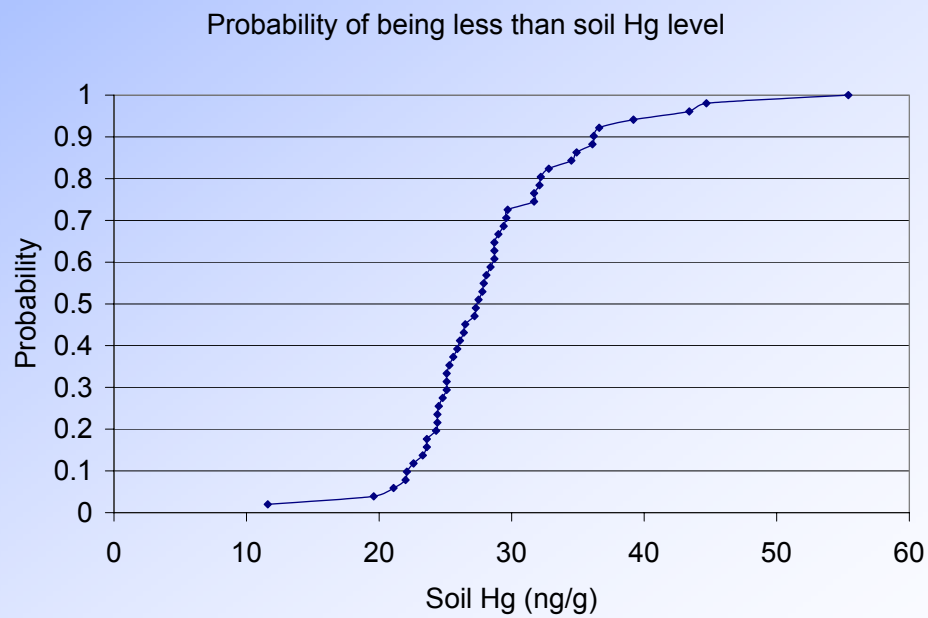
- Cover an area of 64 km^2 primarily south west of plant
- At each of the 51 grid locations collect:
  - 3 soil samples from top 5 cm (3 meter spacing)
  - 1 deep soil sample from 5 – 10 cm
  - 1 vegetation sample

Analysis

- All samples shipped back to BNL
- Samples analyzed on Direct Mercury Analyzer (DMA-80). (Moisture determined separately.)
- Each sample measured 3 times to verify homogeneity.
- Blank analysis every 10th sample
- NIST Standard every 10th sample

Results

- 51 Sample Sites Average 28.7 ng/g
  - Median 27.4 ng/g
  - Standard Deviation – 7 ng/g
  - Maximum – 55 ng/g
  - Minimum – 11.6 ng/g

