Use of passive sampling methods to understand sources of mercury to high elevation sites in the Western United States



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Acknowledgement

- Undergraduate students at UNR

  Matthew Peckham, Douglas Yan, Travis Lyman, Musheng Alishahi, and Jennifer Arnold

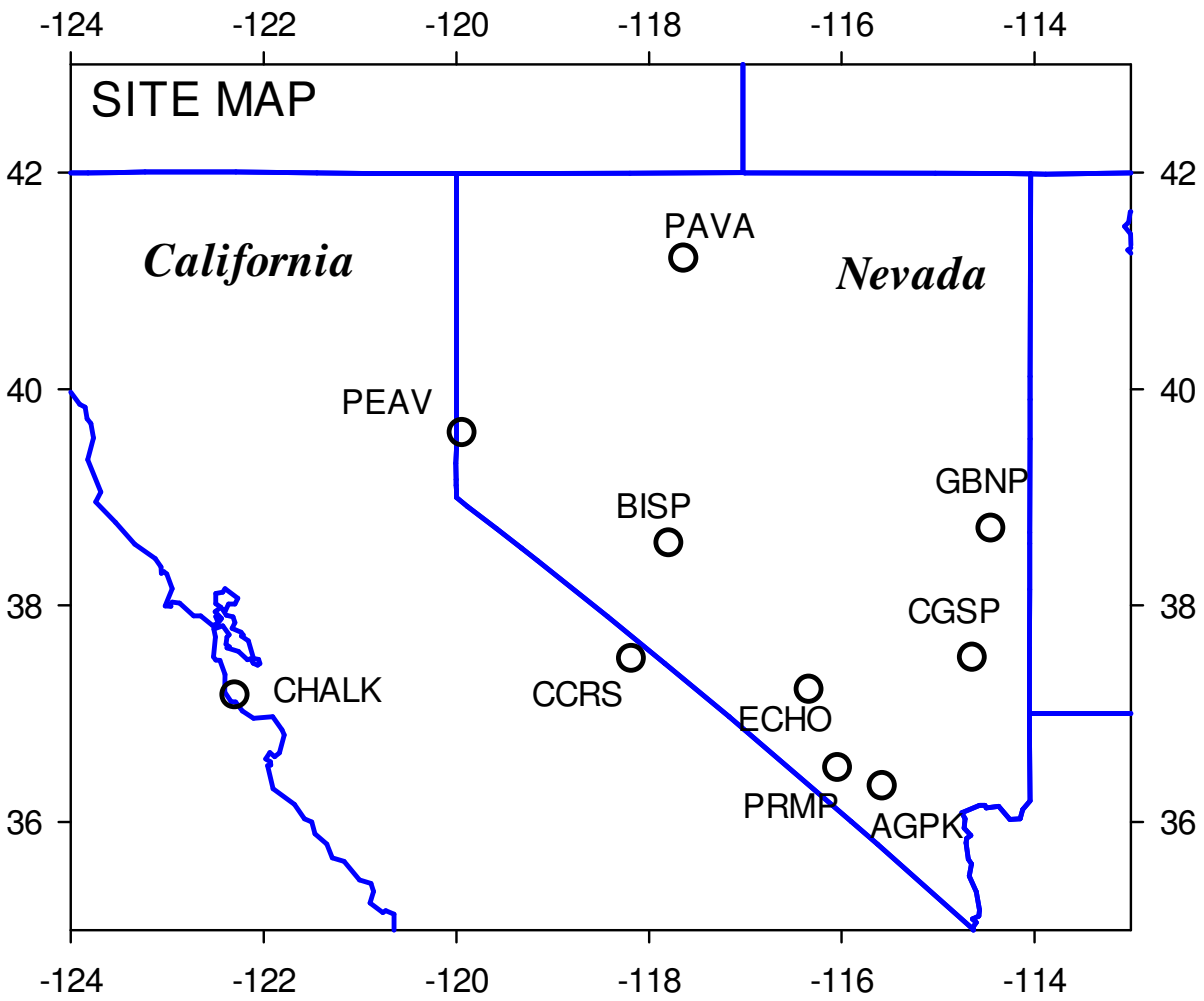
- The site operators

  Jeff Morris (BISP), Cody Tingey (CGSP), Tim Forsell (CCRS), Russ Merle (PRMP), Jerry Dries (ECHO), Daren Winkelman (AGPK), and Li Zhang (AGPK), Tony Lesperance (PAVA), Ben Roberts (GBNP), and Peter Weiss-Penzias (CHALK)

