

# Atmospheric Mercury Deposition Modeling in the Northeast

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Northeast Regional Mercury Science & Policy Conference

April 26, 2006

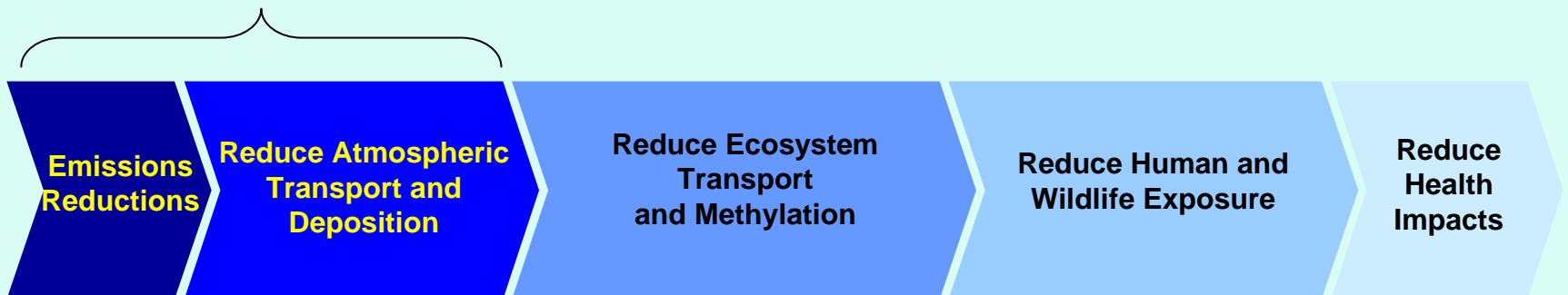
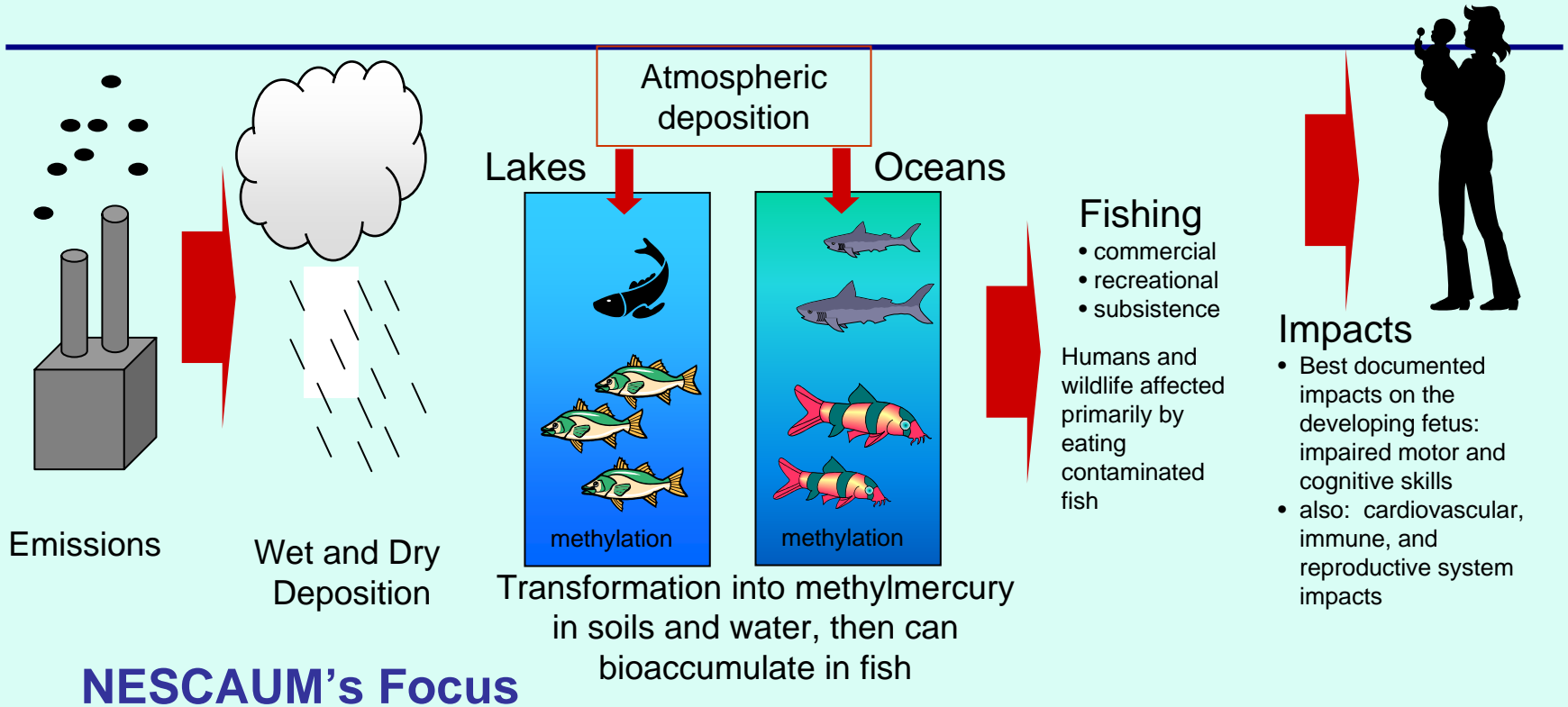
Newport, RI

