



MANE-VU

Mid-Atlantic/Northeast
Visibility Union



**Tools and Techniques for Identifying
Contributions to Regional Haze in the
MANE-VU Region**

**MANE-VU Board Meeting
May 5, 2005
Gary Kleiman, NESCAUM**

Contribution Assessment and Long-term Strategy

- Long-term strategy requires a “pollution apportionment”
- Long-term strategy also requires an emissions management plan (i.e. control strategies) and BART determinations



What tools and techniques has MANE-VU developed to improve our understanding of attribution?

- MANE-VU is building a **weight of evidence** approach looking at monitoring data, emissions inventory data, regional air-quality modeling and key data analysis findings
- All these techniques have been synthesized and interpreted in an interim “**contribution assessment**” or pollution apportionment report



Lye Brook Falls
Lye Brook
Vermont

Conceptual Model

- Summertime PM results largely from the regional transport/production of sulfate
- Wintertime PM results from the regional transport/production of sulfate + local sulfate + local organics + local nitrate
- Worst twenty percent days are mostly summer, but include several winter days as well

Woodcock
Moosehorn
Maine



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March 15, 2004

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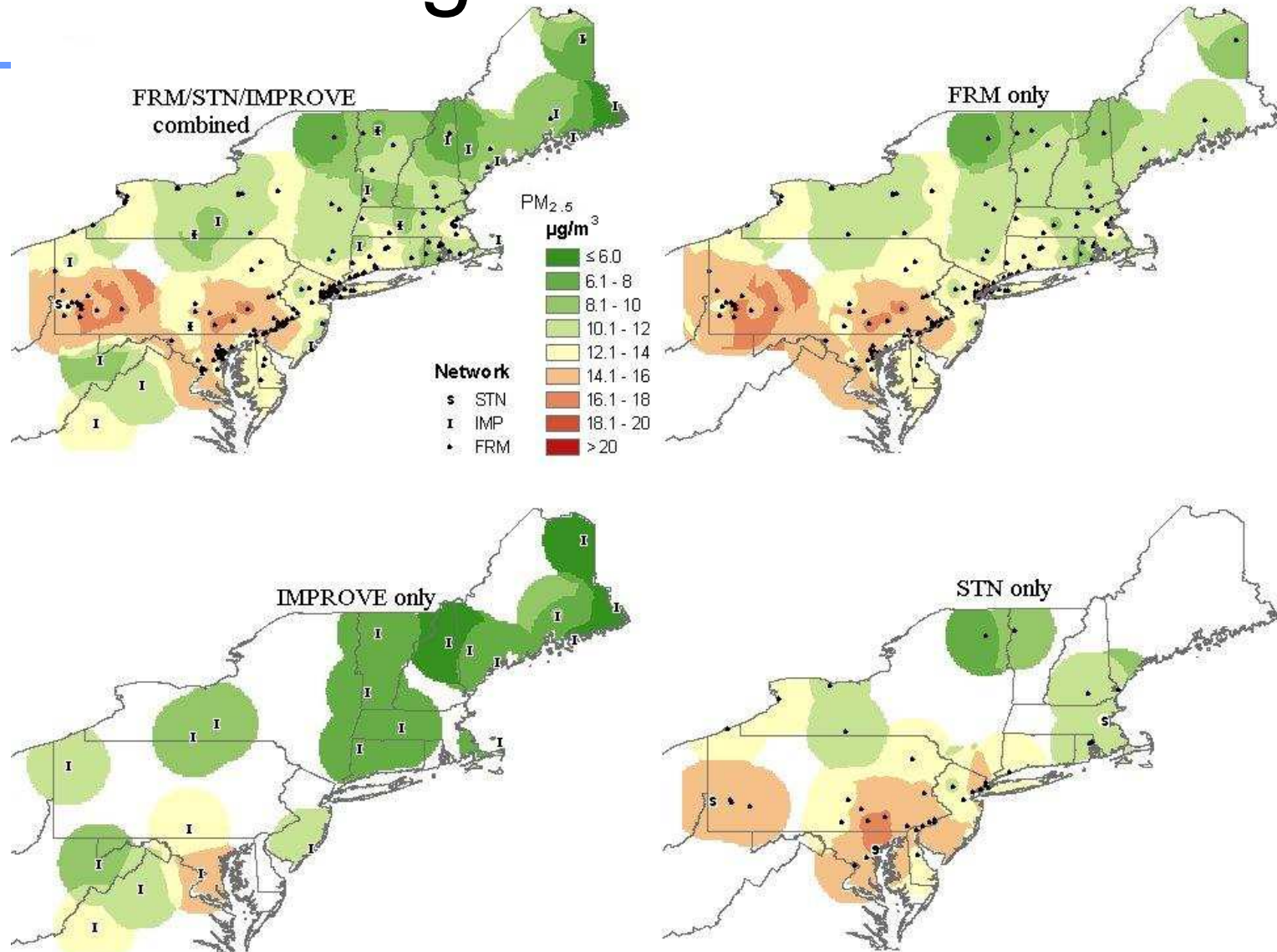
Monitoring

- Review 2002 monitoring data
- Demonstrate how these data support the conceptual model
- Review Baseline Conditions
- Illustrate implications for control strategies
- Review RAIN and how M-V is preparing for long-term demands of monitoring strategy

