

Mercury Deposition in the Great Lakes Region

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What do we know about mercury deposition in the
upper Midwest?
February 22, 2006
Chicago, Illinois



Ohio Mercury Measurement and Receptor Modeling Study

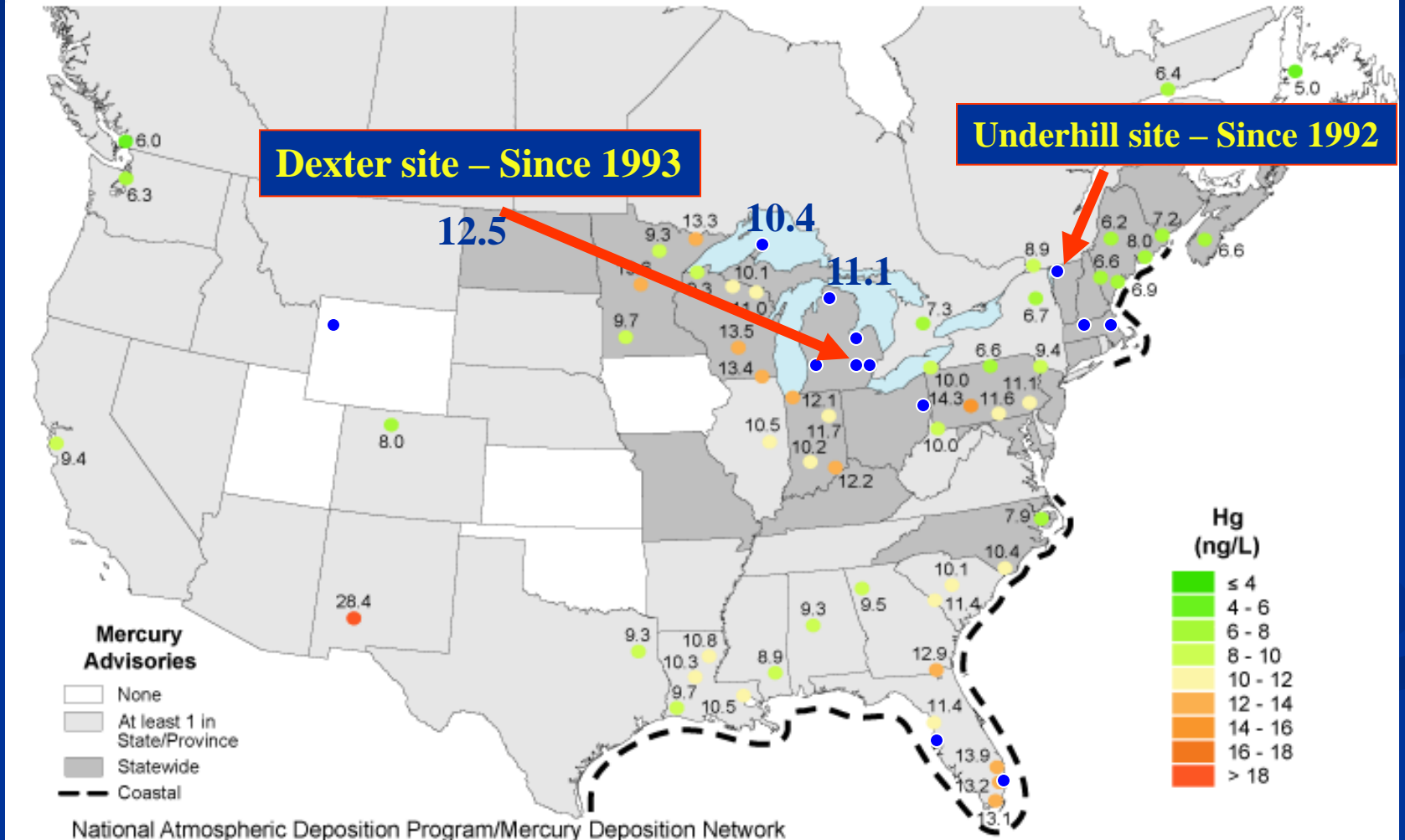
Objective

Determine the impact of local/regional coal combustion sources on Hg deposition in the Ohio River Valley