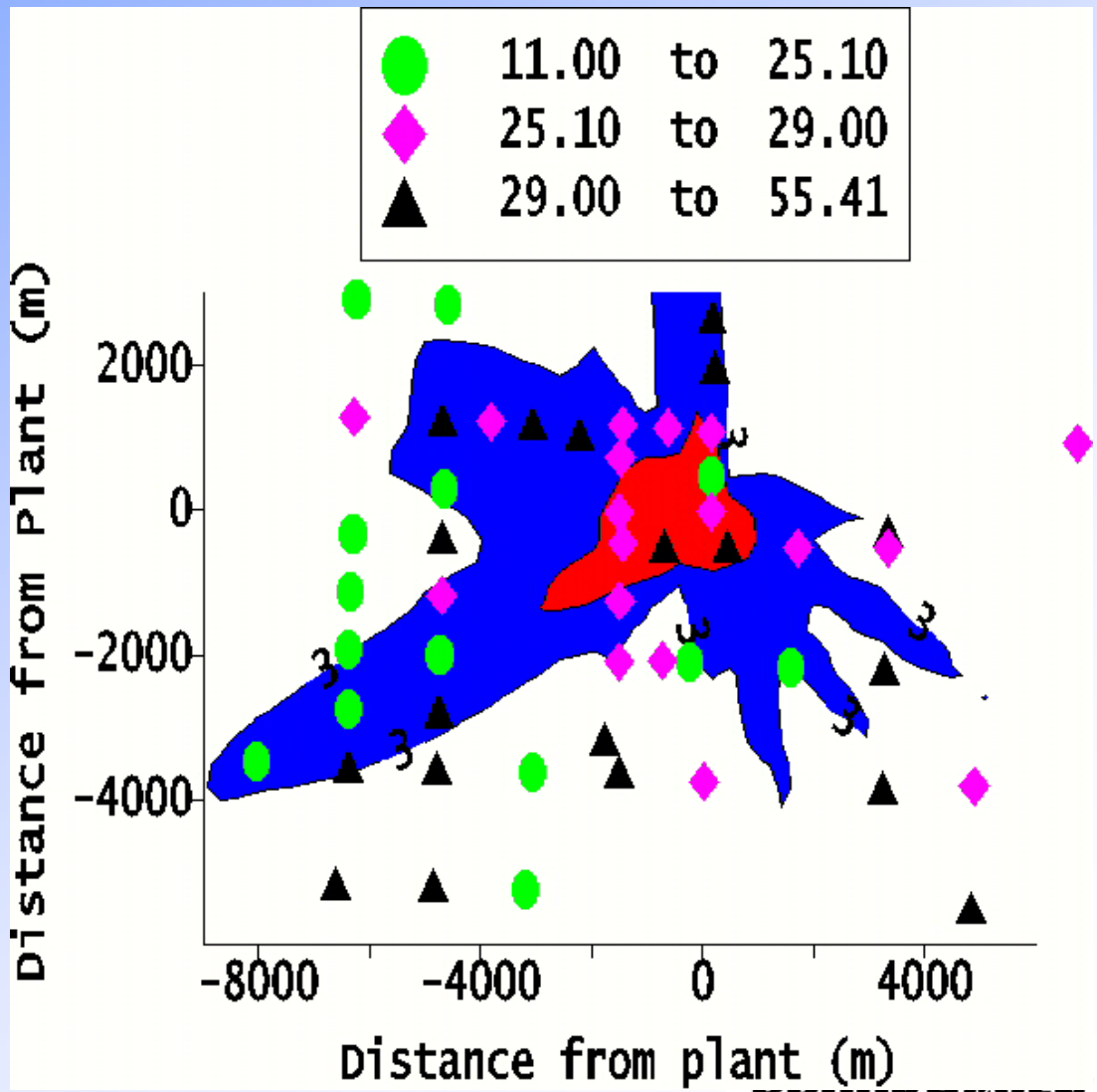


Soil Results

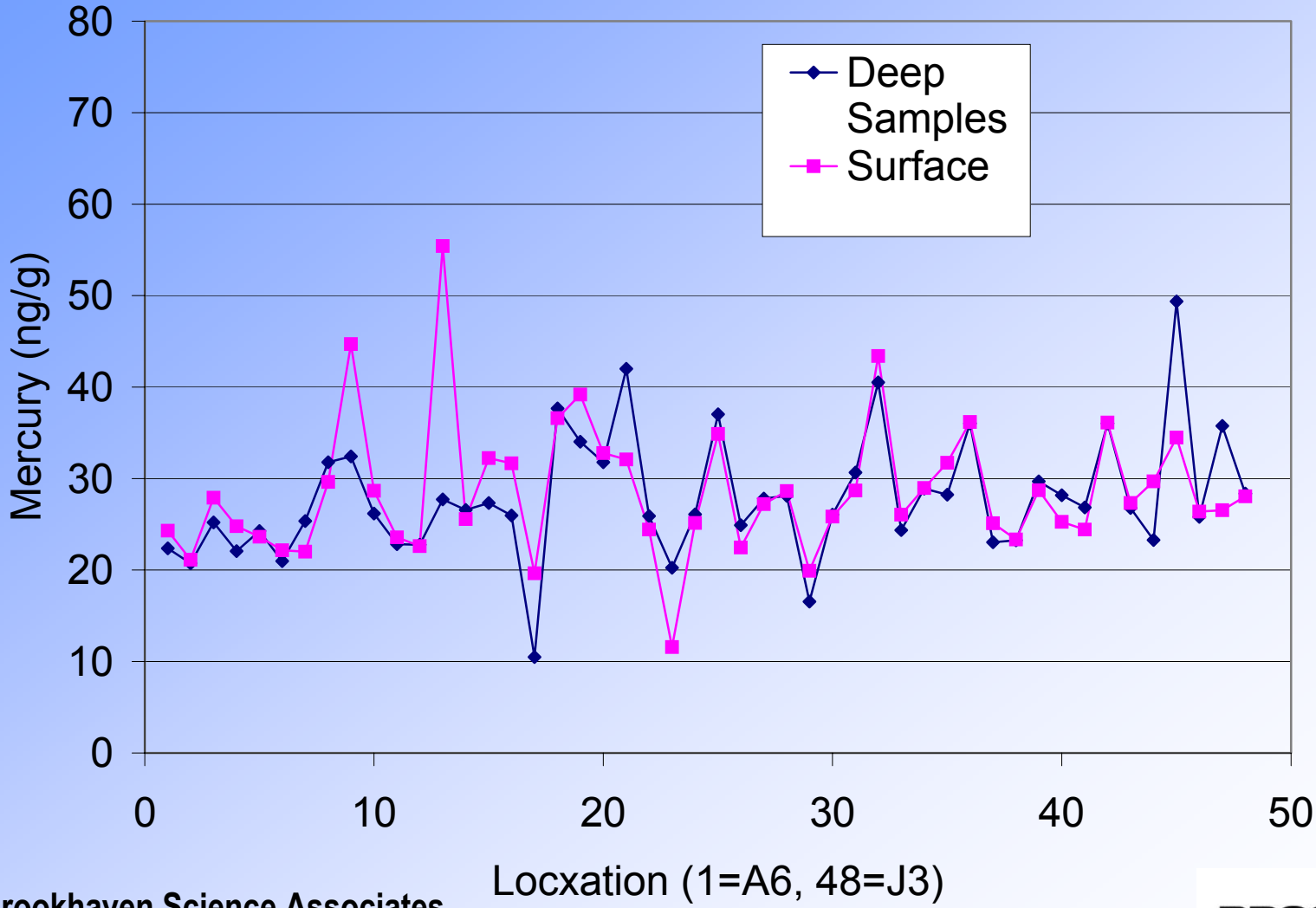
Effects of deposition are subtle and there is variability in the spatial distribution of Hg in soils.

Statistically significant agreement between model and data not found.

No clear definition of background.



Results (deep vs. surface samples)