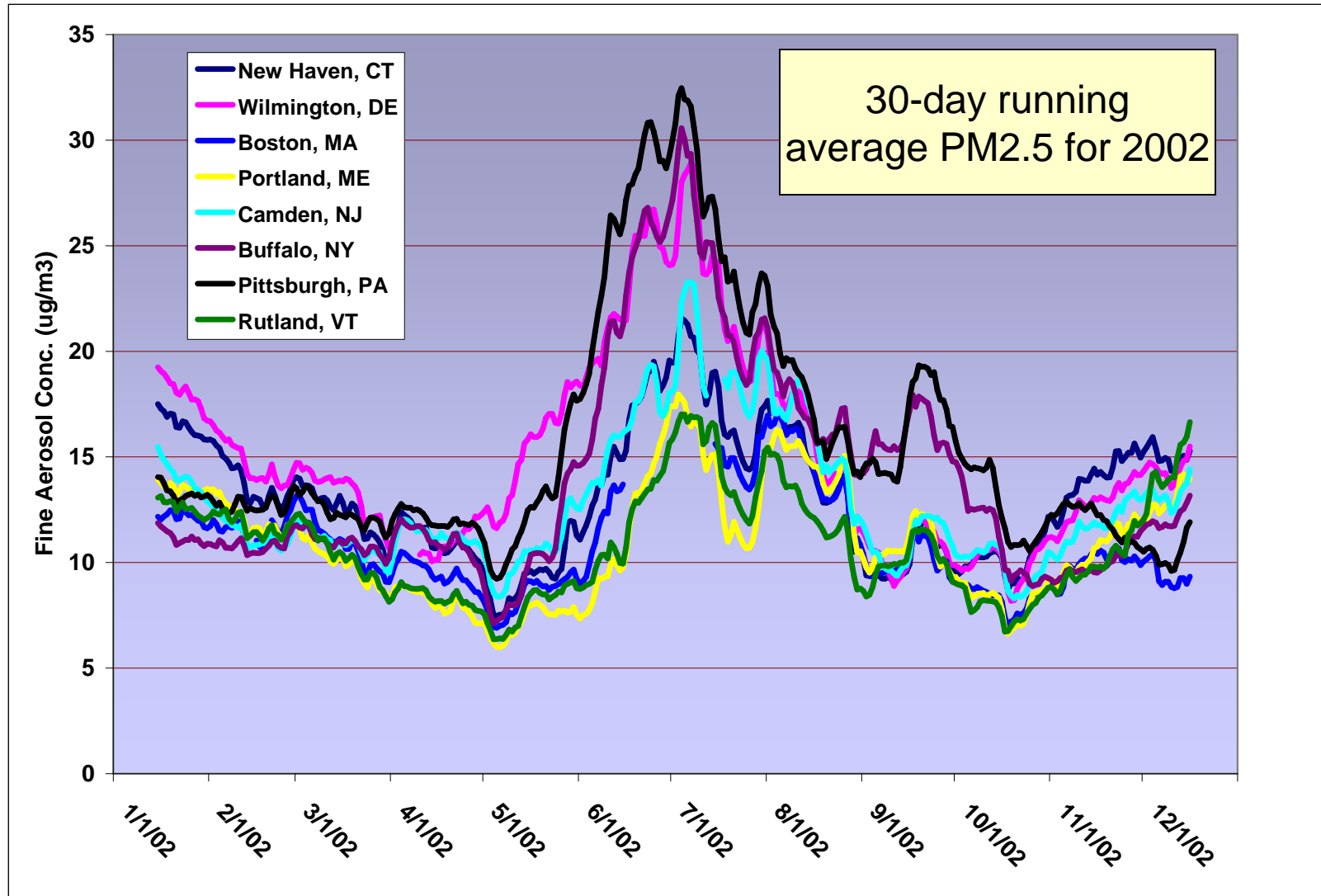


Mulholland Point Lighthouse
Roosevelt Campobello
Maine

Monitoring Data: Rural/Urban



Monitoring Data: Seasonality

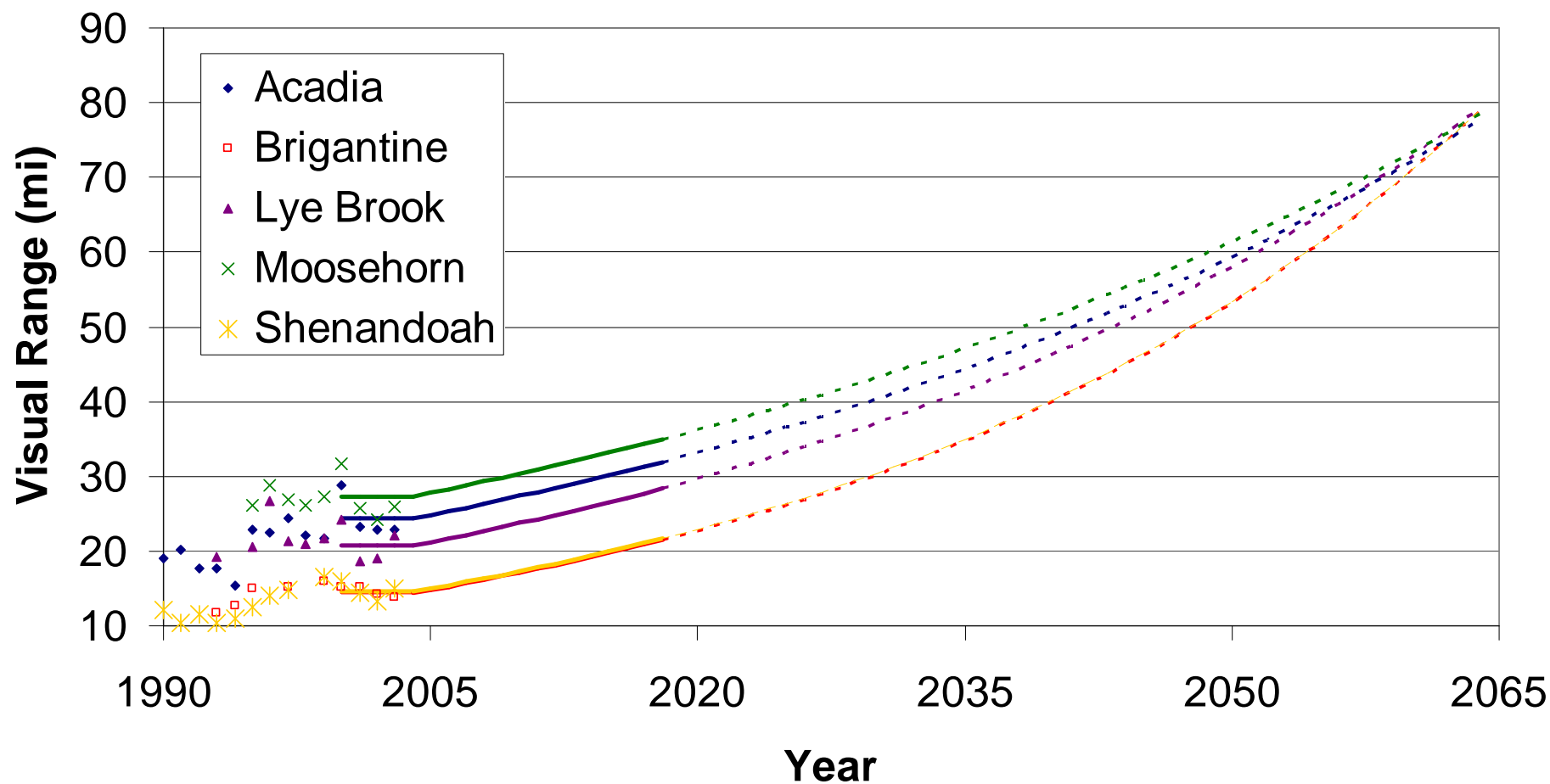


Monitoring Data: Baseline Conditions/Uniform Progress

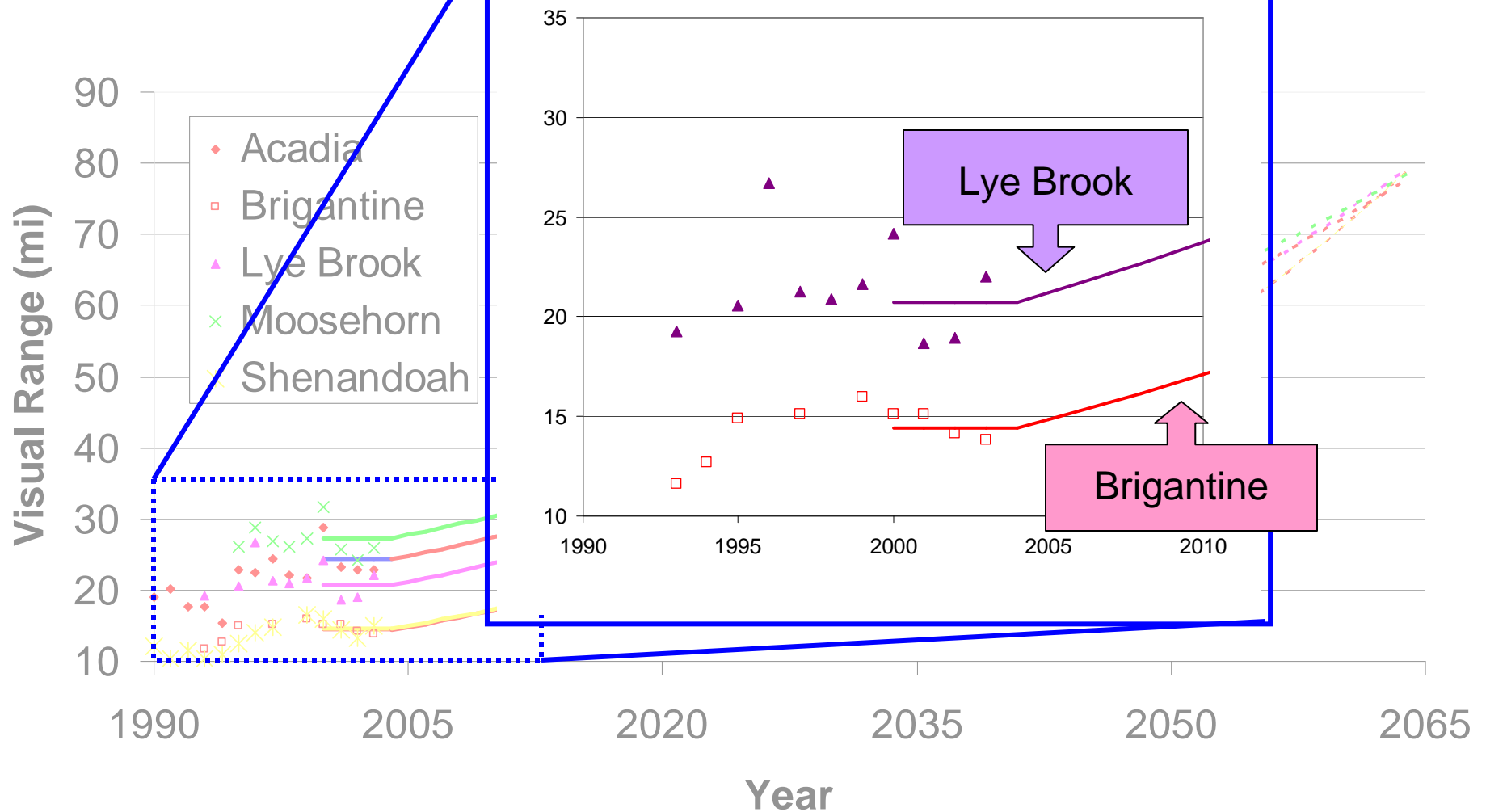
Natural Background and Baseline calculations for Select Class I areas				
Site^[1]	Natural Background (DV)	Baseline 2000-03 (DV)	Uniform Rate (DV/year)	Interim Progress Goal 2018 (DV)
Acadia	11.45	23.06	0.19	20.35
Brigantine	11.28	28.30	0.28	24.33
Lye Brook	11.25	24.67	0.22	21.54
Moosehorn	11.36	21.91	0.18	19.45
Shenandoah	11.27	28.19	0.28	24.24

^[1] The MANE-VU Class I monitoring site, Great Gulf, is not tabulated since only 2001-2003 data are available.

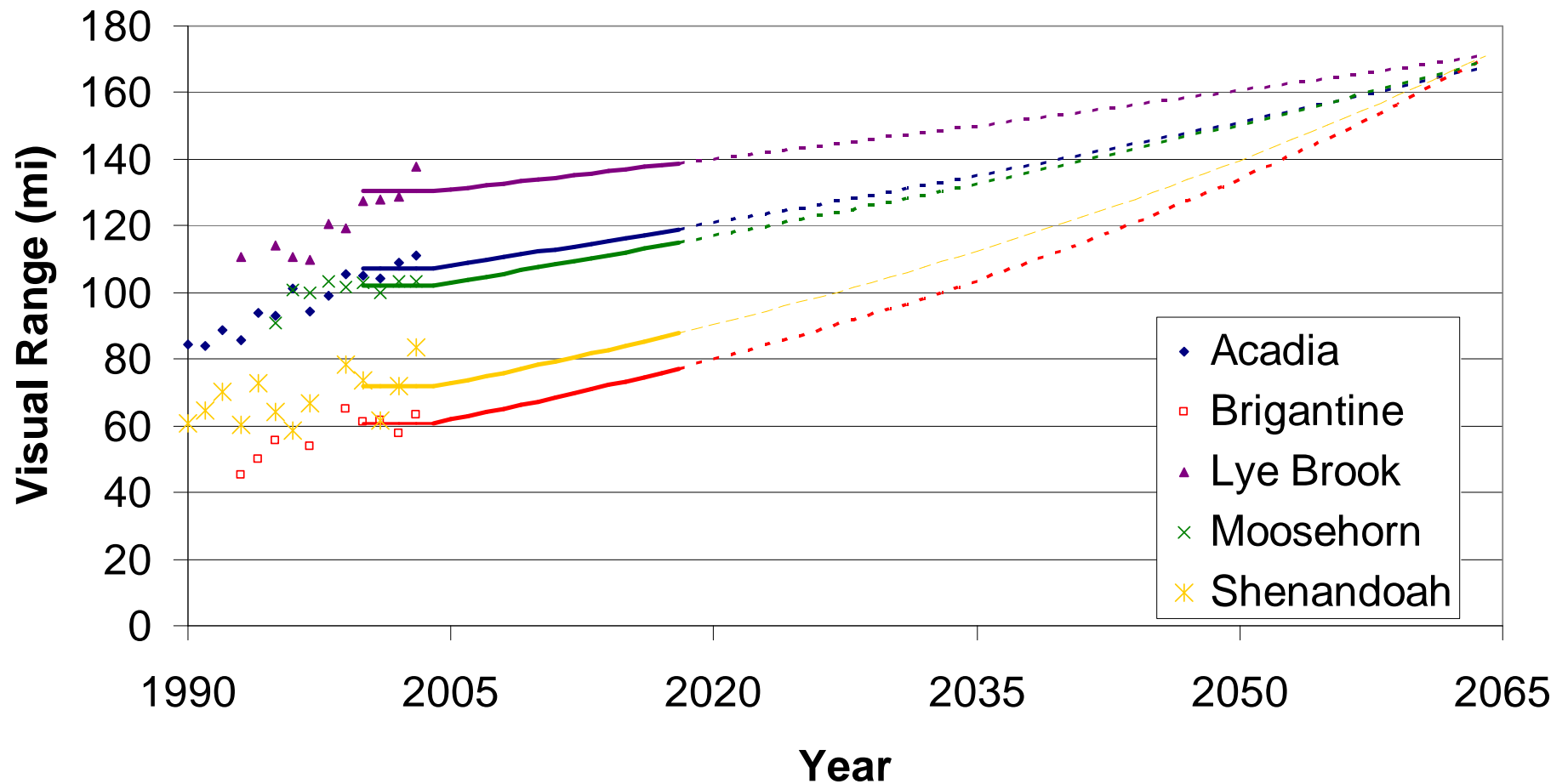
Preliminary Uniform Progress Goals (20% Worst Visibility Days)