UMAQL EVENT SAMPLING SITES

Total Mercury Concentration, 2001



Ohio Mercury Study

- **Sate-of-the-art measurement & analyses**
 - Aerosols - Integrated and Continuous
 - Wet Deposition - Daily Event
 - Criteria Gases - Continuous
 - Meteorology - Continuous
- **Receptor Modeling**
 - UNMIX, and PMF
 - Hybrid Modeling (Regional Transport)



Steubenville EPA PMF

Apportionment Results 2003-2004

Analyte	Factor 1 (Iron/Steel)	Factor 2 (P Source)	Factor 3 (Coal)	Factor 4 (Crustal)	Factor 5 (Metals)	Factor 6 (Oil/Incineration)
Mg	187.14	95.11	*	539.31	29.58	*
Al	49.19	*	75.71	346.68	34.67	52.20
P	*	64.36	*	*	*	*
S	*	172.33	11187.00	363.19	*	*
Cl	257.26	*	602.59	186.41	647.79	1745.00
V	2.82	*	*	*	*	1.26
Cr	2.40	*	*	*	*	0.62
Mn	53.93	14.02	*	33.01	*	*
Fe	337.11	15.32	22.52	12.40	*	136.26
Ni	*	0.53	*	*	*	3.93
Cu	*	2.29	19.90	*	8.23	14.38
Zn	3.31	4.20	*	*	13.78	44.79
As	*	0.04	0.70	0.09	0.27	0.60
Se	*	*	2.39	*	1.25	0.26
Rb	*	0.26	0.23	0.14	0.08	0.20
Sr	0.51	1.53	1.77	5.54	*	2.19
Mo	*	*	*	*	3.60	*
Cd	0.09	*	0.33	*	0.25	0.25
La	*	*	*	0.61	0.01	0.07
Ce	0.02	*	*	1.19	*	*
Hg	0.011	0.003	0.136	*	*	*
Pb	0.91	*	3.83	*	*	6.26
NO ₃	*	216.00	5993.80	1325.70	*	5296.70
% Hg	4 ± 3	2 ± 1	67 ± 14	*	*	*

* = Not Significant at 95% confidence interval

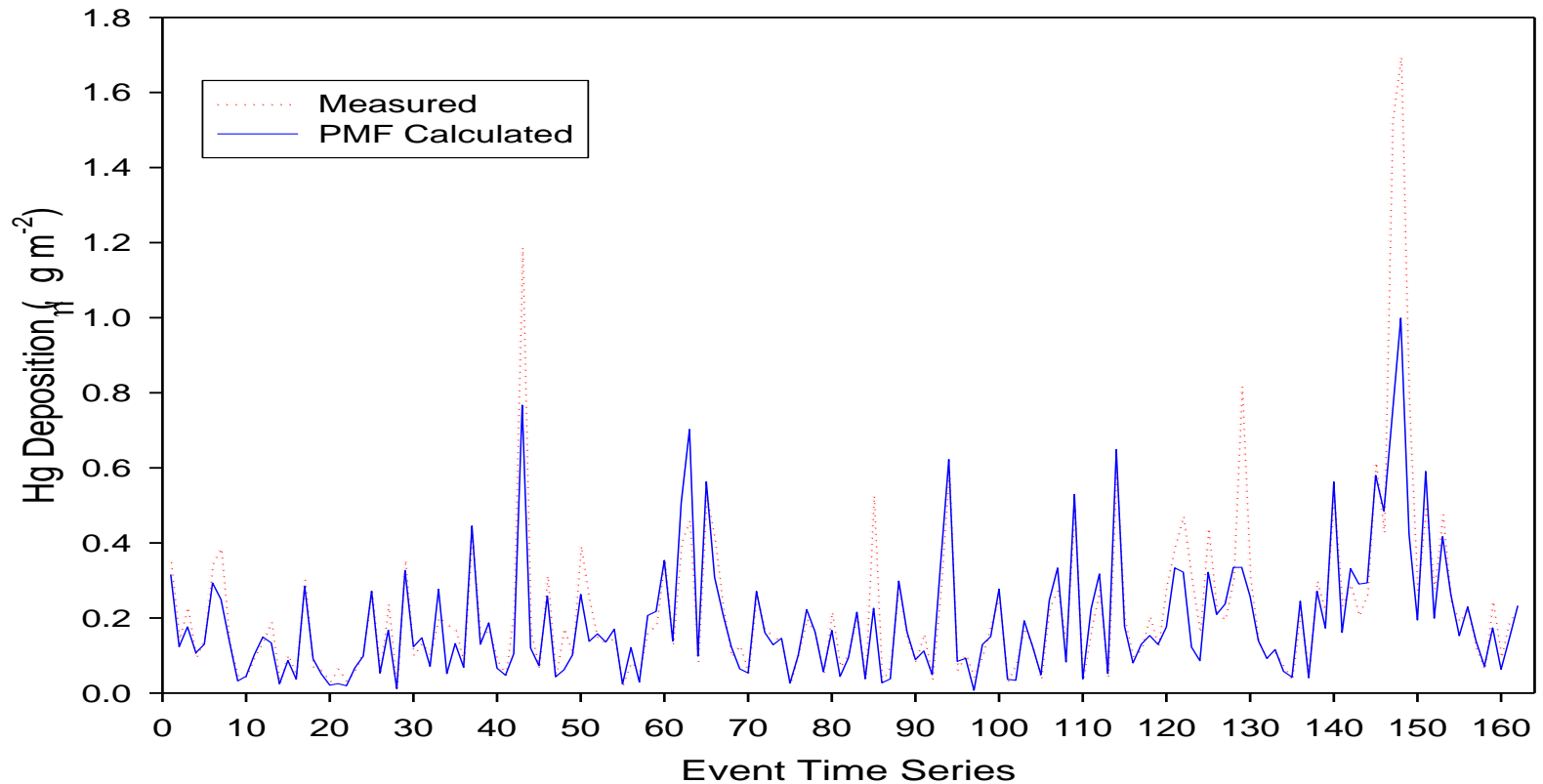
Source Apportionment Results Steubenville, Ohio