# Overview

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- Introduction to Mercury
- NESCAUM's Work:
  - 2002 Emission Inventory (EI) Development
    - Track Progress
    - Model input
  - Modeling of 1996 and 2002 EI
    - Rationale:
      - Update old modeling
      - Demonstrate impact of emission reductions through tags
      - Provide input for other model applications
    - Results:
      - Model Performance Evaluation
      - Interpretation

# The Mercury Cycle



# Mercury Policy Context in the Northeast

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- 1998 New England Governors/Eastern Canadian Premiers' Regional Mercury Action Plan (MAP)
  - 50% reduction by 2003
  - 75% reduction by 2010
  - Virtual elimination of anthropogenic discharges of mercury is long-term goal

# MAP MWC/MWI

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- Objective: By 2003, reduce overall amount of Hg emitted in the region through combination of source reduction, waste segregation and emission controls
- Recommendation MWC: Adopt 0.028 mg/dscm emission limit, perform annual emission testing
- Recommendation MWI: Adopt 0.055 mg/dscm (evaluate if 0.028 limit feasible), perform annual emission testing
- Result:: Emissions in Northeast from MWC reduced by 86% between 1998 and 2002, achievable emission rate < 0.028. Emissions from MWI reduced 98%, primarily through facility closure prompted by tightened emission limits



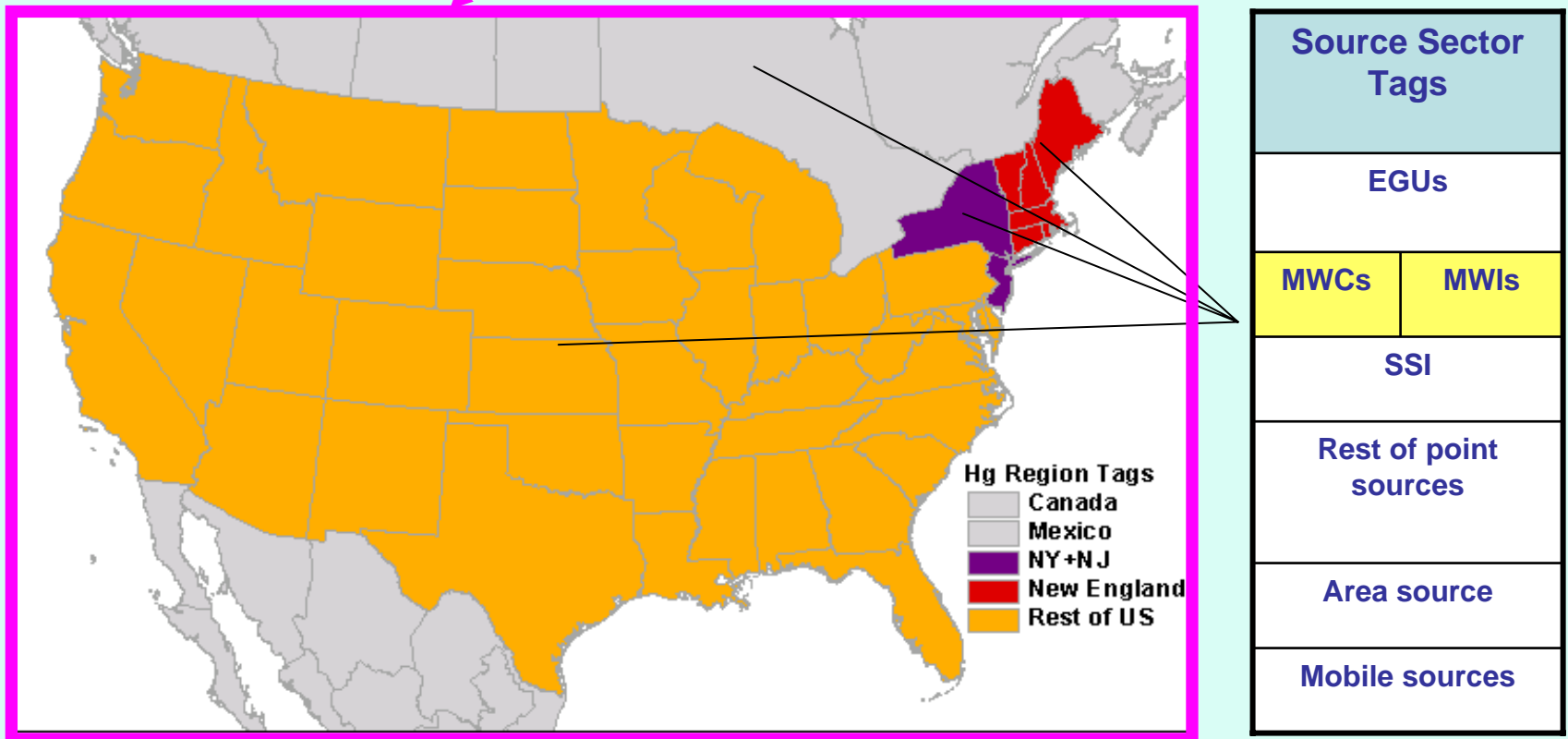
# Regional Modeling System for Aerosols and Deposition (REMSAD)