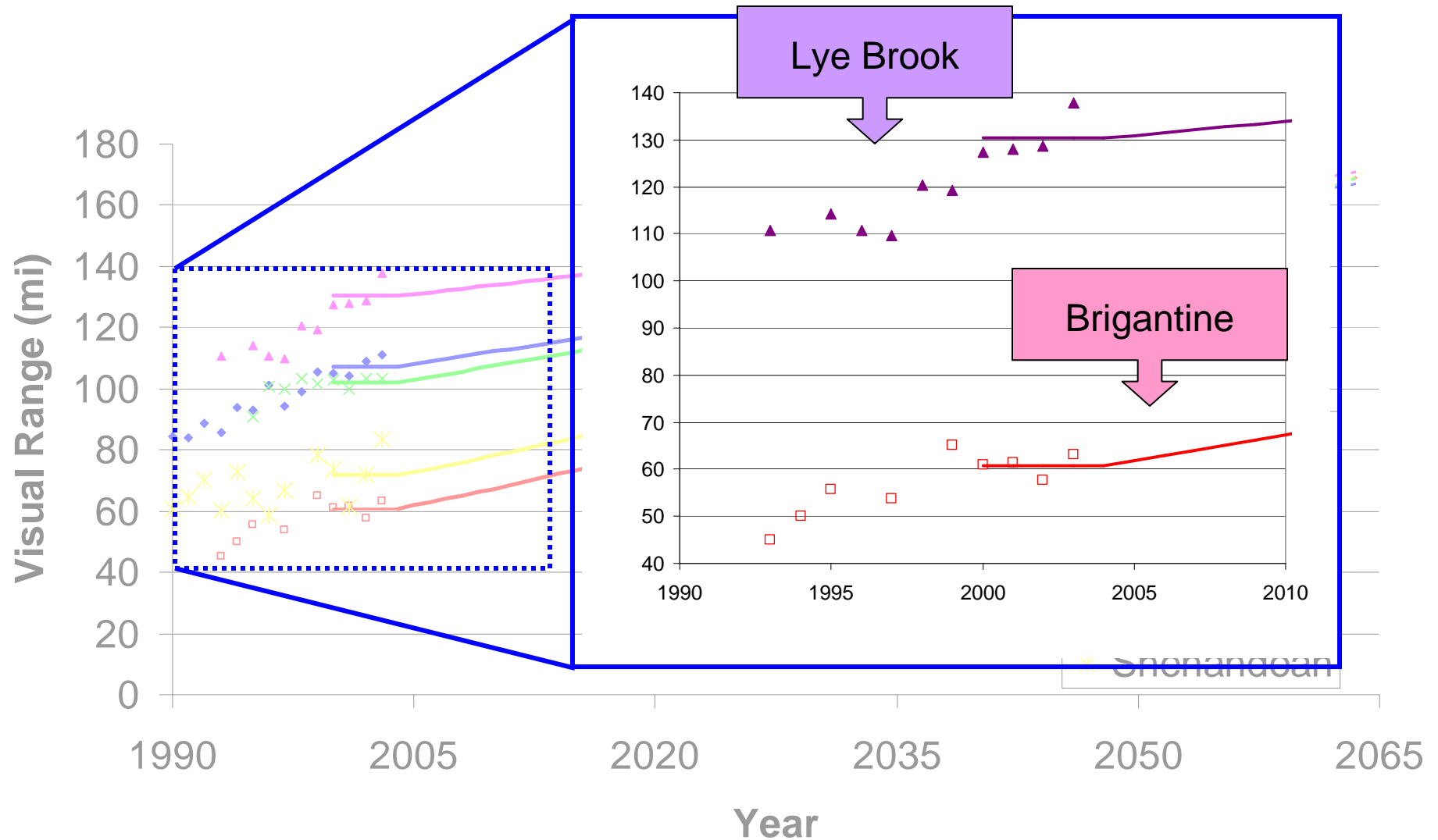
Preliminary Uniform Progress Goals (20% Worst Visibility Days)



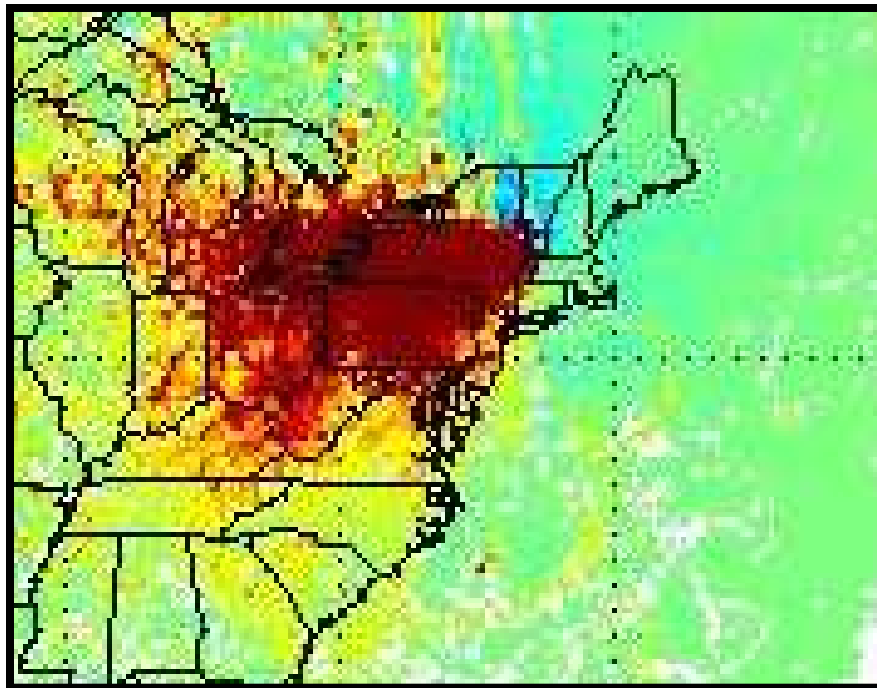
Preliminary Uniform Progress Goals (20% Best Visibility Days)



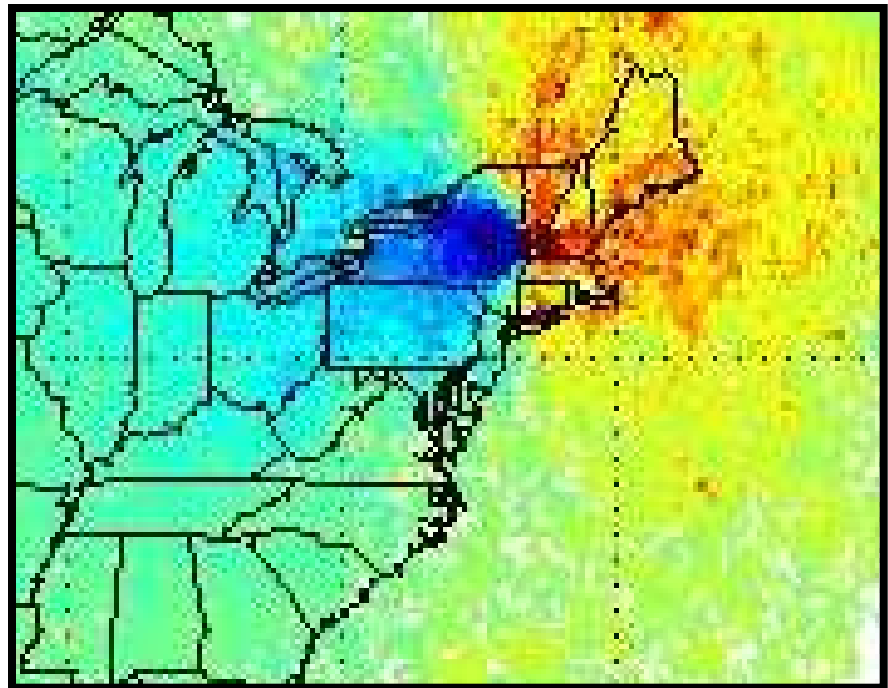
Preliminary Uniform Progress Goals (20% Best Visibility Days)