	Measured	PMF Estimated CFUB* Contribution	UNMIX Estimated CFUB* Contribution
2003	13.2	Mean = 9.5 (5-95% CI ^Ω) = (7.2 – 15.8)	Mean = 9.9 (5-95% CI ^Ω) = (4.9 – 14.9)
2004	19.8	Mean = 12.0 (5-95% CI ^Ω) = (9.0 – 19.8)	Mean = 15.4 (5-95% CI ^Ω) = (7.7 – 23.1)

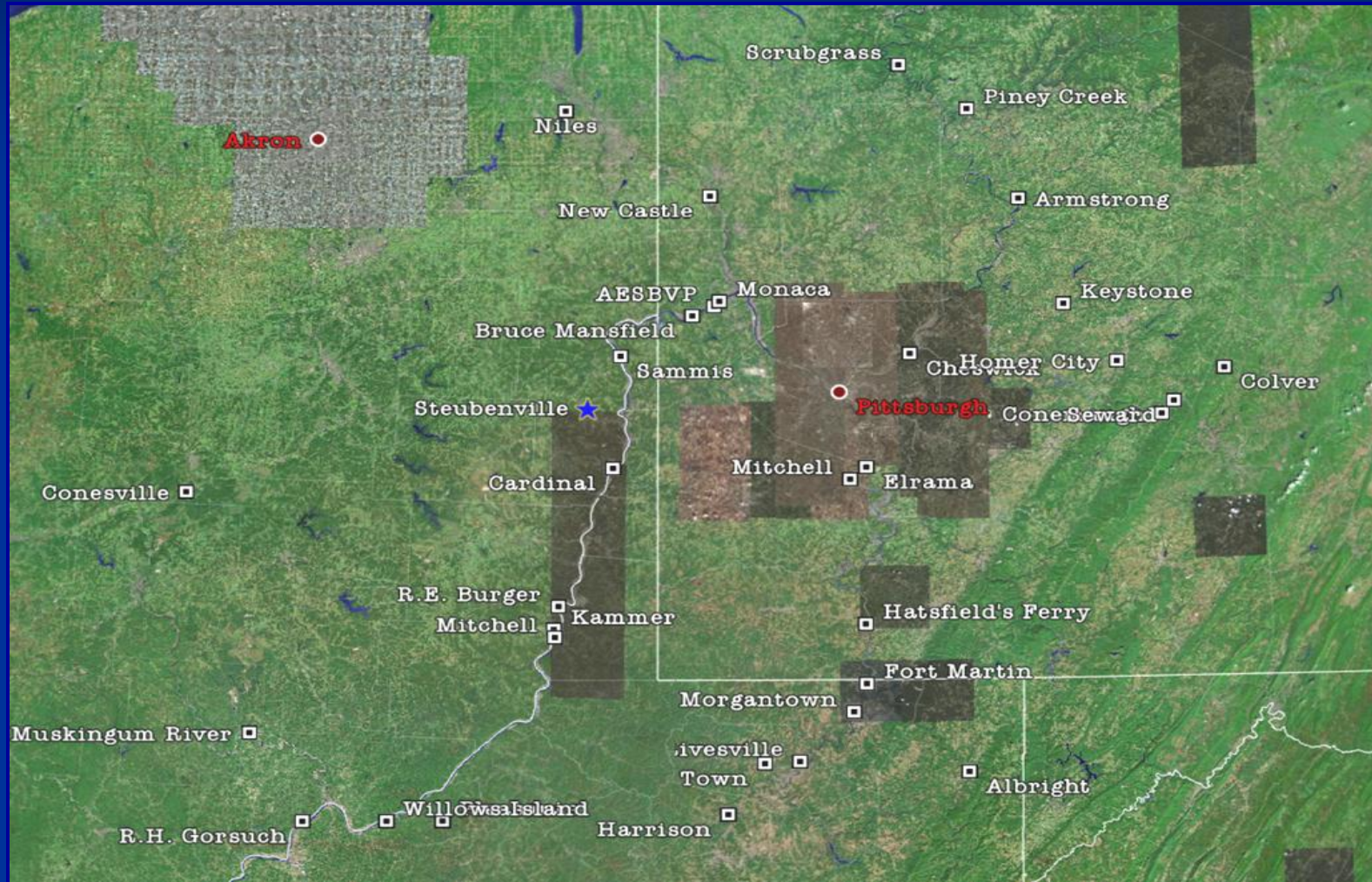