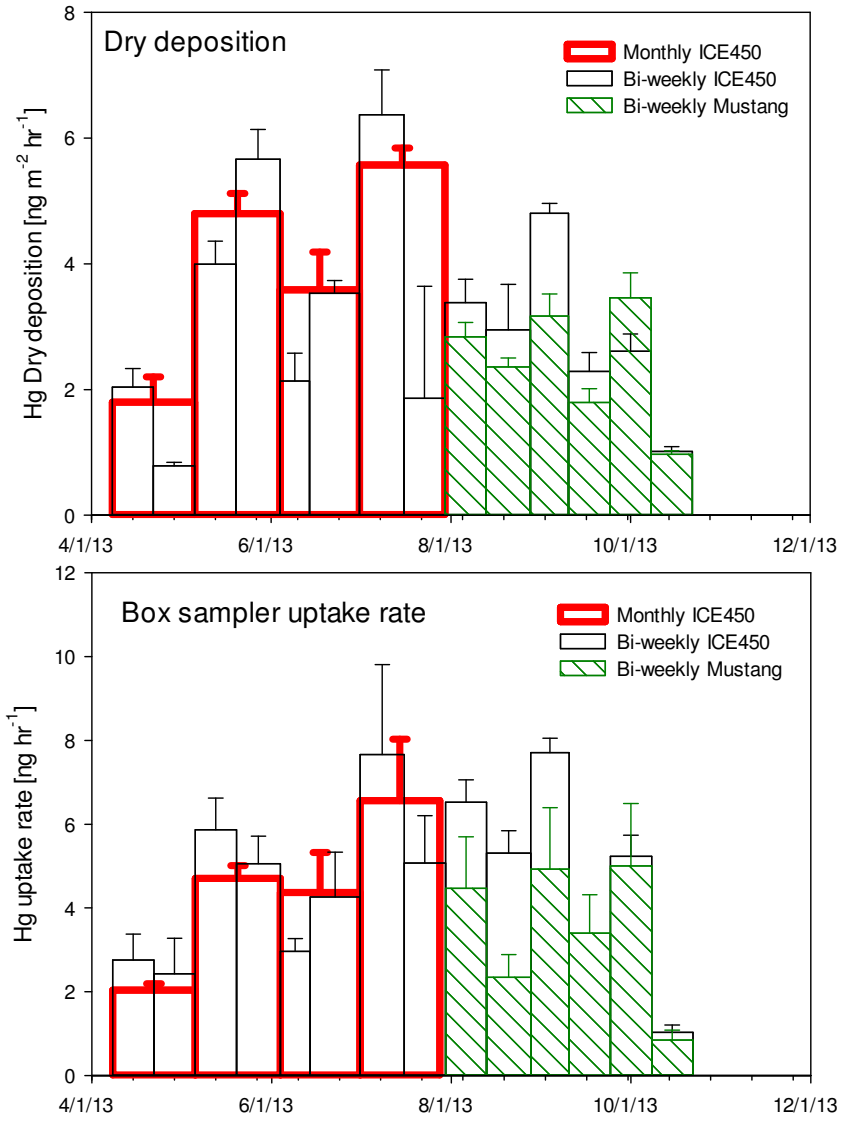
Methods

- Box sampler-concentration
- Surrogate surface-dry deposition
- A 3-times correction factor
- Multiple-resistance model
- α=β=2, α=β=10, no canopy resistance
- Hybrid Single Particle Lagrangian Integrated Trajectory
- $Probablity\ function, P_{i,k} = \frac{N_{i,k}}{M_{i,k}}$