Lye Brook Source Regions



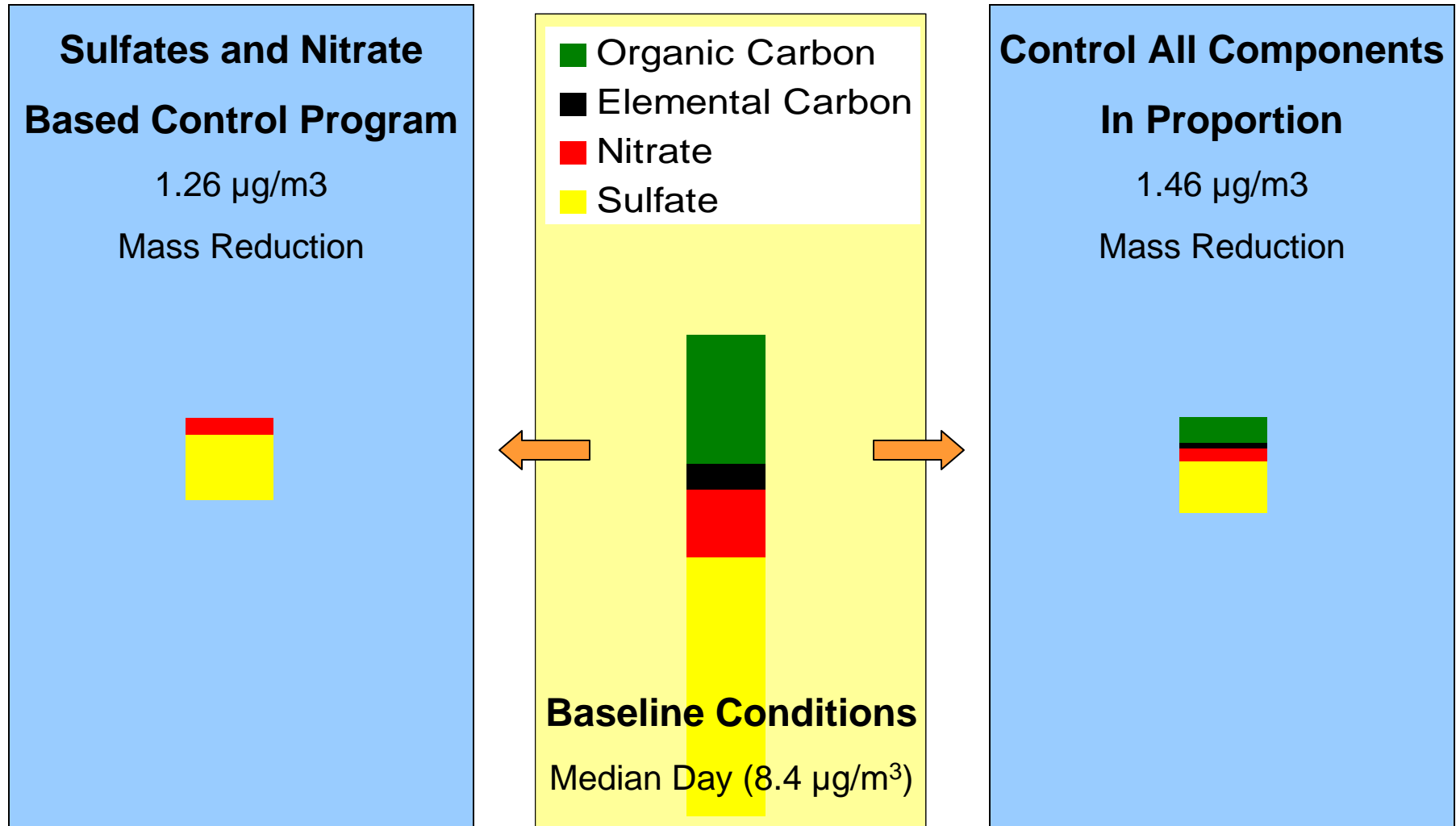
Meteorological source region on 10% highest sulfate days. **Red** indicates increased probability of contributing to **high** days.



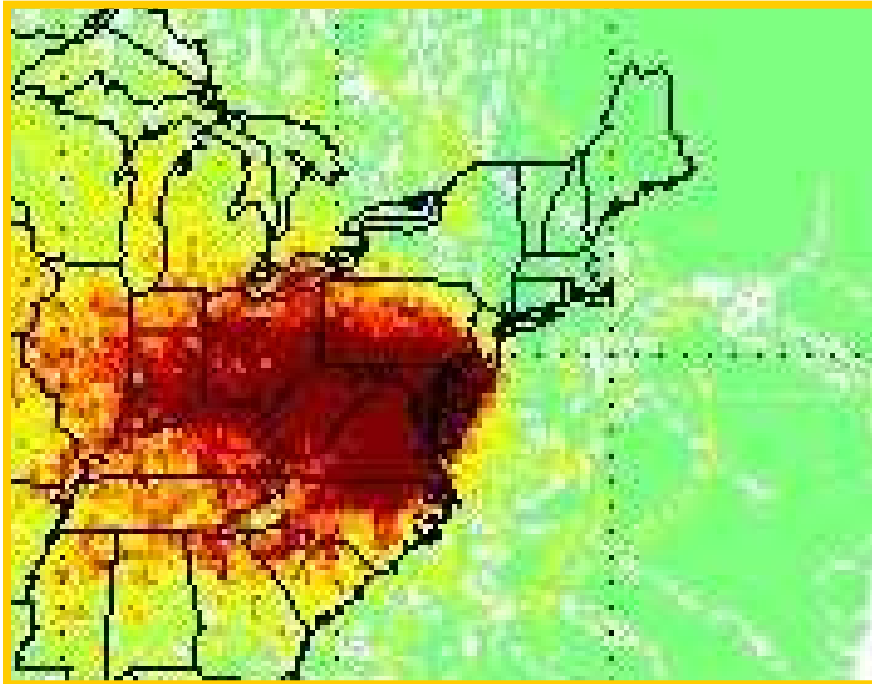
Meteorological source region on 10% lowest sulfate days. **Red** indicates increased probability of contributing to **low** days.

What to control??

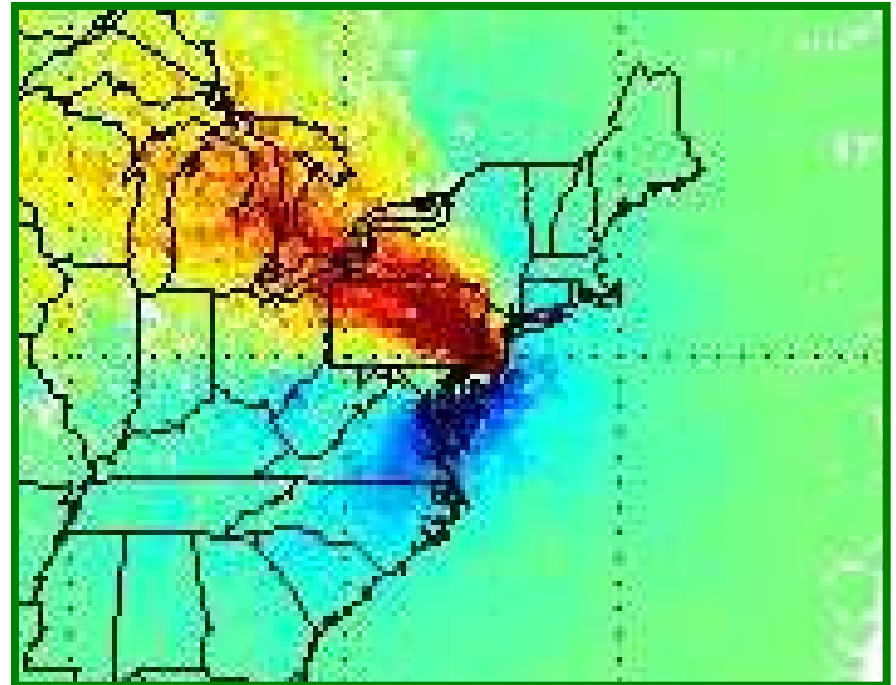
(Example: Brigantine, NJ)



Same source region??



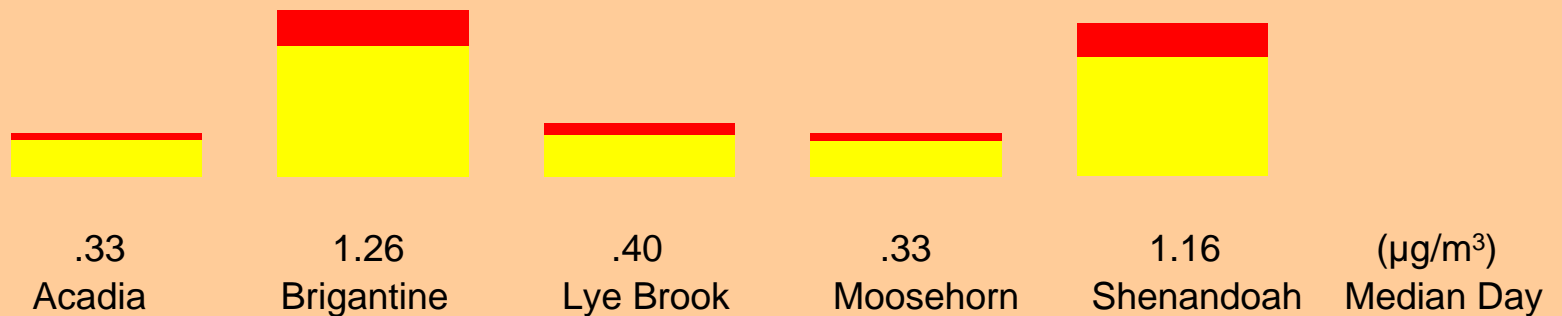
Meteorological source region on 10% worst **sulfate** days at Brigantine, NJ



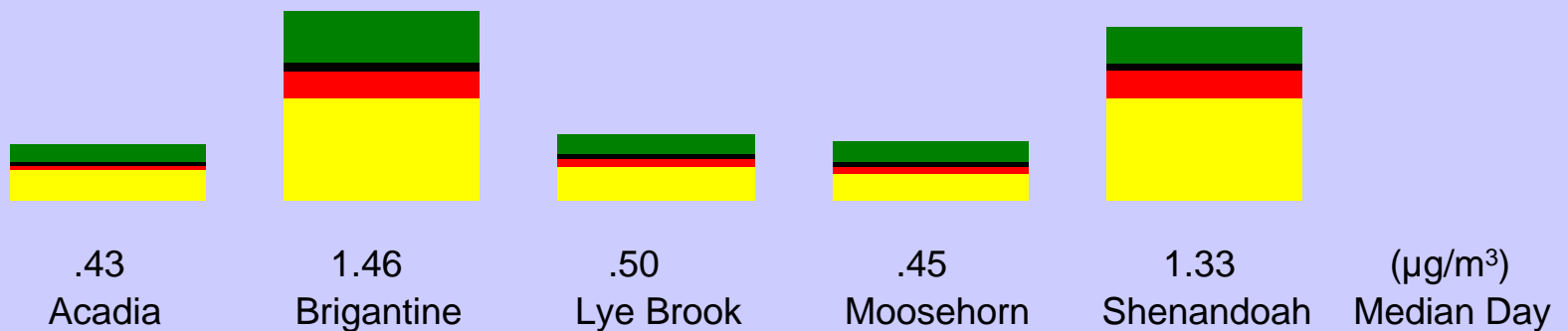
Meteorological source region on 10% worst **organic carbon** days