*Coal-fired Utility Boiler

^Ω Confidence Interval

Estimated versus Measured Mercury Deposition



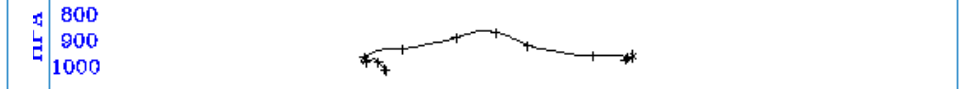
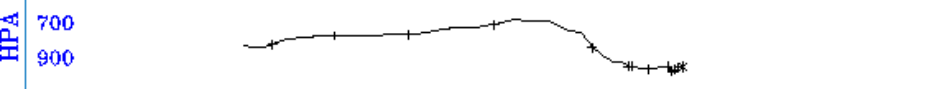
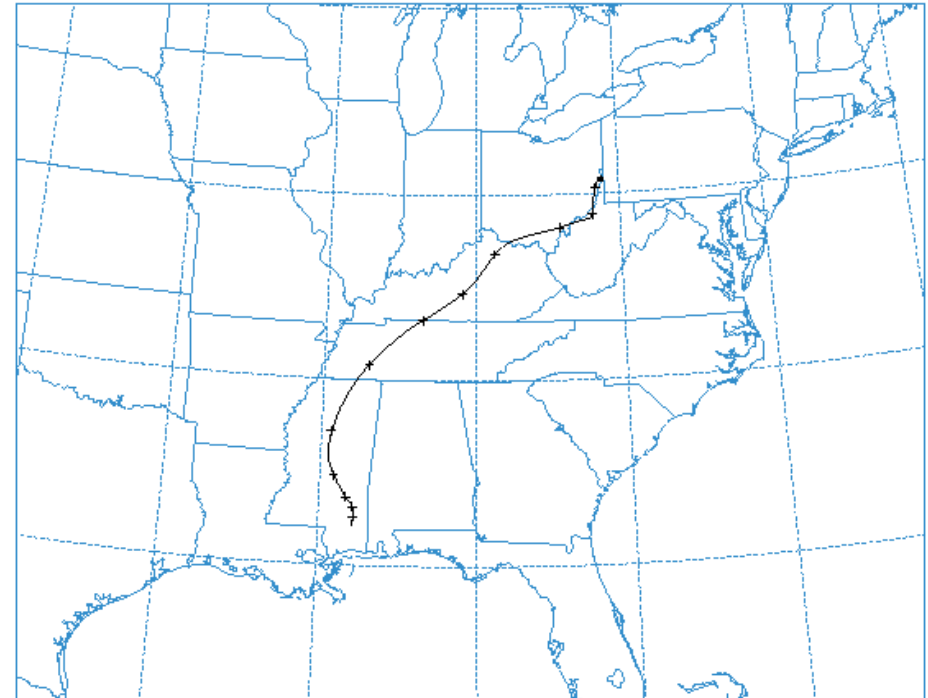
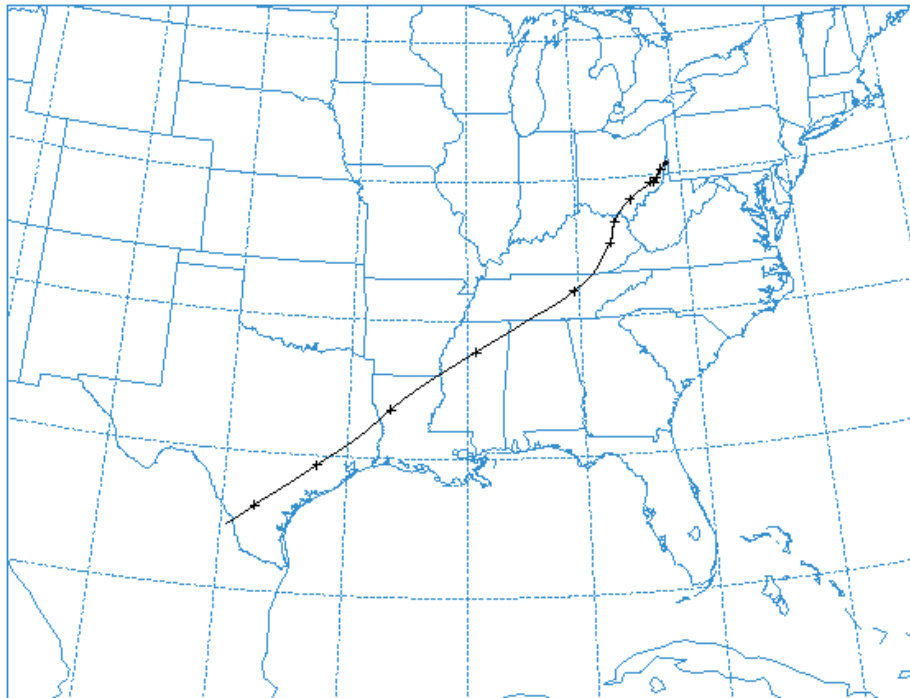
Steubenville Site