Sampling sites



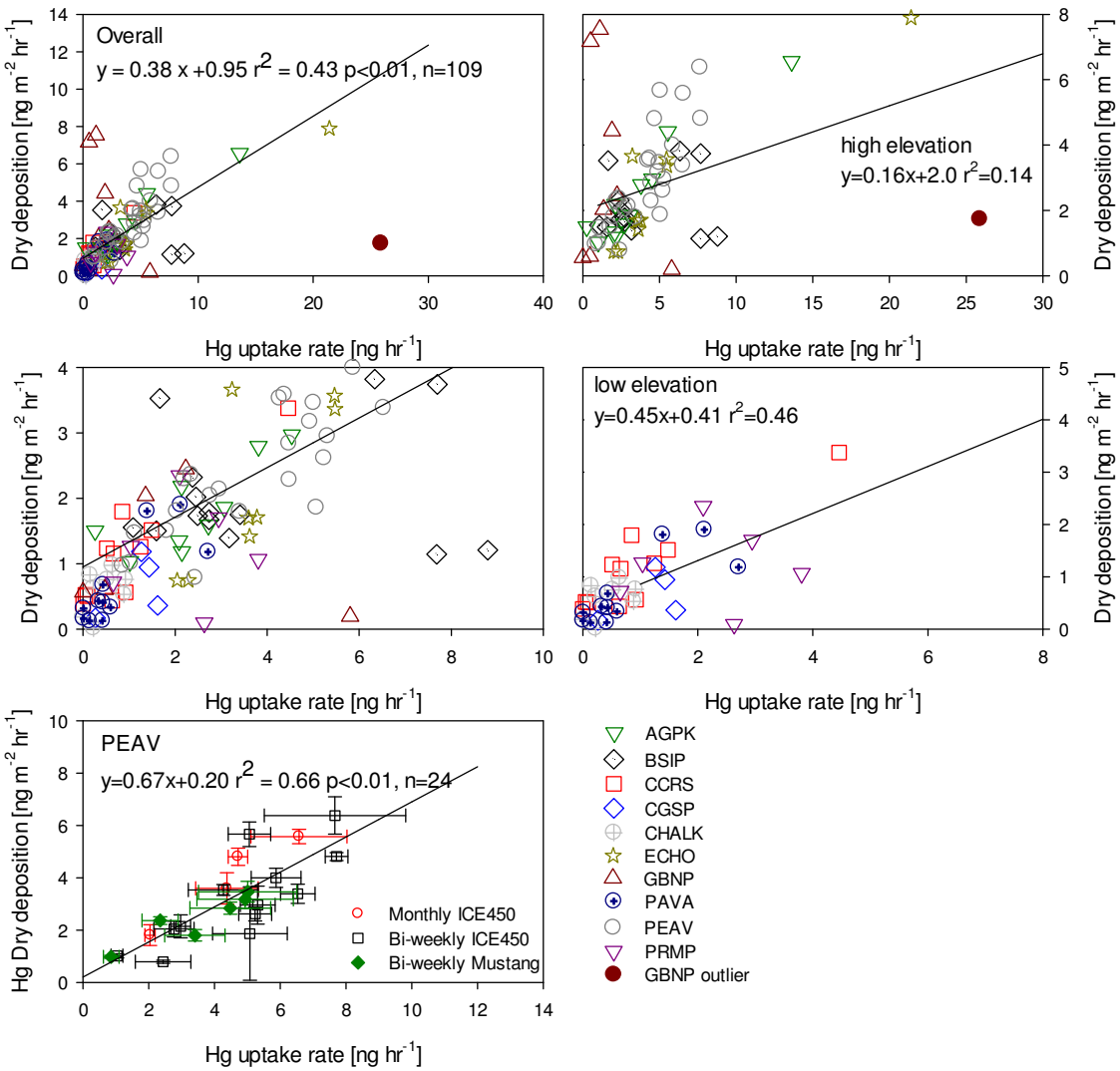
Different materials and exposure times



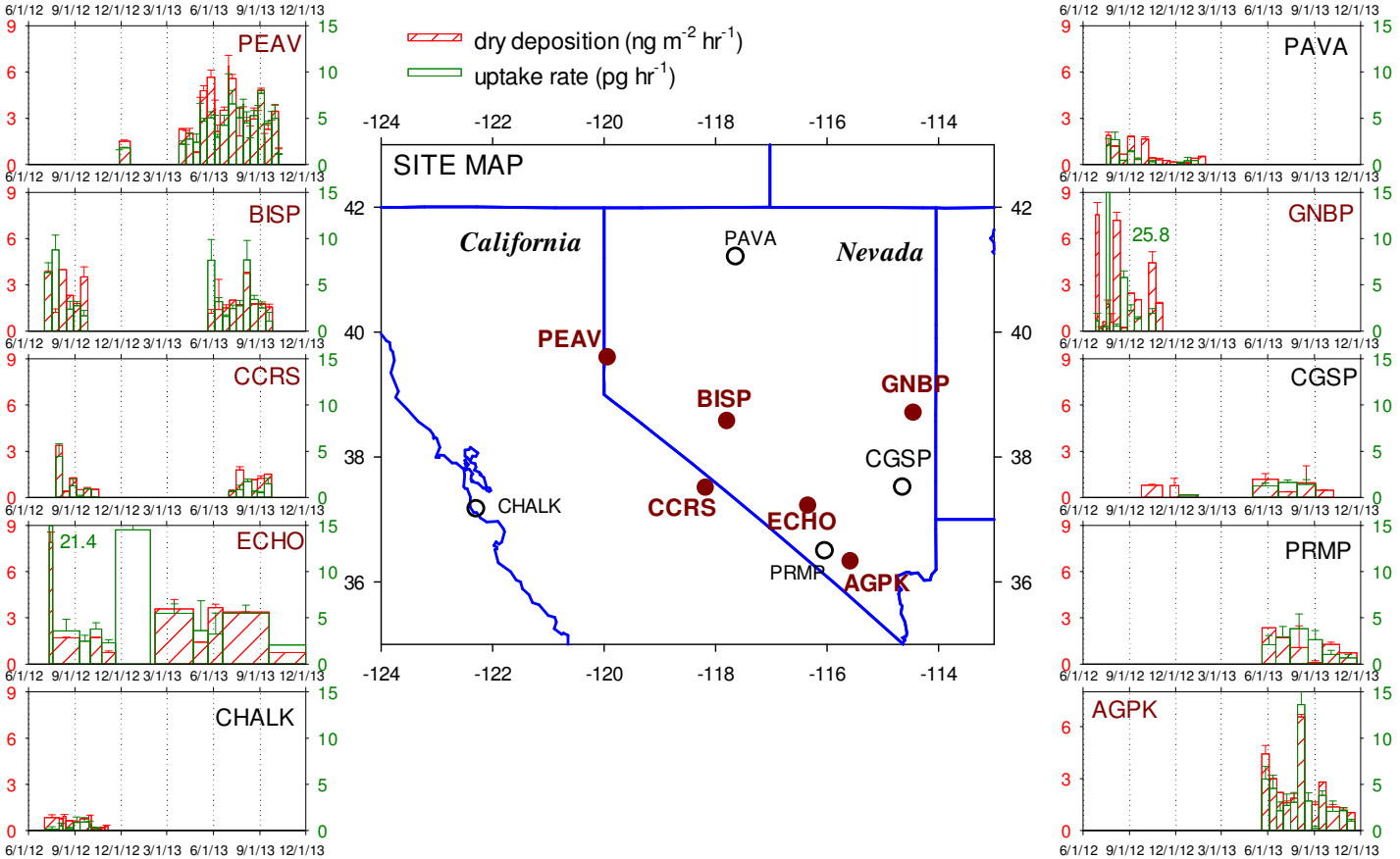
polysulfone membranes, ICE 450

polyethersulfone membrane, Mustang S

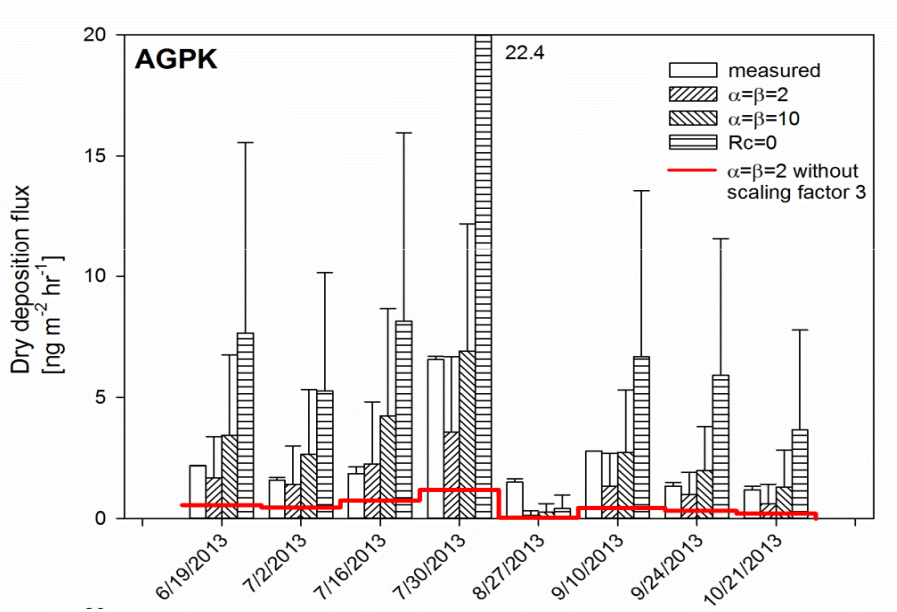
Correlations

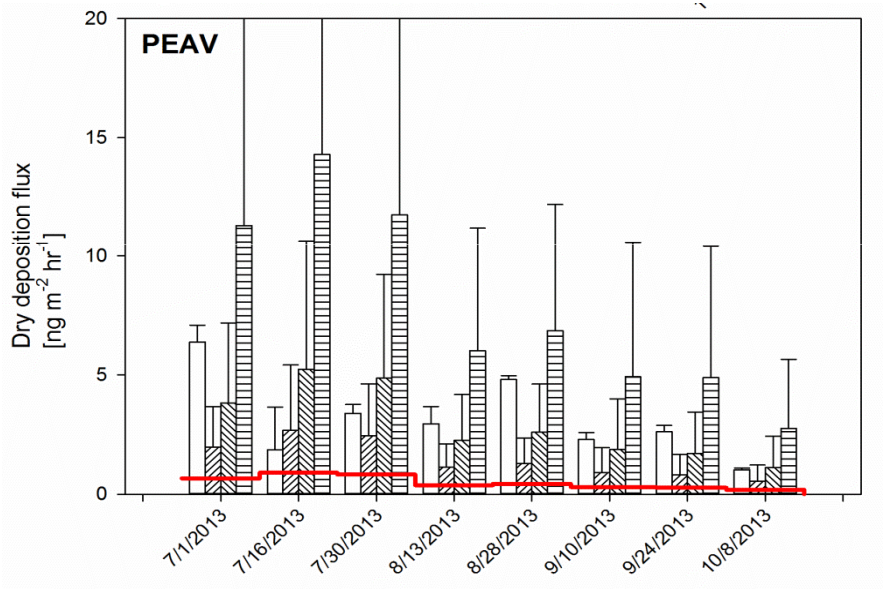


Spatial and temporal variation



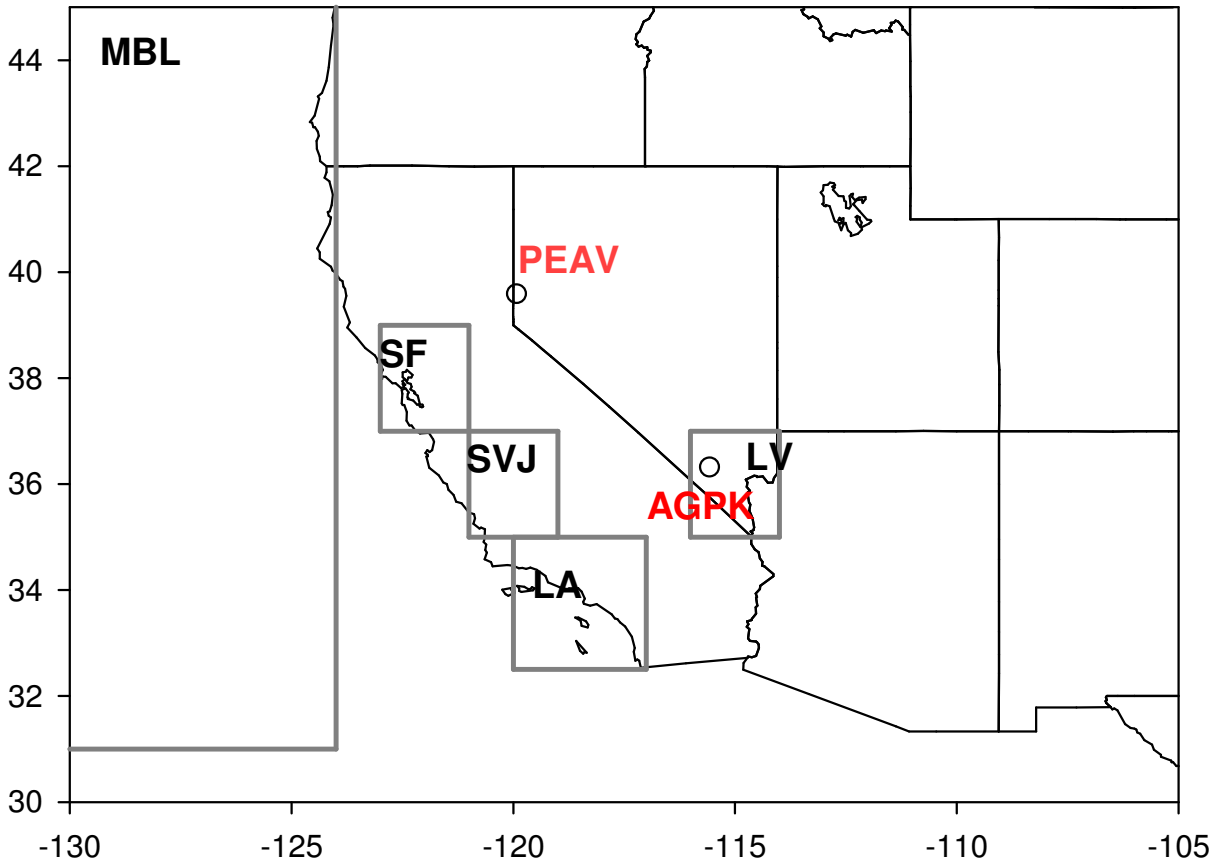