Alternative strategies for achieving uniform progress by 2018

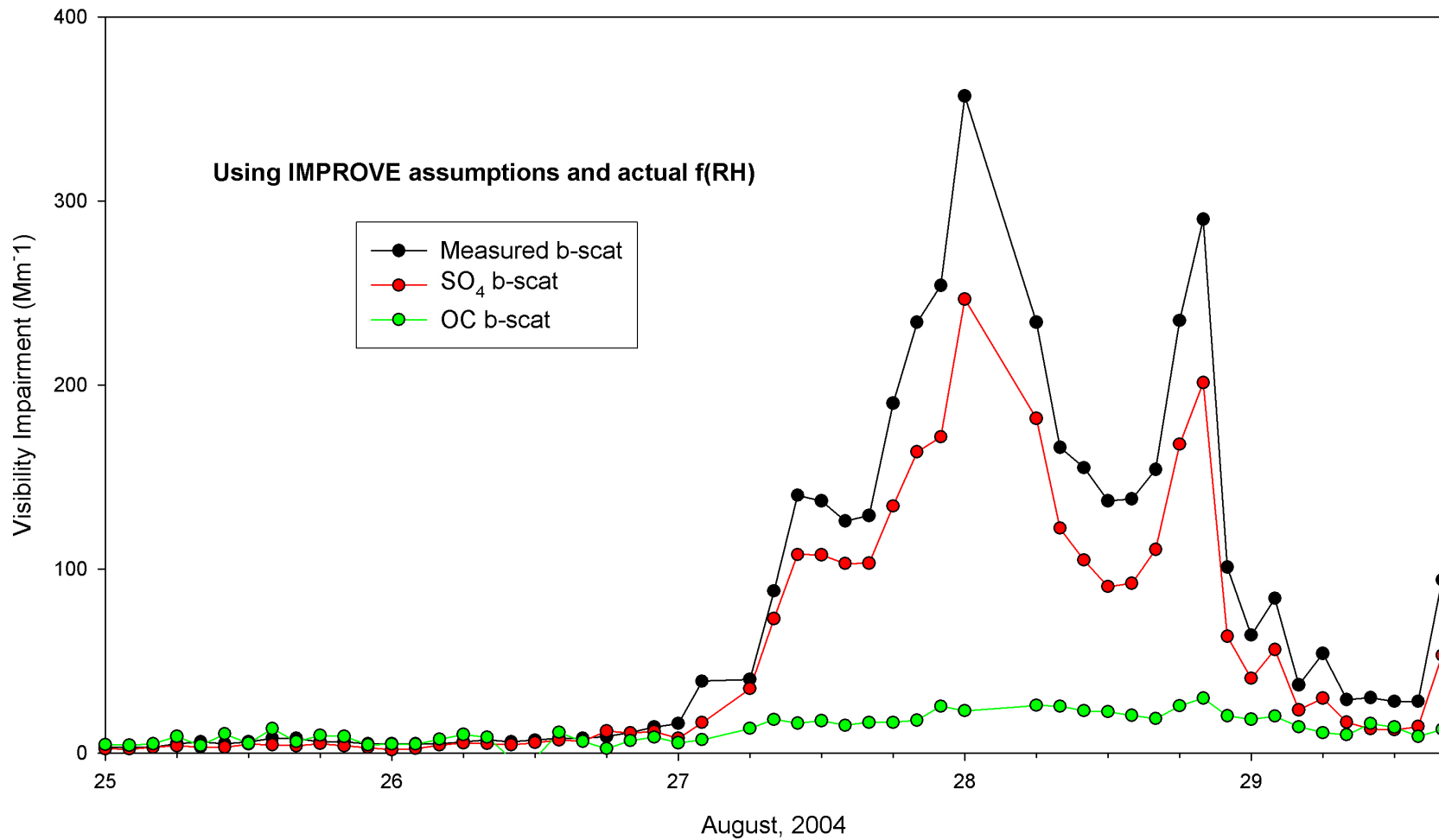
Proportional reductions in sulfate and nitrate only, or ...