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- Eulerian Grid Model
  - Includes atmospheric transport and chemistry
  - 36 km grid size; 12 vertical layers
  - Boundary conditions from Global Hg model (GEOS-CHEM)
- “tagging”
  - Allows tracking of emissions through space and time; can choose individual source, source type, source region

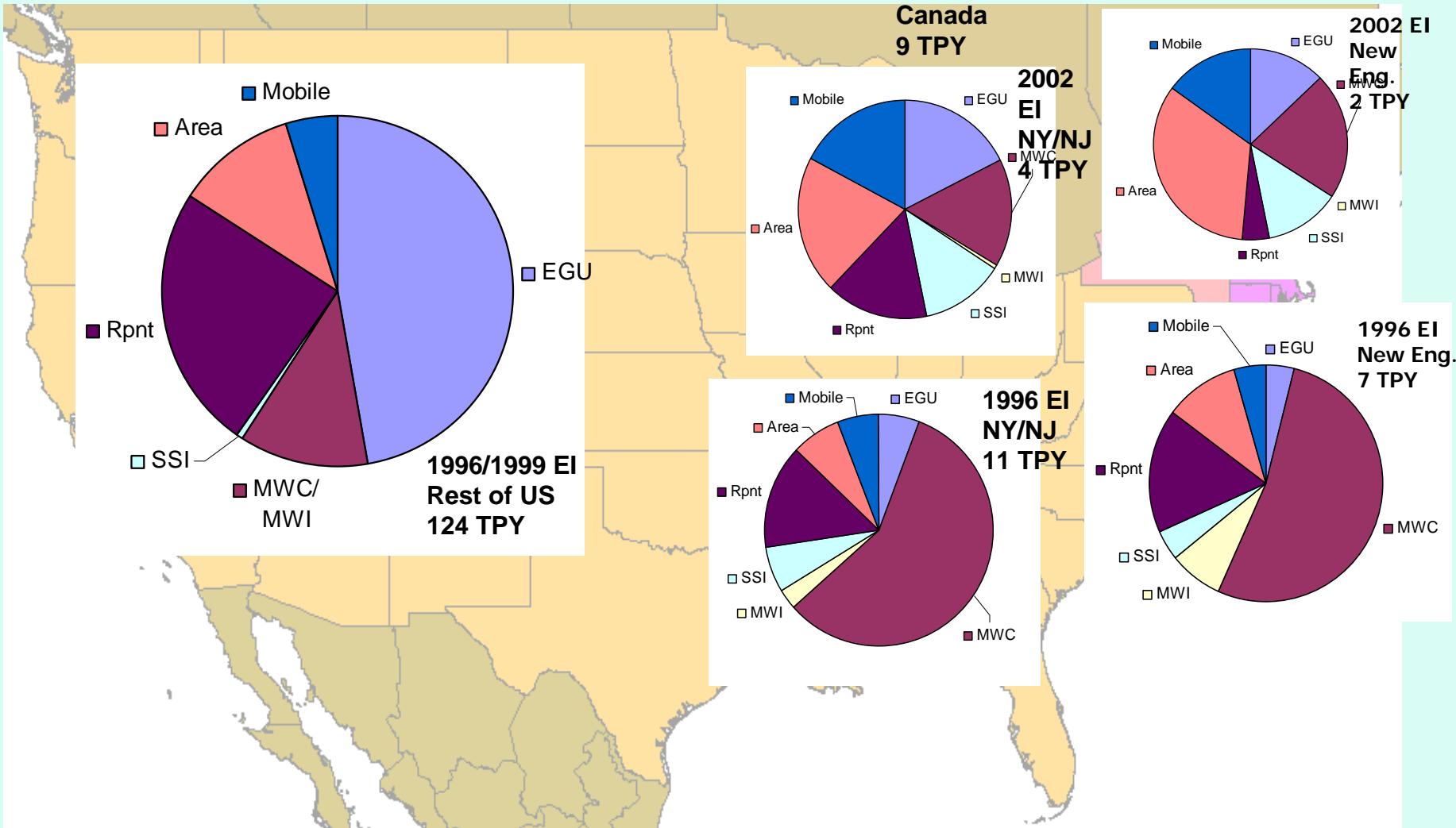
# Modeling Design

The boundary conditions are tagged, too



- Note : 1. New England + NY/NJ 2. All Canadian point sources are treated as one tag  
3. Mobile sources = On-road + Non-road

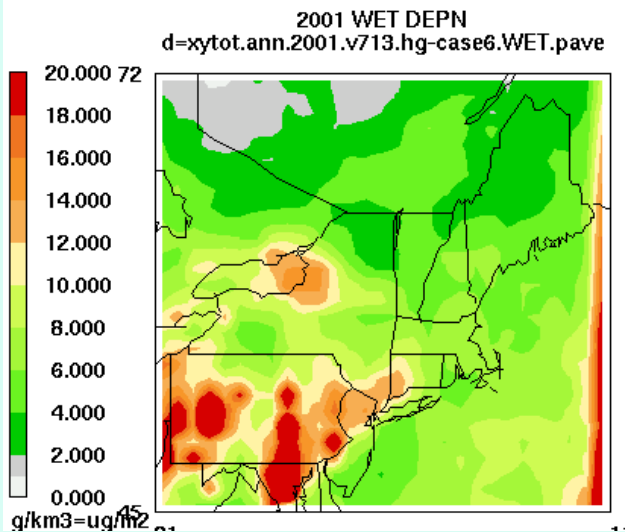
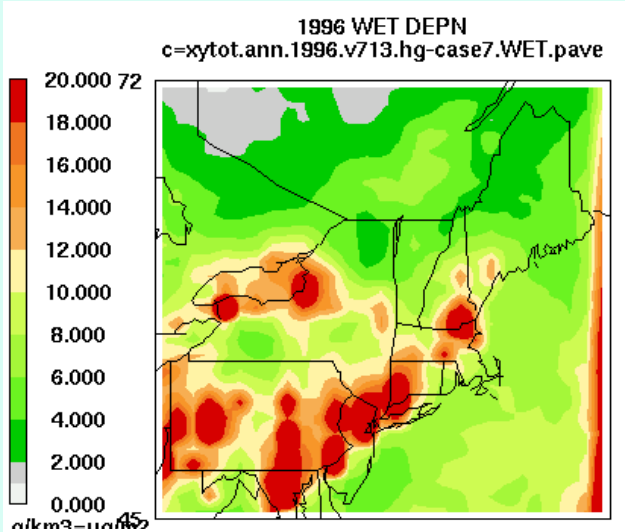
# Emissions - by Tags