Modeled and measured results





thorn shrubs sites

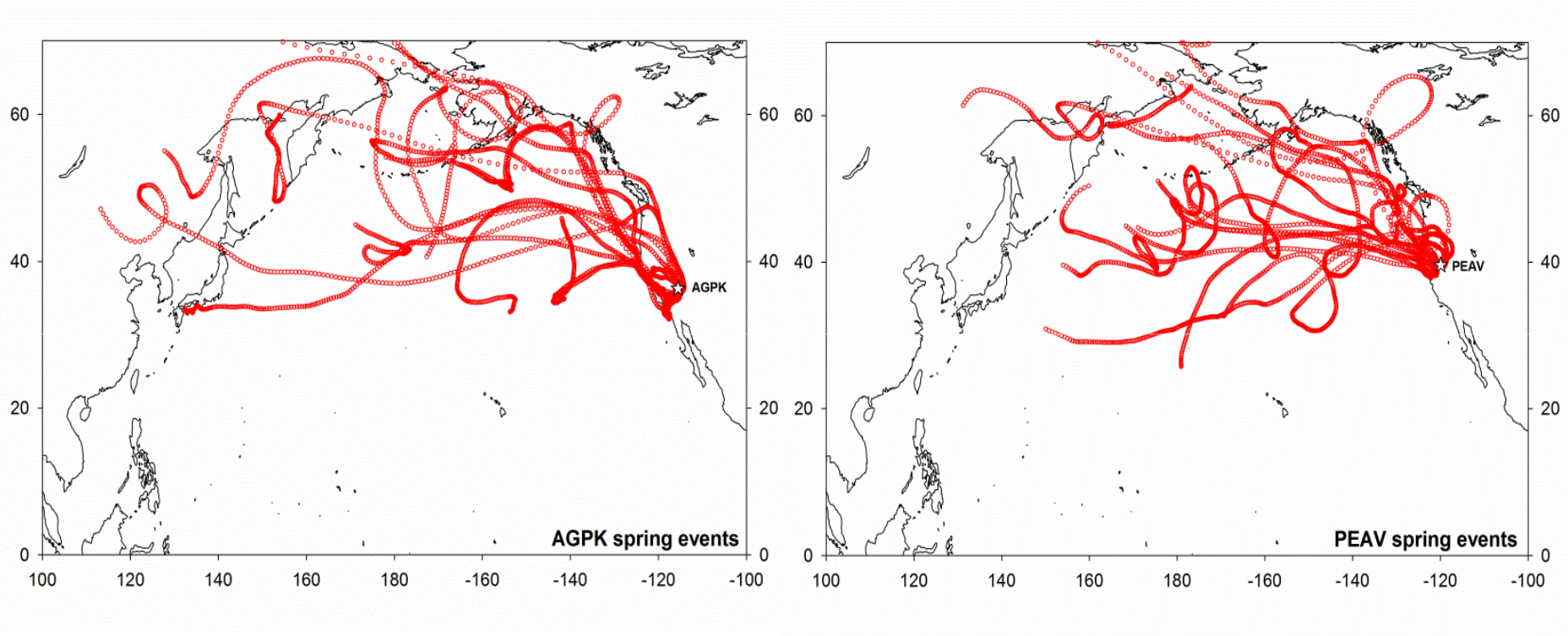
Probability function domain



Source regions

- AGPK
  - LA and MBL boxes-high elevation
  - LA, Las Vegas, MBL, and San Joaquin Valley low elevation.
- PEAV
  - SF all elevations
  - LA less points

Asian long range transport



Summary

- Hg amount collected on Mustang S is comparable that on ICE 450.
- Hg dry deposition was higher at high elevation sites than at low elevation sites.
- Dry deposition uncertainties are still high and different GOM species were observed.
- Regional and long range transport sources affect Hg level at high elevation sites in the Western US.

The Influence of a Local Coal-Fired Power Plant on Ambient Mercury Concentrations