Proportional reductions in sulfate, nitrate, organic carbon and elemental carbon

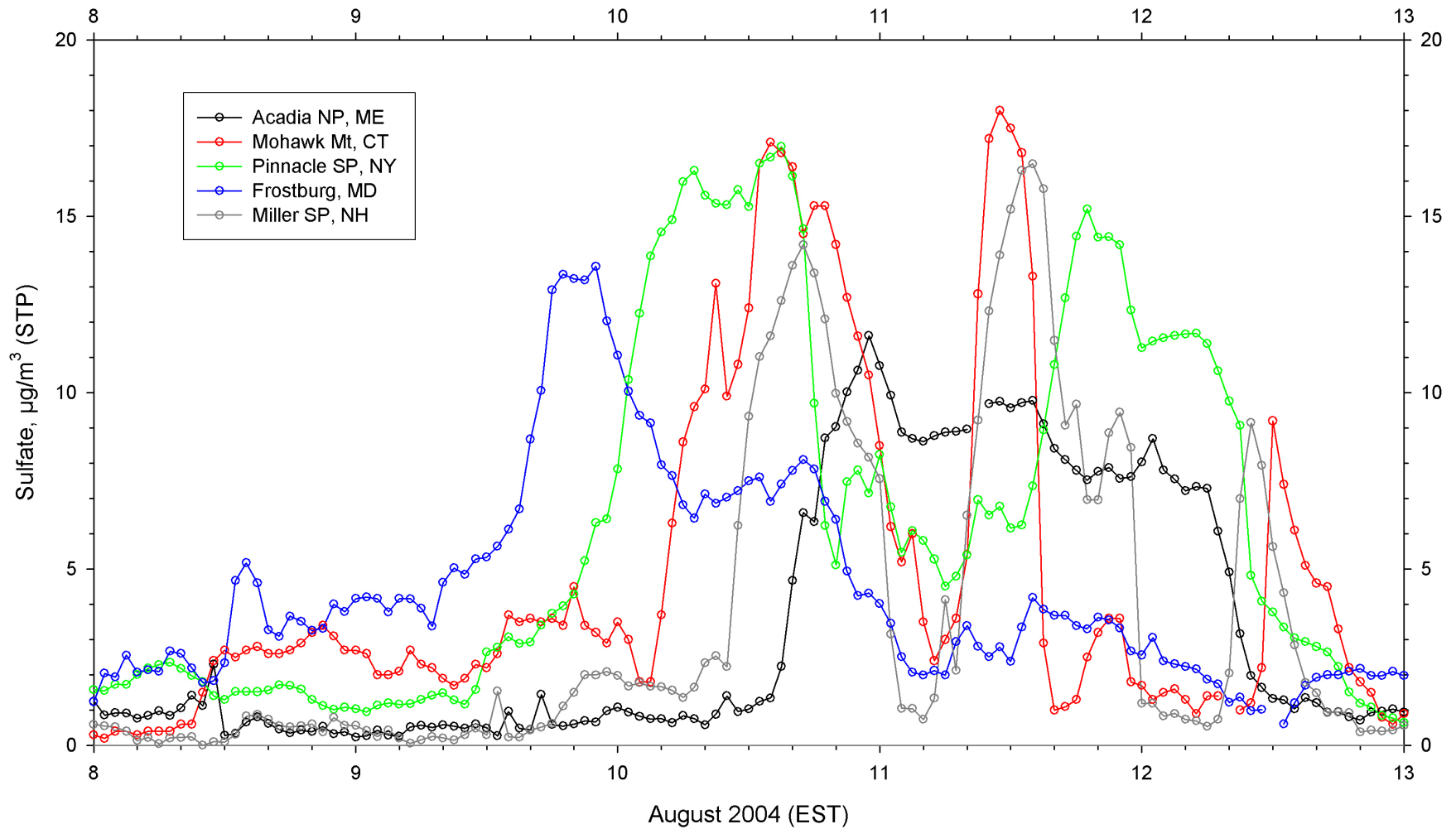


Monitoring Data: RAIN

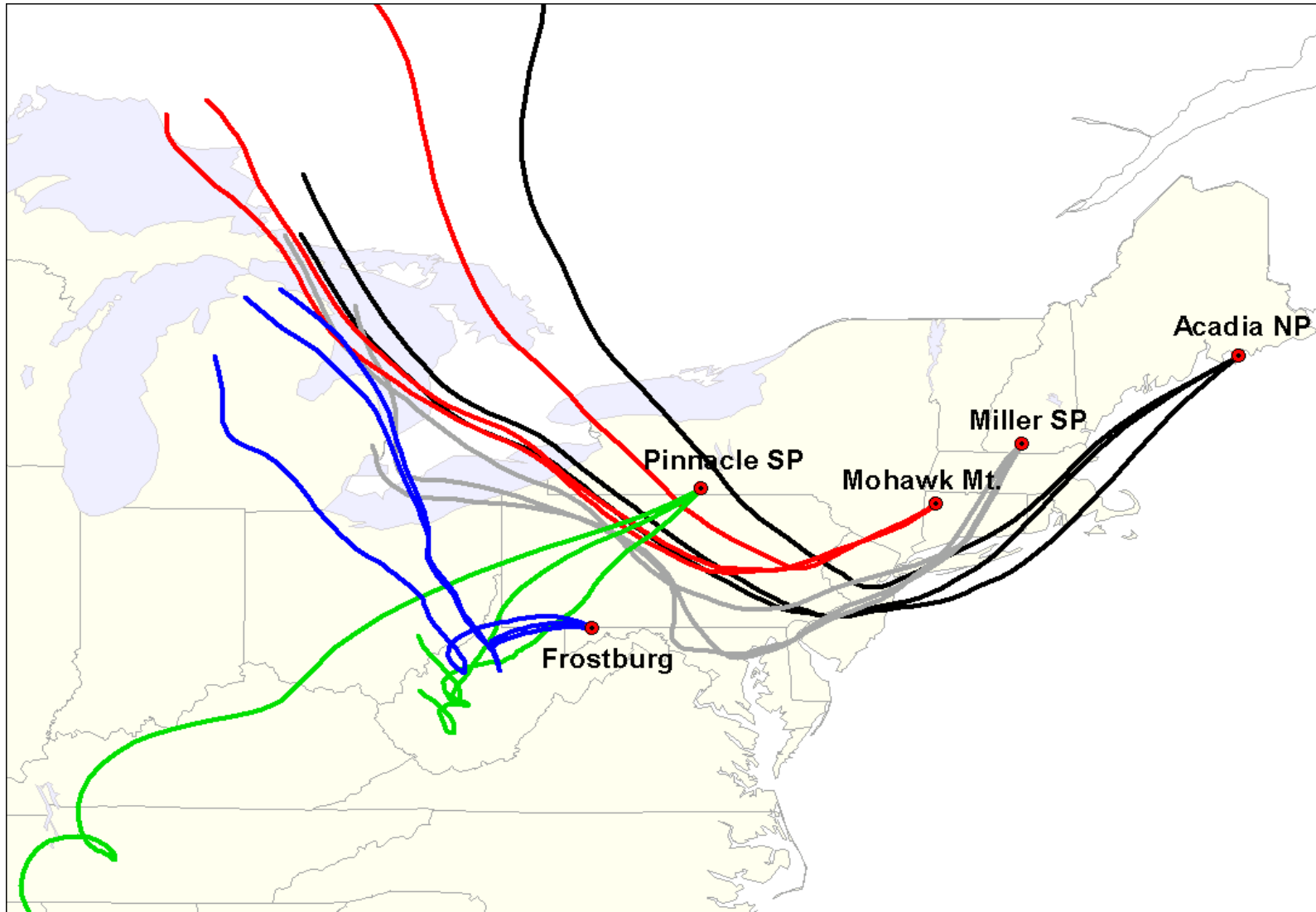


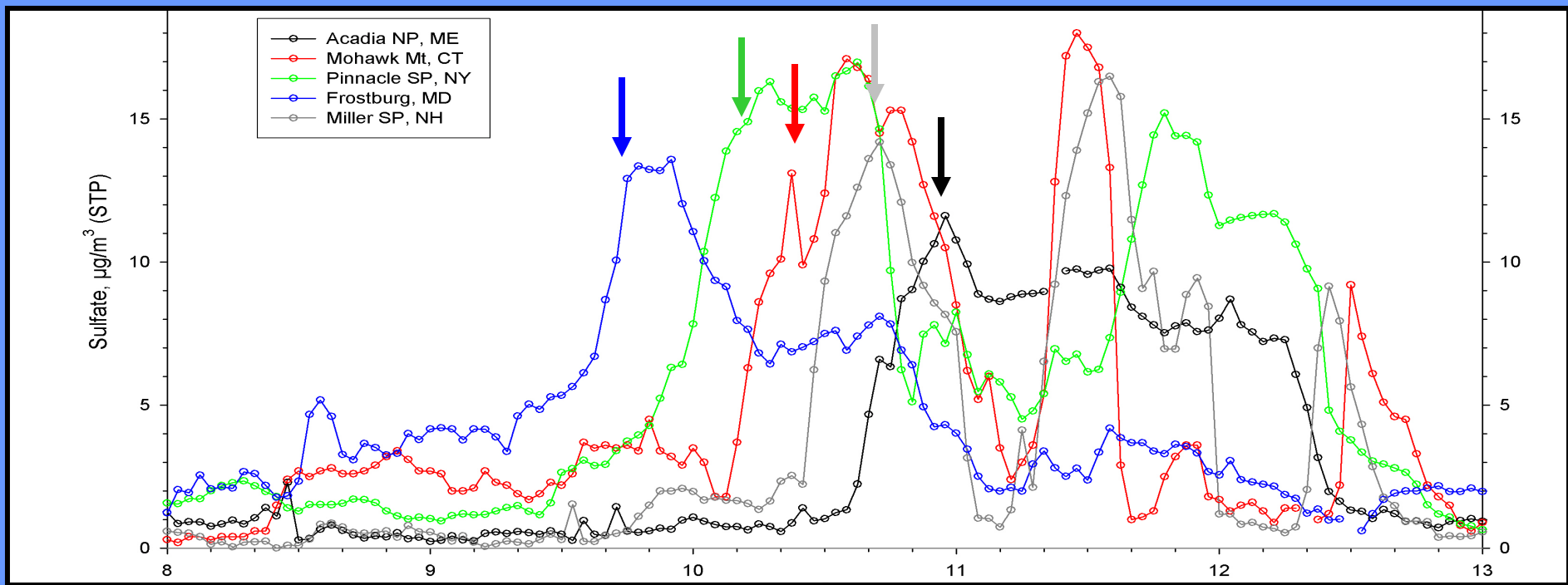
Monitoring Data: RAIN

Thermo 5020 Hourly Sulfate

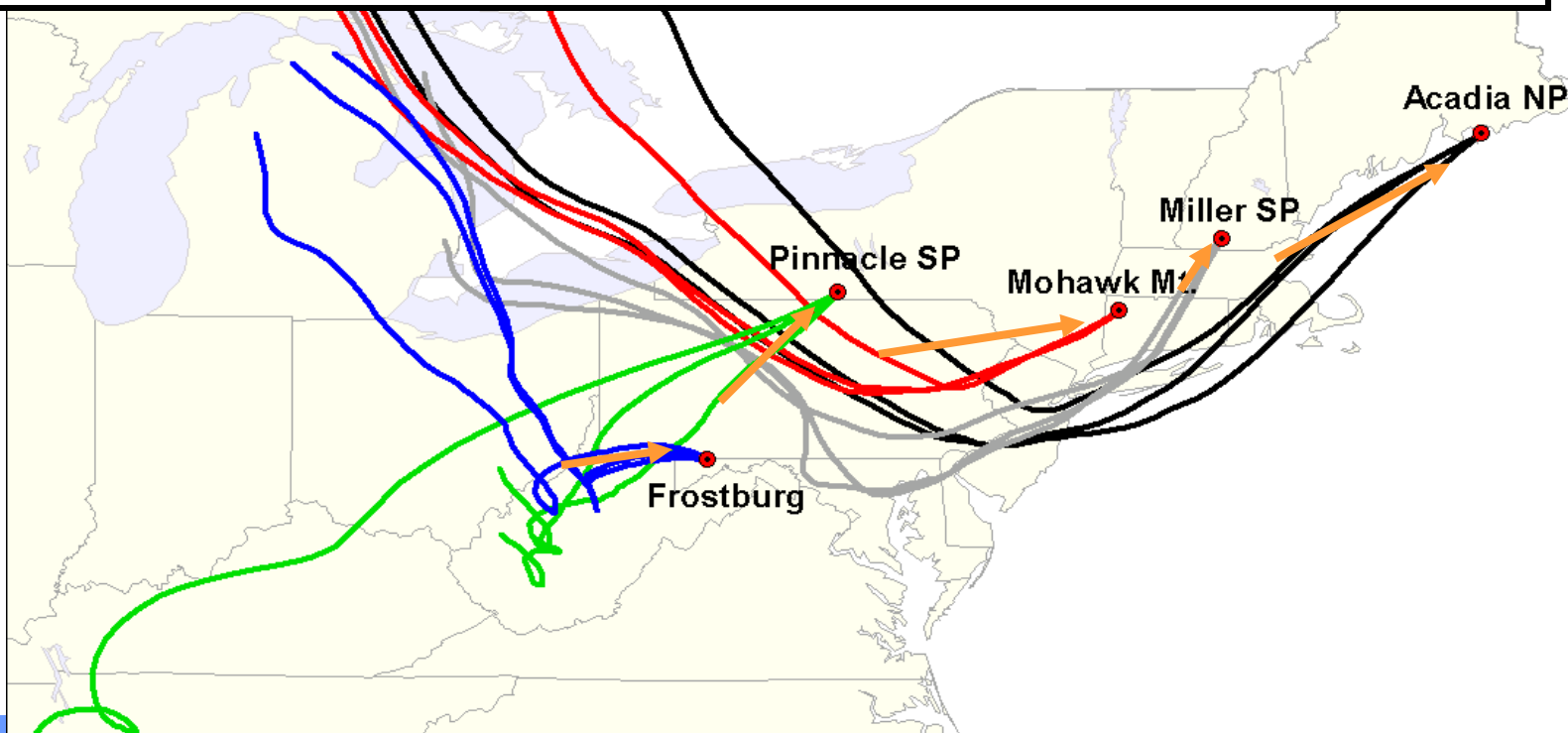


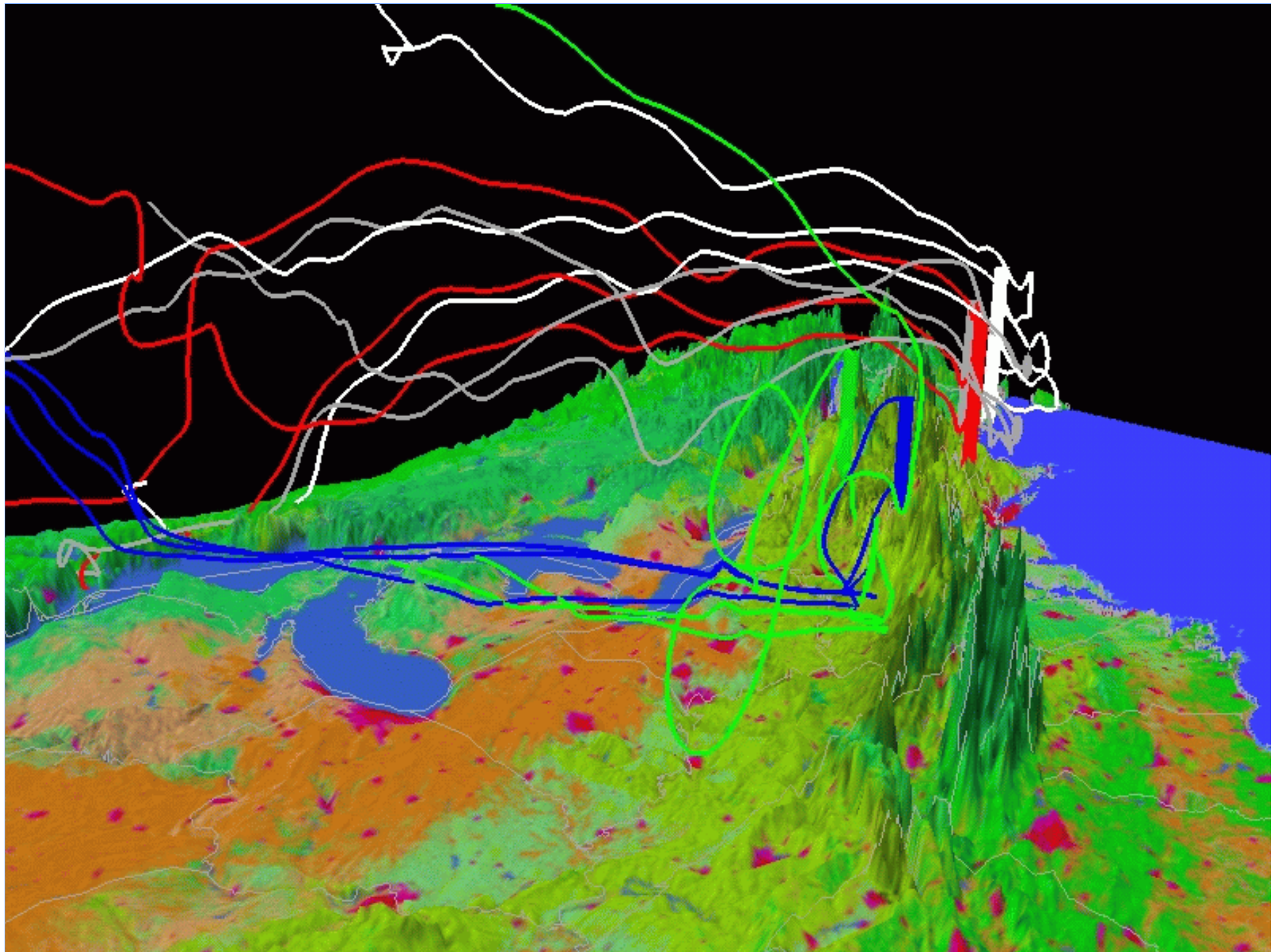
Where did these peaks come from?