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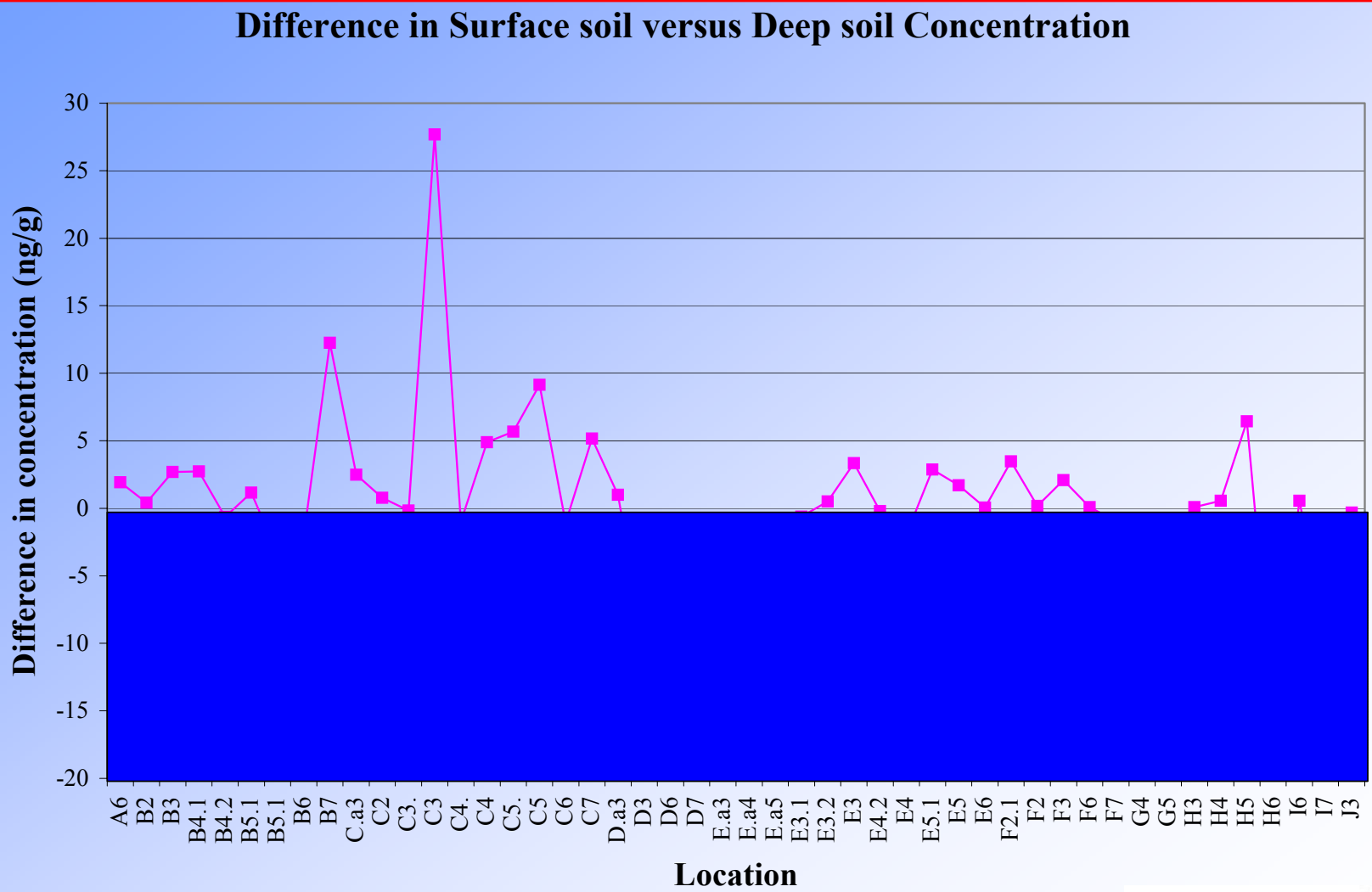
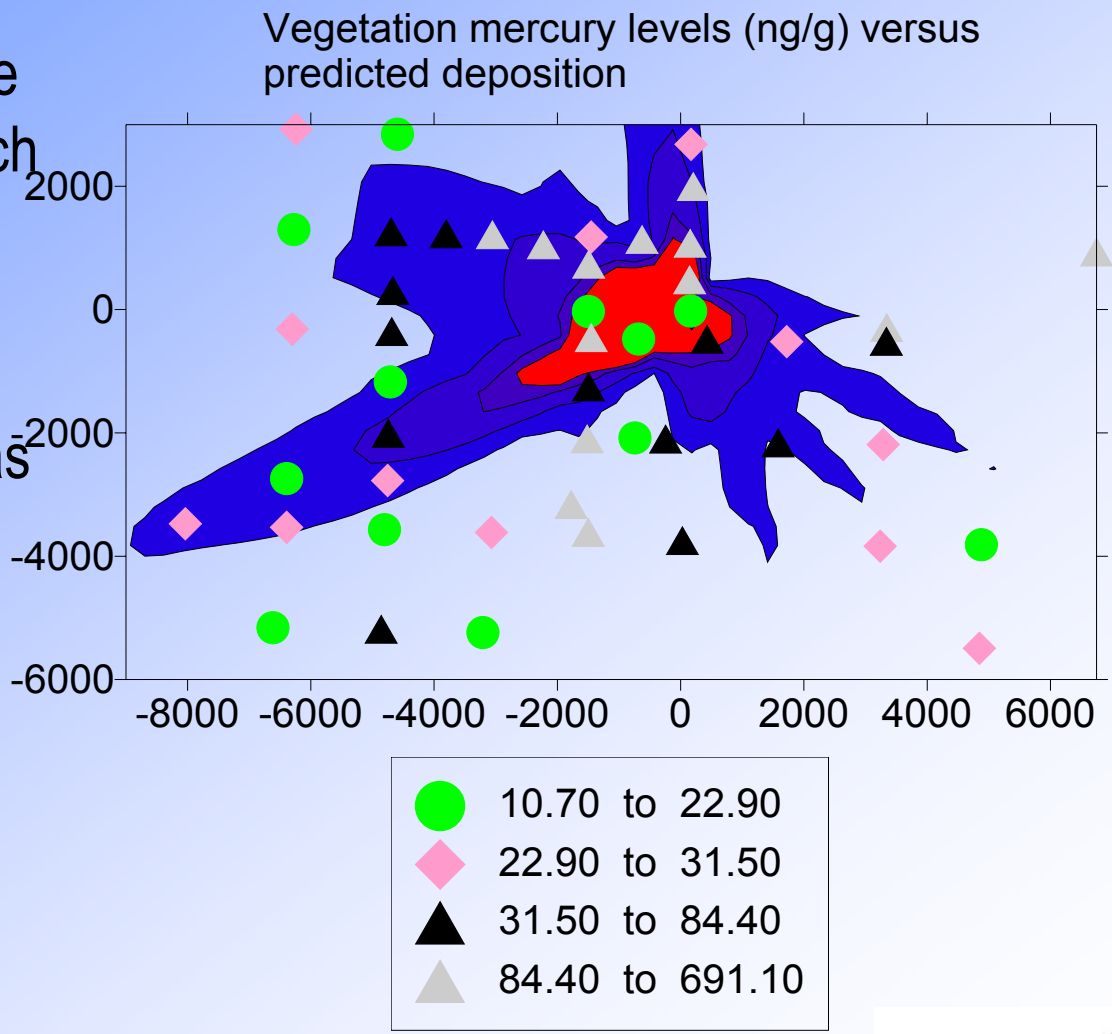


Vegetation Results

Effects of deposition are similar and there is much larger variability than in the soil samples.

Same general pattern as Soil samples.



Comparison of deposition modeling and data on mass deposition

- Three estimates obtained:
  - Mass deposited = Excess in surface soils versus deep soils (0.7 ng/g)
  - Mass deposited = Surface soil average minus average of the lowest 1/3 of the samples (8.4 ng/g). Lowest 1/3 taken as pre-operational background.
  - ISCT model annual deposition prediction multiplied by plant life.

Estimates of Mass Deposited

Case	Total Mass Required over plant life time of 23 years (g)	Percentage of total Hg emission	Percentage of reactive Hg emissions
Deep vs. Surface Soils	2700	0.04	0. 2
Lowest 1/3 as background (upper bound)	30000	0.4	2.1
Deposition Modeling (23 years)	9400	0.12	0.7

Conclusions

- At the power plant under study a small fraction (< 0.5%) of mercury appears to be deposited within 5 miles of the plant.
- No evidence for ‘hot spots’ in soil.
- General agreement between estimates of total mass deposited between data and model.
- Agreement between data and model in terms of spatial pattern is not statistically significant.
- Next step: Repeat at another plant