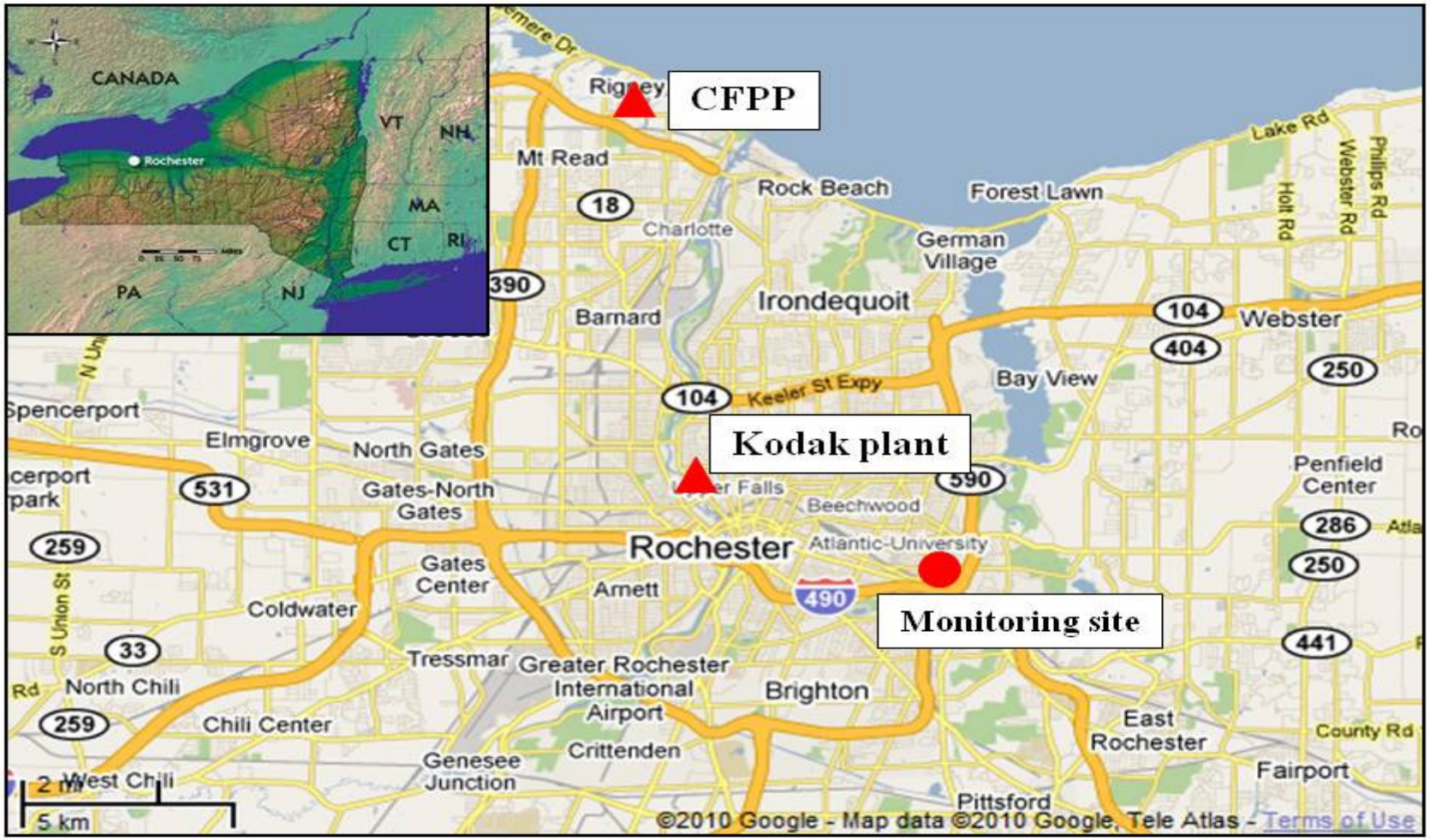




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SITE MAP


CANADA
VT
NH
MA
CT
RI
PA
NJ
Rochester
CFPP
Kodak plant
Monitoring site
Mt Read
Rock Beach
Forest Lawn
Charlotte
German Village
Irondequoit
Barnard
Webster
Bay View
Keeler St Expy
Spencerport
Elmgrove
North Gates
Gates-North Gates
Penfield Center
Beechwood
Rochester
Atlantic-University
Gates Center
Arnett
Coldwater
Tressmar
Greater Rochester International Airport
Brighton
East Rochester
North Chili
Chili Center
Crittenden
Genesee Junction
West Chili
Fairport
Pittsford
Lake Rd
Webster Rd
Phillips Rd
Holt Rd
S Union St
County Rd
2 mi
5 km
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INSTRUMENTS

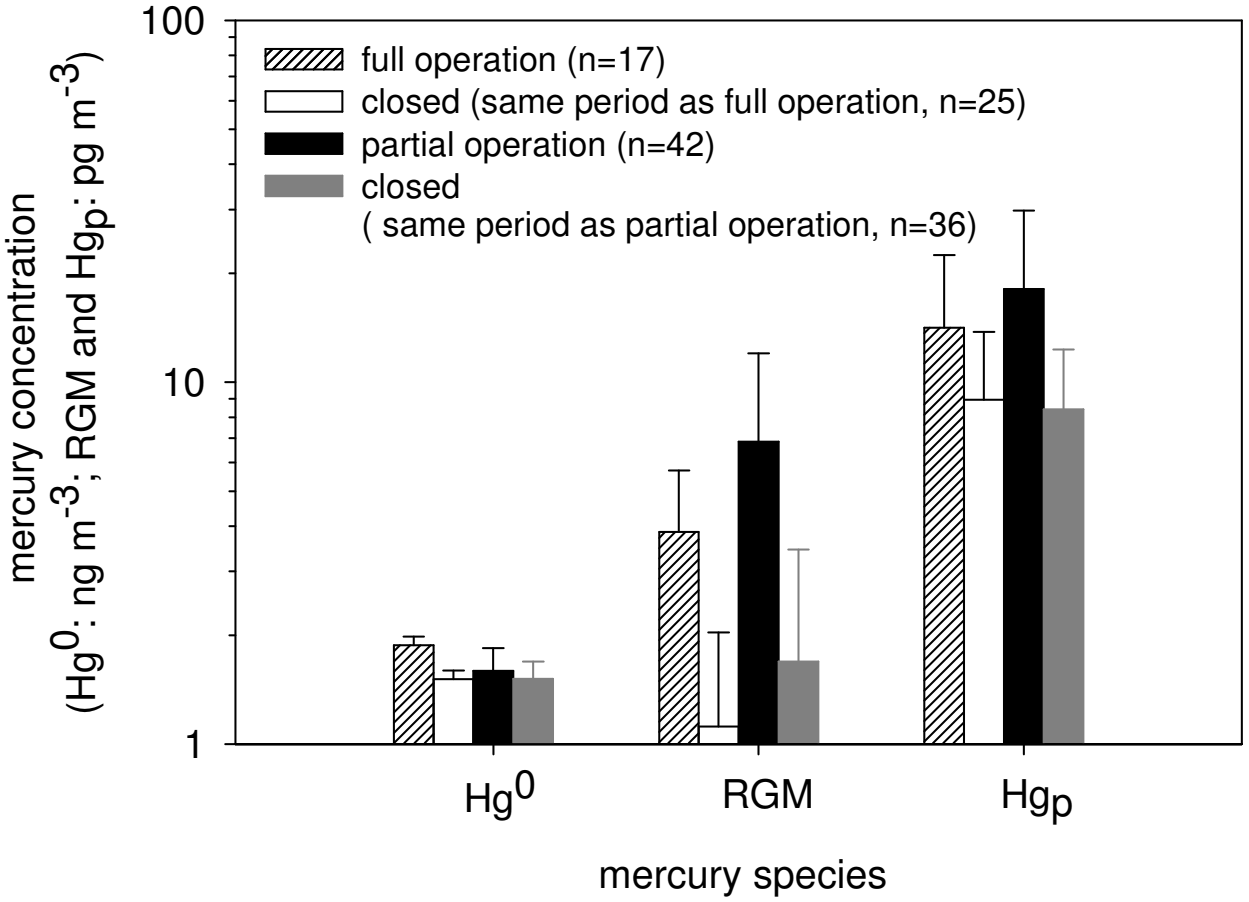
- Tekran® 2537/1130/1135
- Trace gases instruments (CO, ozone, SO_2)
- Scanning mobility particle sizer
  - differential mobility analyzer
  - ^{85}Kr aerosol neutralizer
  - Condensation particle counter
- $PM_{2.5}$: tapered element oscillating microbalance (TEOM)
- Two-wavelength aethalometer