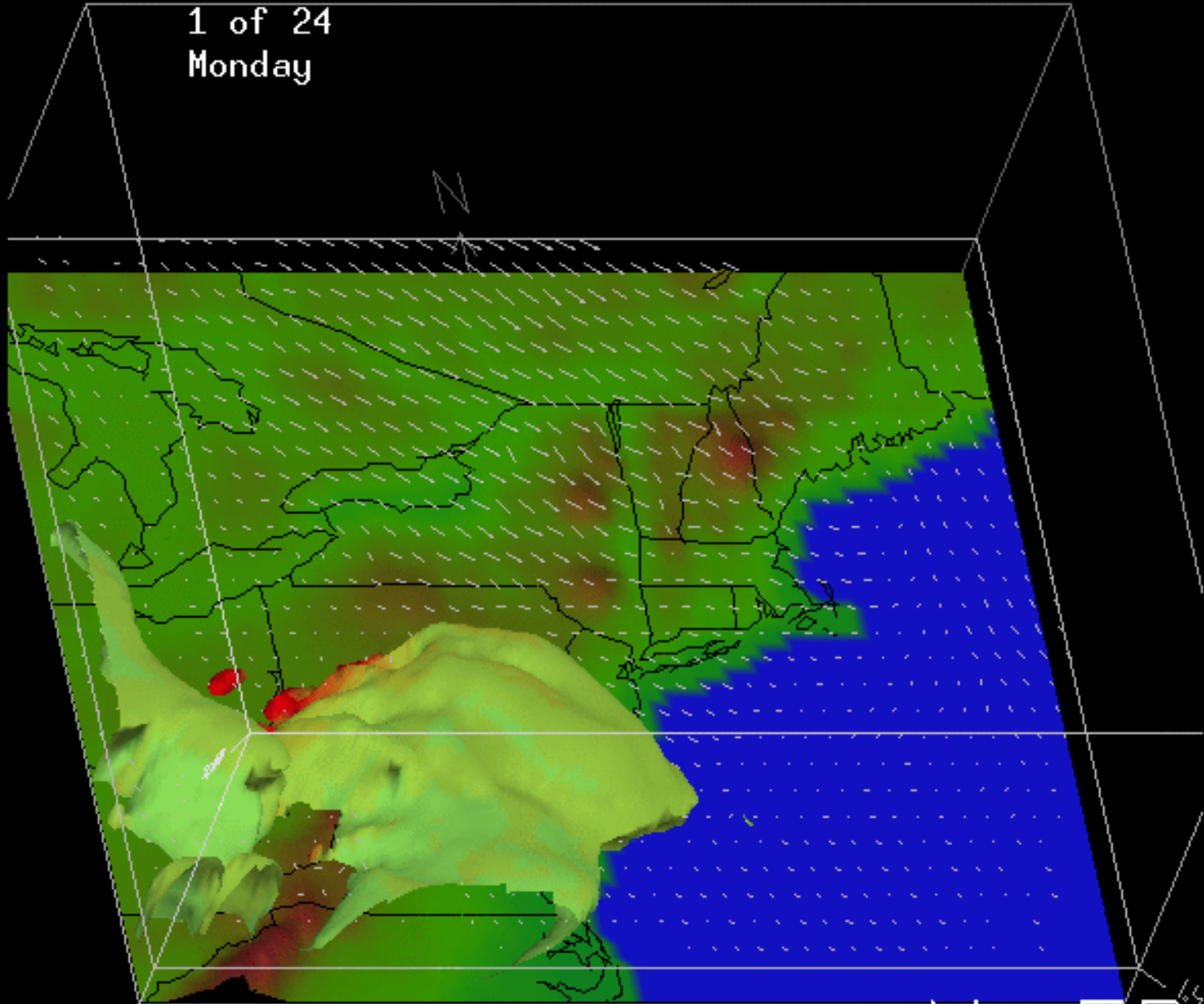


Put them
together
and...