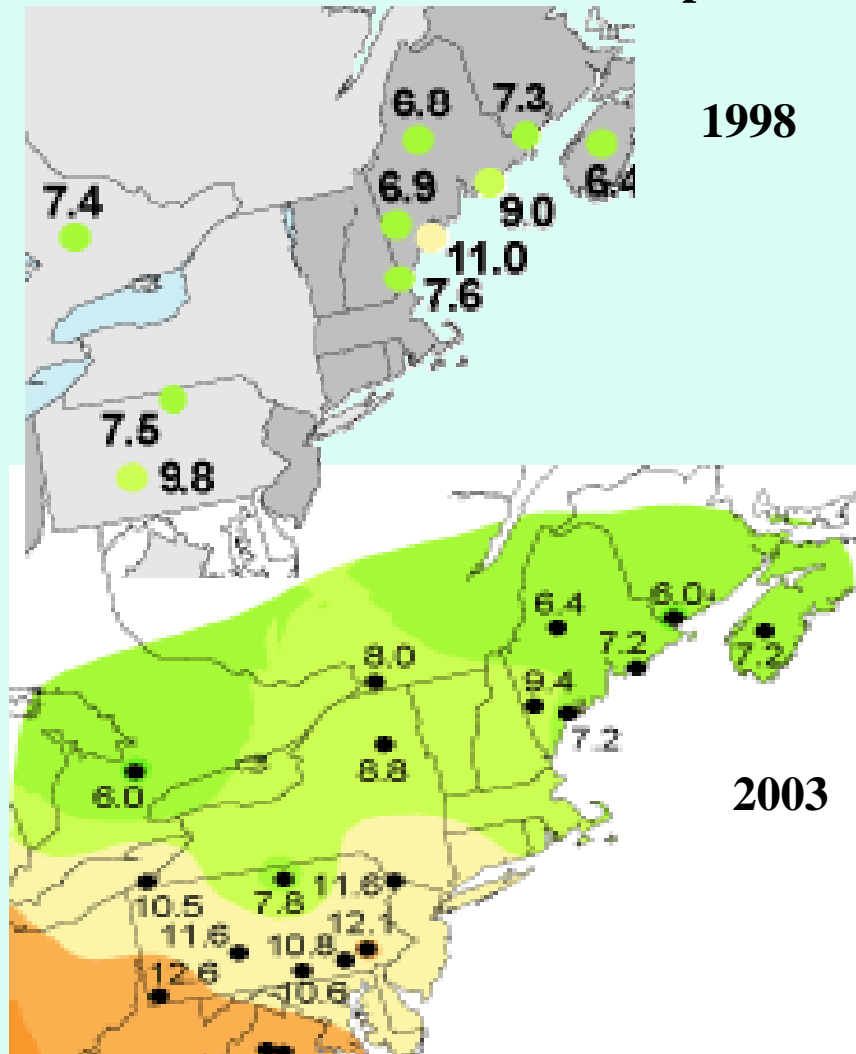
# MODEL vs. MONITOR

## Performance Test

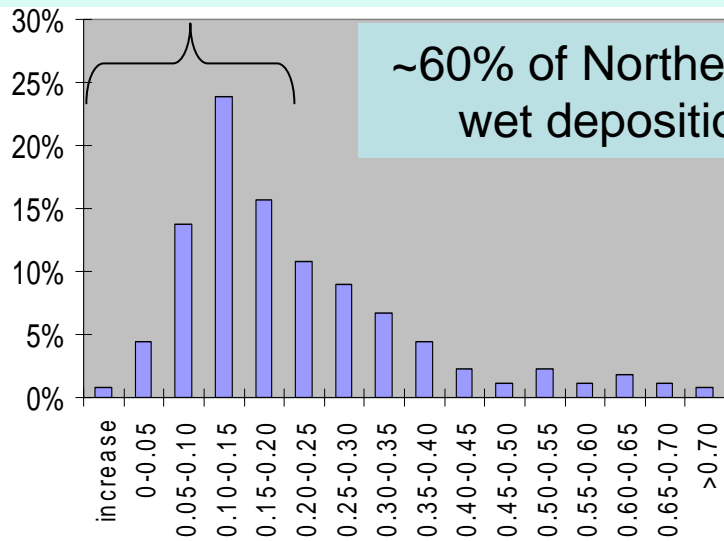
### REMSAD RUN



### MDN Monitored Deposition

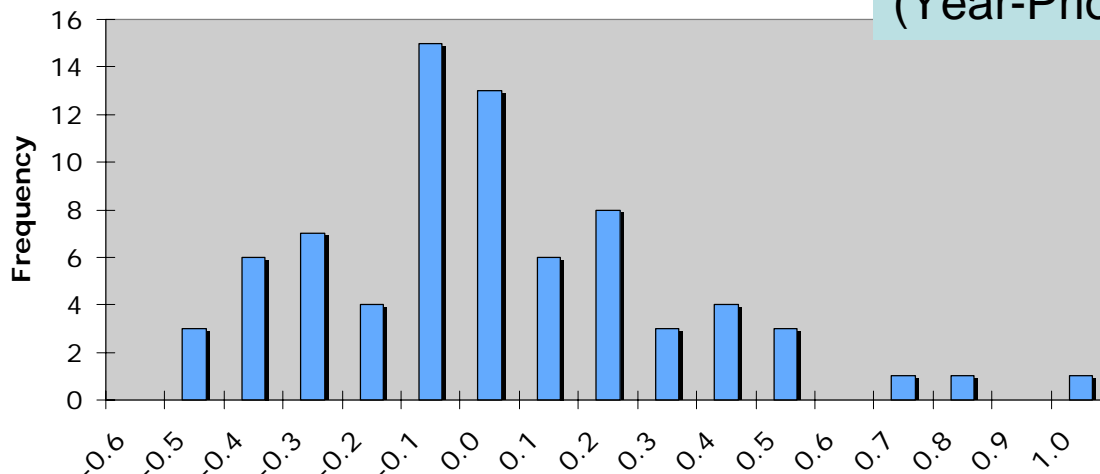


# Percent Change in Modeled Wet Deposition & Monitored Year to Year Change



X-axis = Range of decrease (1996-2002) / 1996;  
Y-axis = % of cells in NESCAUM Region

Monitored Percent Change year to year for 16 sites in northeast.  
Calculated as:  
 $(\text{Year} - \text{PriorYear}) / \text{PriorYear}$



**Implication:** Year to year changes due to differences in meteorology are of the same order or greater than predicted model changes in locations of monitors, which masks the impact of emission reductions.