POSITIVE MATRIX FACTORIZATION

$$x_{ij} = \sum_{k=1}^{p} g_{ik} f_{kj} + e_{ij}$$

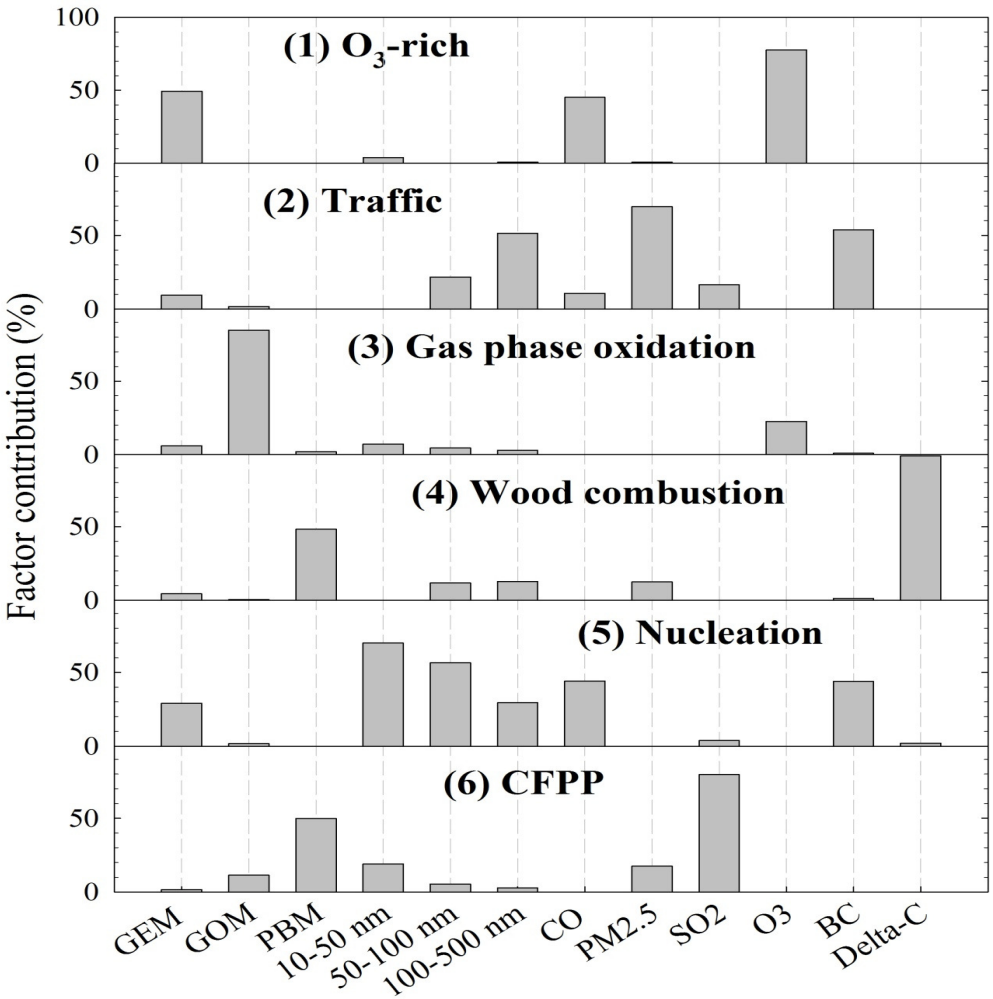
A weighted factorization problem with non-negativity constraints using known experimental uncertainties as input data thereby allowing individual treatment (scaling) of matrix elements