HY-SPLIT Back Trajectories

U OF M AIR QUALITY LABORATORY
BACKWARD ENDING - 08Z 08 MAY 3 (UTC)
EDAS METEOROLOGICAL DATA

U OF M AIR QUALITY LABORATORY
BACKWARD ENDING - 03Z 29 AUG 4 (UTC)
EDAS METEOROLOGICAL DATA



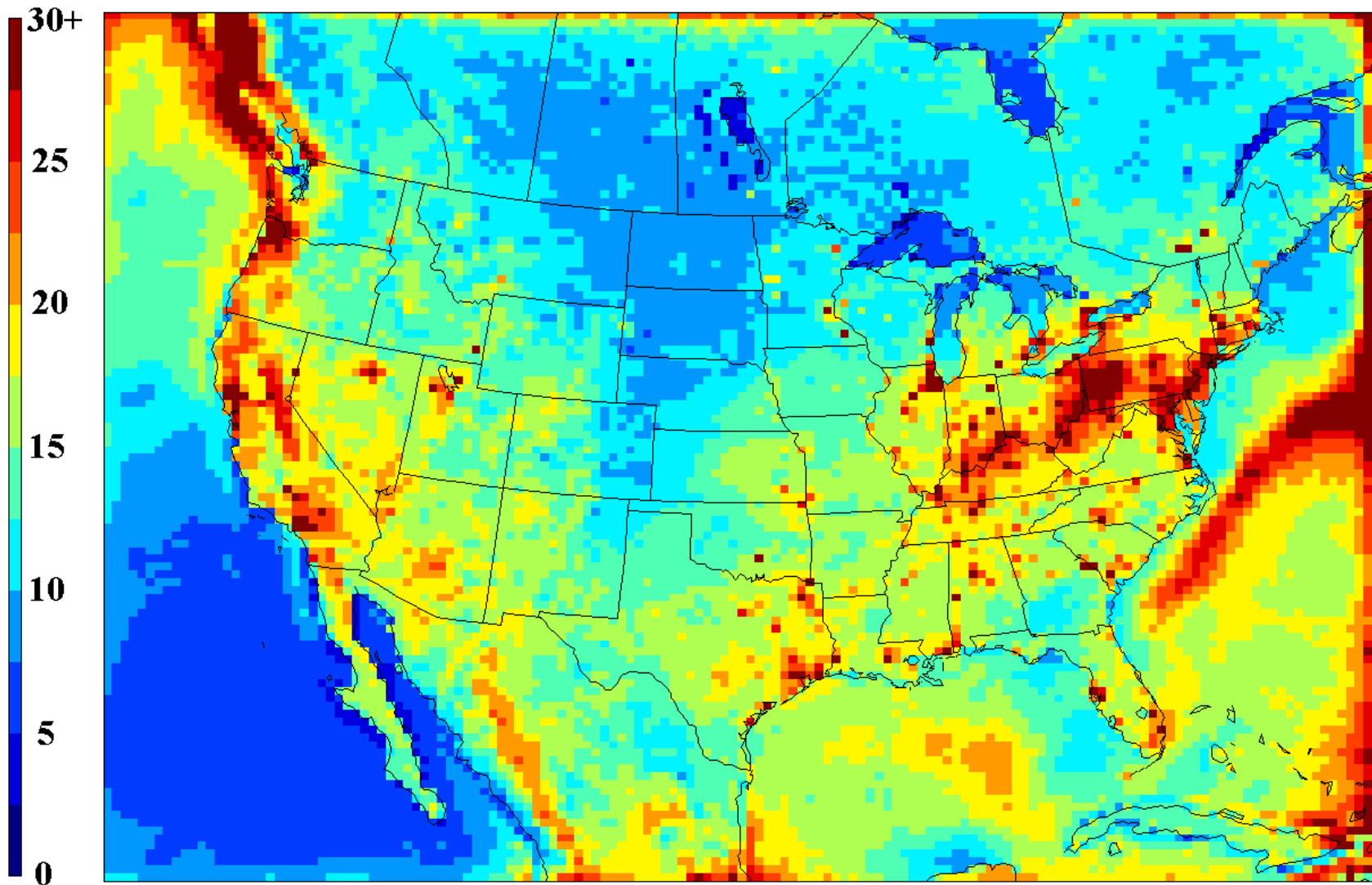
VERTICAL MOTION METHOD - OMEGA

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Summary of Ohio Receptor Modeling 2003-2004

- **Hg wet deposition at Steubenville**
 - ~ 80% attributable to local/regional anthropogenic sources
 - ~ 70% is attributable to coal combustion
 - ~ 20% from reemission/global background
- **A significant portion of total Hg wet deposition is driven by a few local coal combustion dominated precipitation events**
 - In 2004, >8% of Hg wet deposition occurred during 1 event
- **Hybrid-receptor Modeling results being completed.**

CMAQ-simulated total mercury deposition for 2001 (micrograms per square meter)



Base case

Comparison of CMAQ Model Results to Measured Mercury Wet Deposition at Steubenville

	Hg Deposition ($\mu\text{g m}^{-2}$)	CFUB Contribution (%)
CMAQ 2001	13.6	43
PMF & UNMIX 2003 & 2004	15.6	~70

CMAQ Simulations performed by CSC for EPA (6FEB04)