# Average Total Deposition to NESCAUM States

		Wet + Dry Deposition ( $\mu\text{g}/\text{m}^2$ )		Percent Change
		1996	2002	
NESCAUM Sources	EGU	0.19	0.19	0%
	MWC*	5.49	0.59	89%
	MWI	0.83	0.01	99%
	SSI	0.78	0.49	37%
	ROPs	1.02	0.14	86%
	Area	0.48	0.48	0%
	Mobile	0.11	0.11	0%
<i>NESCAUM TOTAL</i>		8.89	2.01	77%
Rest of the US Sources	EGU	1.77	1.77	0%
	MWC/MWI	0.59	0.59	0%
	SSI	0.05	0.05	0%
	ROPs	0.35	0.35	0%
	Area	0.11	0.11	0%
	Mobile	0.03	0.03	0%
<i>Rest of the US Total</i>		2.89	2.89	0%
<i>Total Non-US Sources</i>		6.94	6.94	0%
<b>Grand Total</b>		18.73	11.82	37%

Modeling Inventories were static for sources outside of NESCAUM.

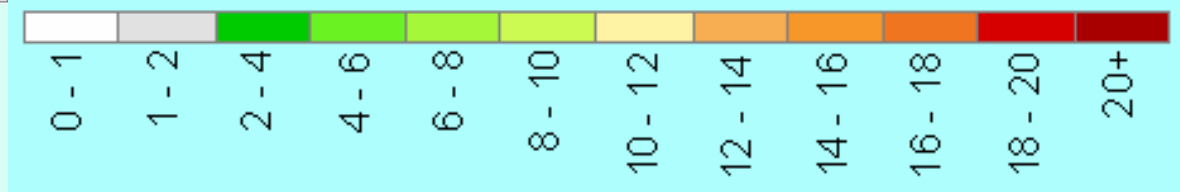
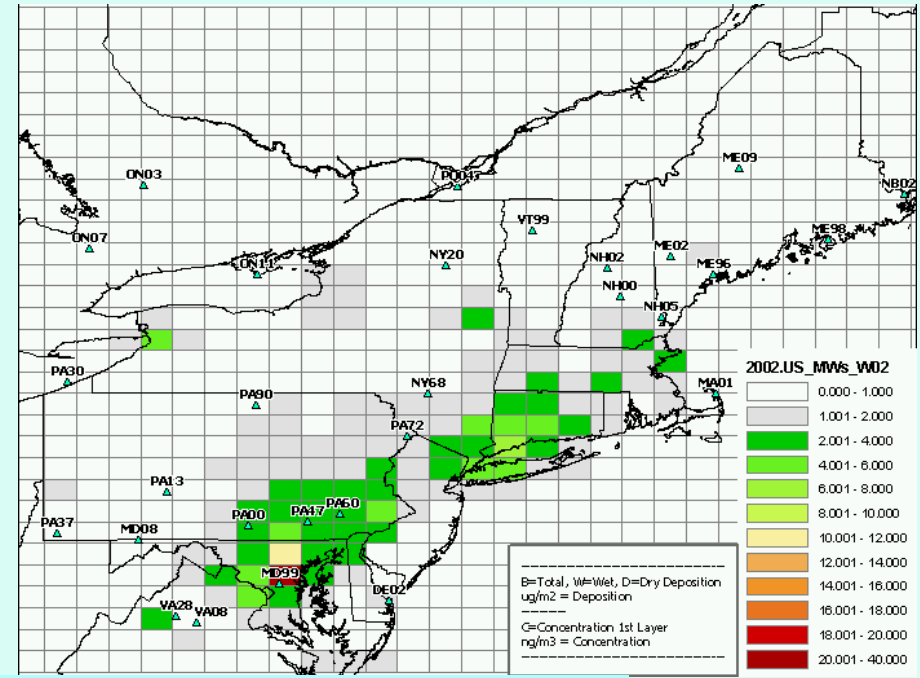
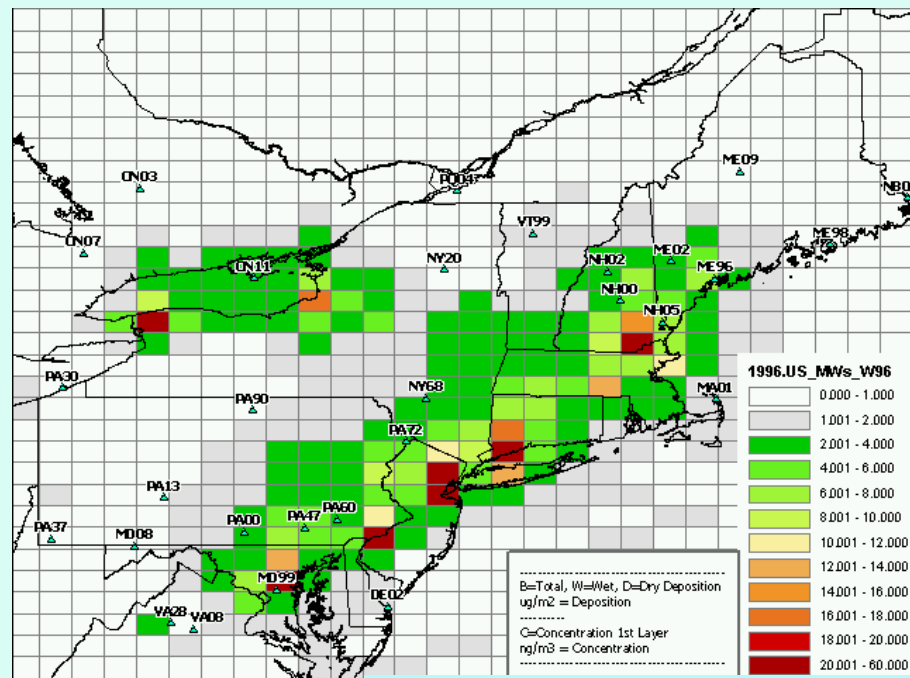
Reductions modeled in the NESCAUM region are due directly to emissions reductions within NESCAUM states.