Ambient Air Hg Concentration Downwind Influences

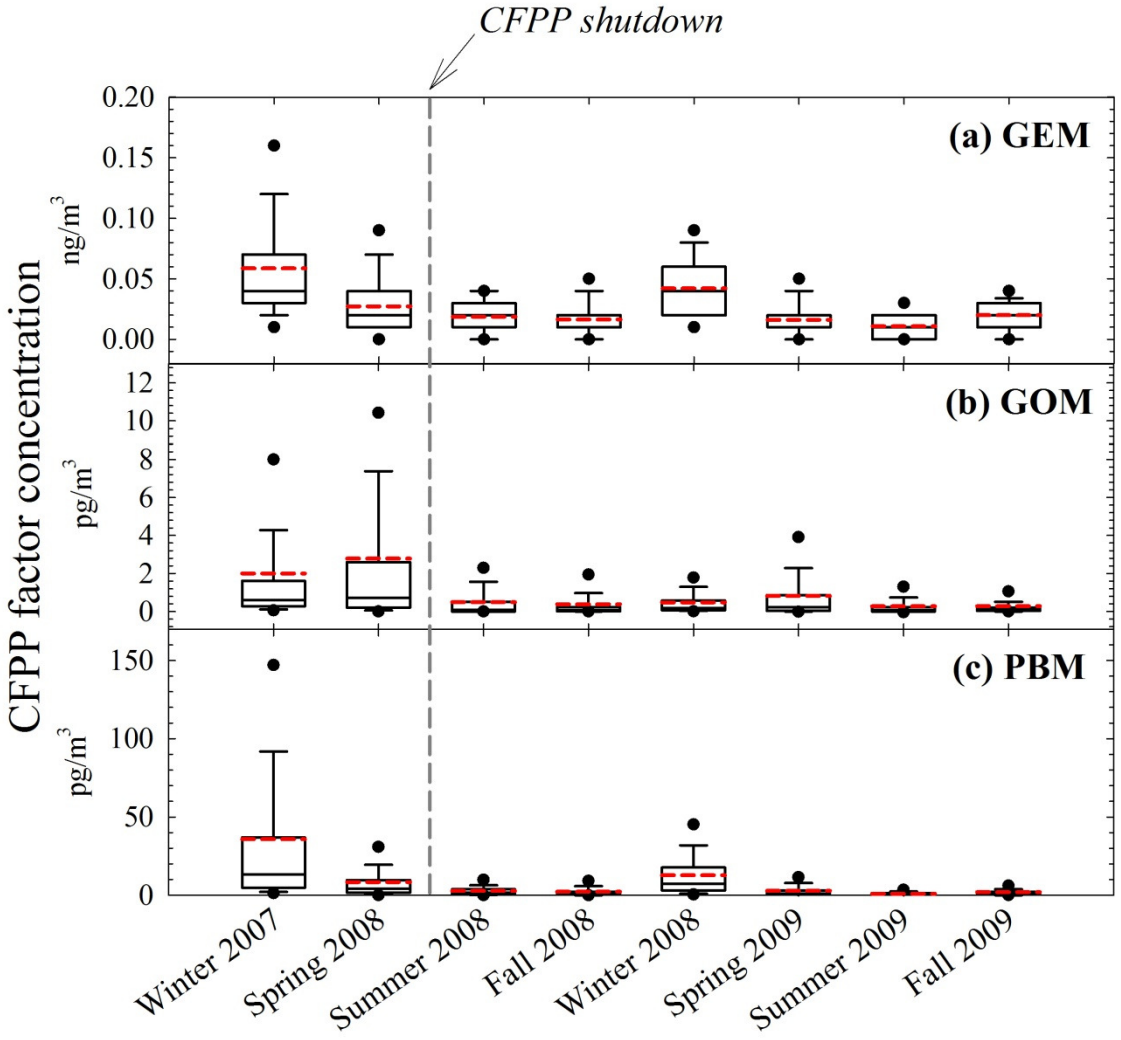


Significantly higher before than after the CFPP closure

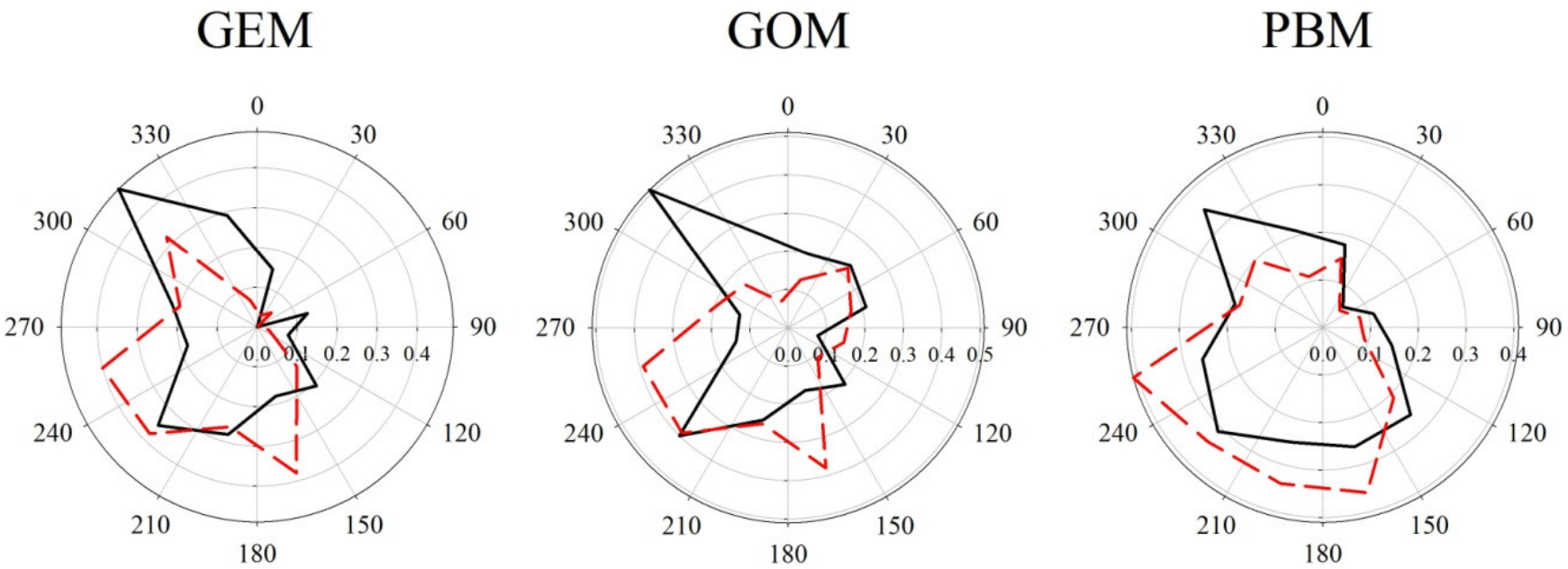
PMF Results


(1) O_3-rich
(2) Traffic
(3) Gas phase oxidation
(4) Wood combustion
(5) Nucleation
(6) CFPP
Factor contribution (%)
100
50
0
GEM
GOM
PBM
10-50 nm
50-100 nm
100-500 nm
CO
PM2.5
SO2
O3
BC
Delta-C

CFPP CONTRIBUTION



CONDITIONAL PROBABILITY FUNCTION



black line: before the CFPP closure

red line: after the CFPP closure

TMH-t5

REACTIVE HG PARTITIONING COEFFICIENT

$$K_p = \frac{PBM/PM_{2.5}}{GOM}$$

Time period	slope	intercept	r^2	K_p ($m^3/\mu g$)
Overall	-1300 ± 120	5.0 ± 0.4	0.11, p< 0.01	1.1 ± 4.0
12/7/2007-4/24/2008	-1400 ± 330	5.7 ± 1.2	0.09, p< 0.01	0.5 ± 0.5
12/7/2008-4/24/2009	-3500 ± 260	13 ± 1.0	0.35, p< 0.01	1.5 ± 6.7
4/25/2008-12/6/2008	-1100 ± 280	4.3 ± 1.0	0.06, p< 0.01	1.2 ± 1.3
4/25/2009-12/6/2009	-2000 ± 490	7.4 ± 1.7	0.07, p< 0.01	1.2 ± 4.0

Partitioning coefficient significantly changed after the CFPP closure

Slide 21

TMH-t5 Why? What is the explantion? Maybe add a box below that explains?
Thomas M. Holsen - tholsen, 04-06-2014

SUMMARY

- A significant reduction of three Hg concentrations after the CFPP closure
- PMF results indicates a low contribution of three Hg forms for the CFPP factor after shutdown
- CPF results also show the low contribution from the CFPP location after shutdown
- A significant change of reactive Hg gas-particle partitioning coefficient

ACKNOWLEDGEMENTS

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- New York State Department of Environmental Conservation

REFERENCES

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  Y Wang, J Huang, PK Hopke, OV Rattigan, DC Chalupa, MJ Utell, ...
  Chemosphere 92 (4), 360-367
- Ambient mercury sources in Rochester, NY: results from principle components analysis (PCA) of mercury monitoring network data
  J Huang, HD Choi, PK Hopke, TM Holsen
  Environmental science & technology 44 (22), 8441-8445

QUESTIONS??