\*MWC inventories for New Jersey reflect pre-controlled levels in the early 1990s.

# Example Tagged Results

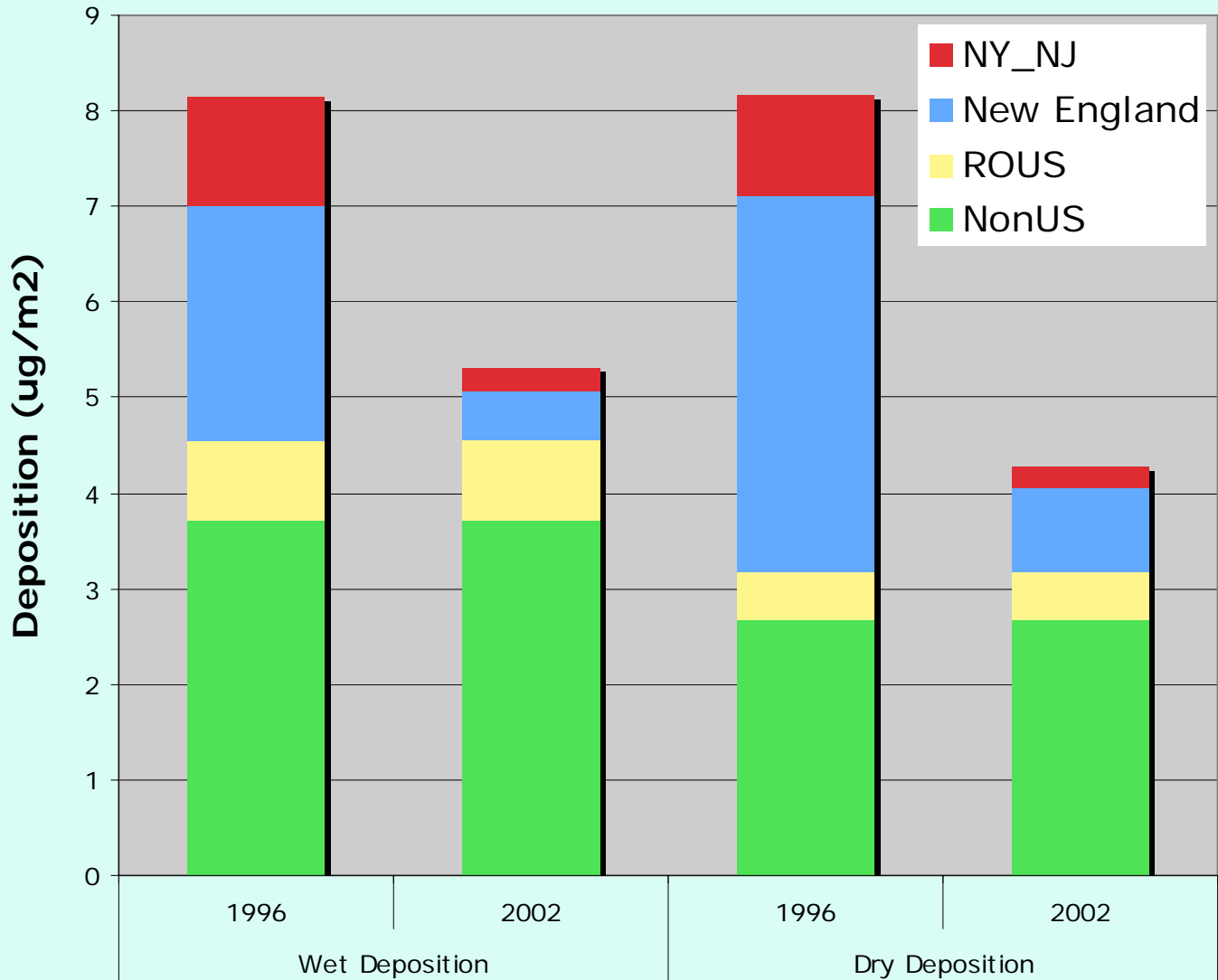
1996 MWC + MWI Wet Deposition ( $\mu\text{g}/\text{m}^2$ )  
from NESCAUM Sources

2002 MWC + MWI Wet Deposition ( $\mu\text{g}/\text{m}^2$ )  
from NESCAUM Sources

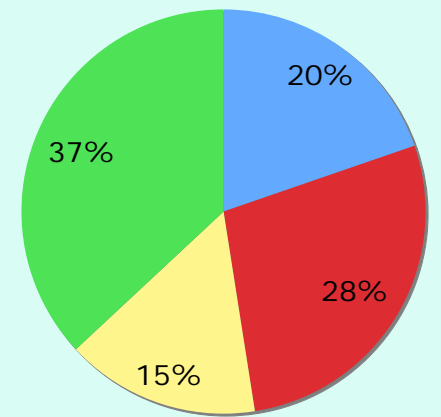


Note the substantial modeled reductions in **local** deposition due to **local** controls

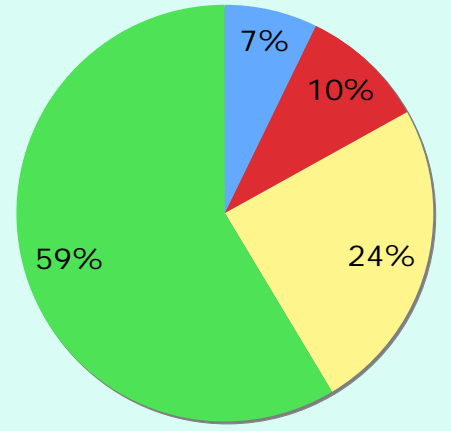
# Average Deposition Results to NESCAUM States



Total Deposition



1996



2002

# Contribution Assessment

	1996	Total Mercury Deposition 2002					
	Deposition to NESCAUM	to NESCAUM	to NY/NJ	to New England	to NY	to MA	to ME
Average ( $\mu\text{g}/\text{m}^2$ )							
In Region Sources	8.89	2.01	2.17	1.86	1.86	4.47	0.52
Other US Sources	2.89	2.89	4.71	1.32	4.02	2.07	0.67
Non-US Sources	6.94	6.94	7.62	6.35	7.50	7.40	5.85
Total	18.72	11.83	14.50	9.53	13.38	13.94	7.04
Percent Contribution							
In Region Sources	47%	17%	15%	20%	14%	32%	7%
Other US Sources	15%	24%	32%	14%	30%	15%	10%
Non-US Sources	37%	59%	53%	67%	56%	53%	83%

- Substantial modeled deposition reduction due to local controls
- Large spatial variation in deposition and source contributions
- Results can be tabulated for wide range of receptor regions and source types/source regions

# Major Findings

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- Local emissions reductions result in local deposition reductions
- Year to year meteorological differences may mask expected deposition changes
- Model predicts lowest deposition changes in areas where MDN sites are located
- Impact of sources *external* to NESCAUM will grow as local measures take effect

# Acknowledgements

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- Thanks to
  - EPA New England Office (Jeri Weiss)
  - MA DEP (Mark Smith)
    - for funding to support this work
  - Research colleagues Emily Savelli & Jung-Hun Woo

# Future Work

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- Refined modeling at 12 km scale
- Updated emission inventory (2004) and corresponding meteorology
- Tagging emissions by mercury species to assess modeled transport behavior
- Include representation of emission from surface