03:00:00
09 Aug 04
1 of 24
Monday



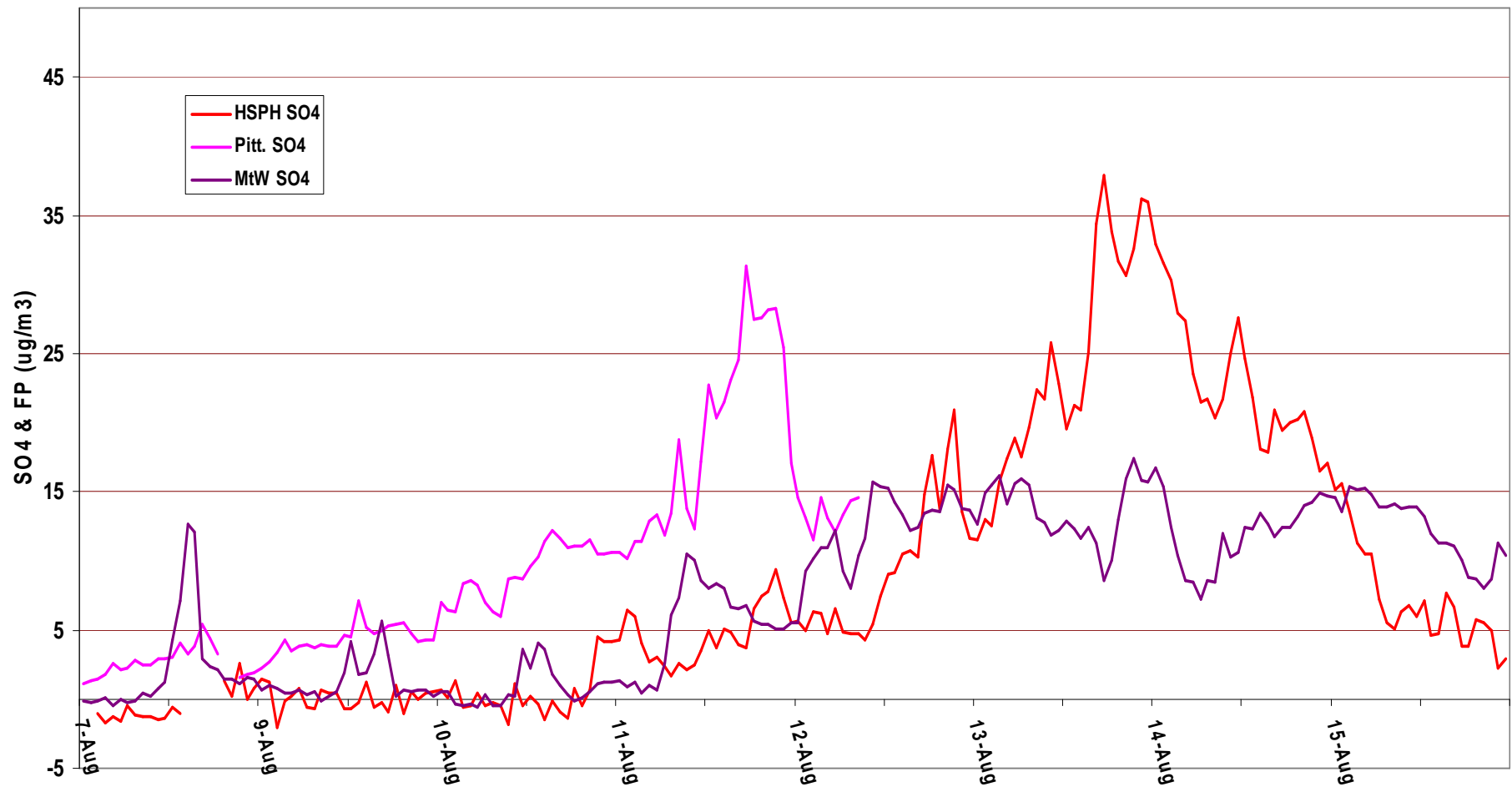
35.8N
84.4W

Vis5D

Atlantic/Northeast
Sustainability Union

2002 Episode w/o RAIN

Summer 2002 SO₄ from 3 Sites

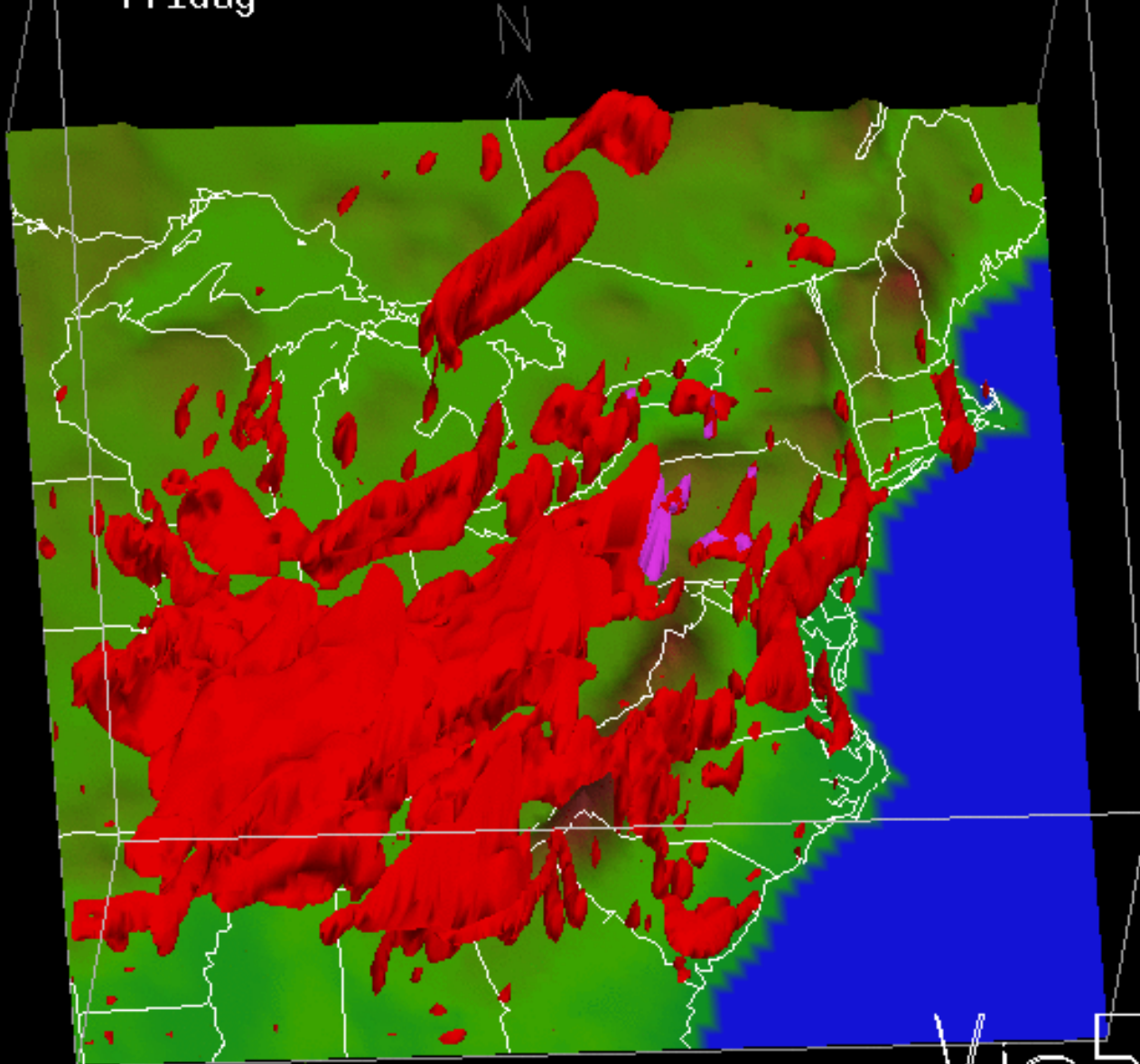


12:00:00 Group 1

09 Aug 02

85 of 264

Friday



Vis5D

Northeast
Union

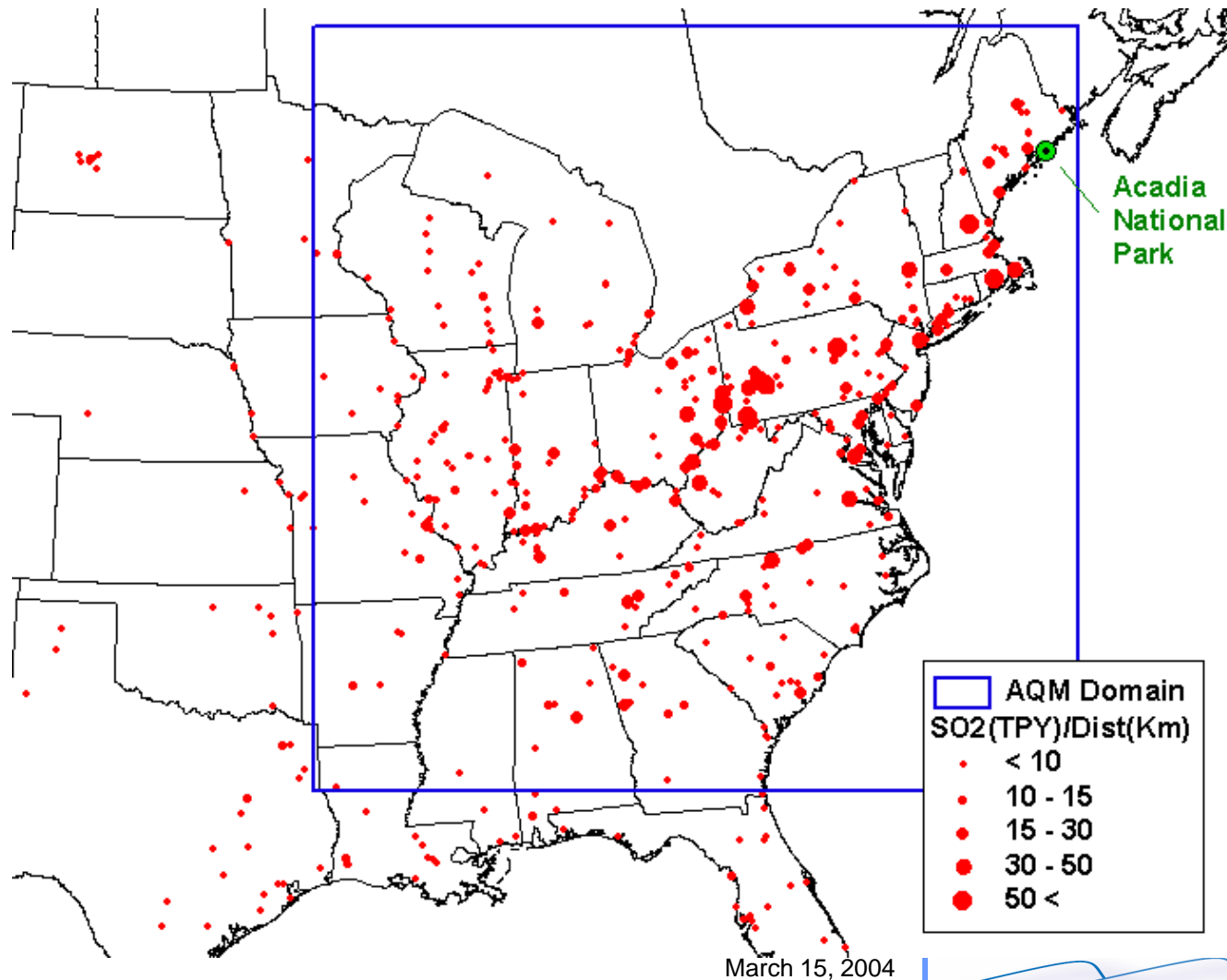
Weight of Evidence Approach

Analytical technique	Approach
Emissions/distance	Empirical
Incremental Probability	“Receptor”-based trajectory technique
Cluster-weighted Probability	“Receptor”-based trajectory technique
Emissions x upwind probability	Empirical/trajectory hybrid
Source Apportionment Approaches	Receptor model/trajectory hybrid
REMSAD tagged species	“Source”-based grid model
CALPUFF with MM5-based meteorology	“Source”-based dispersion model
CALPUFF with observation based meteorology	“Source”-based dispersion model

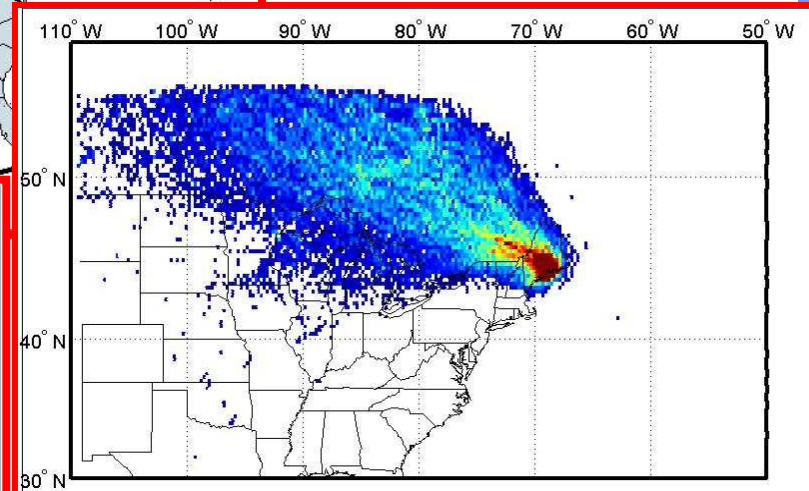
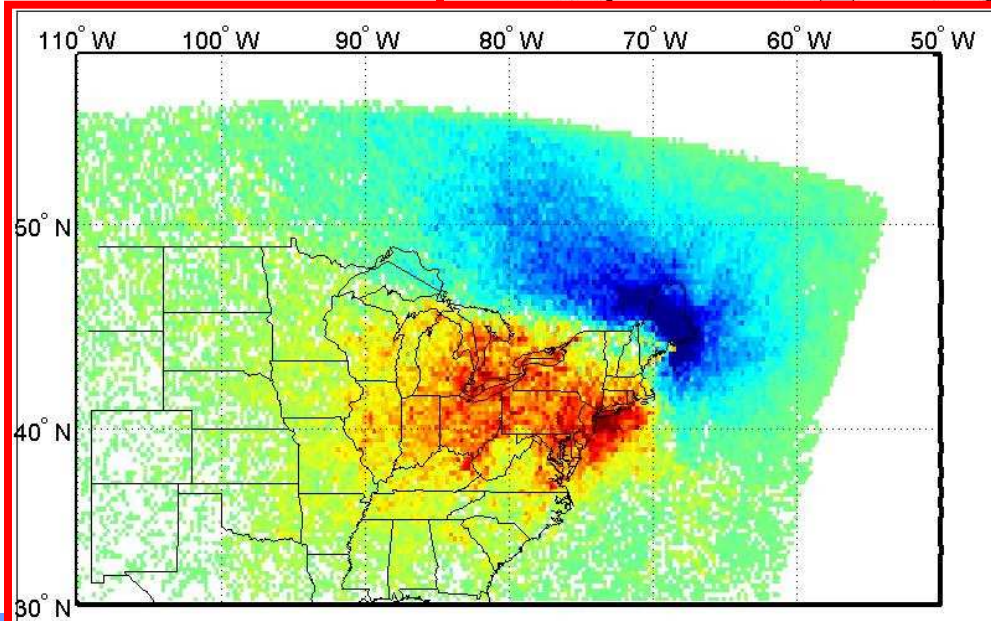
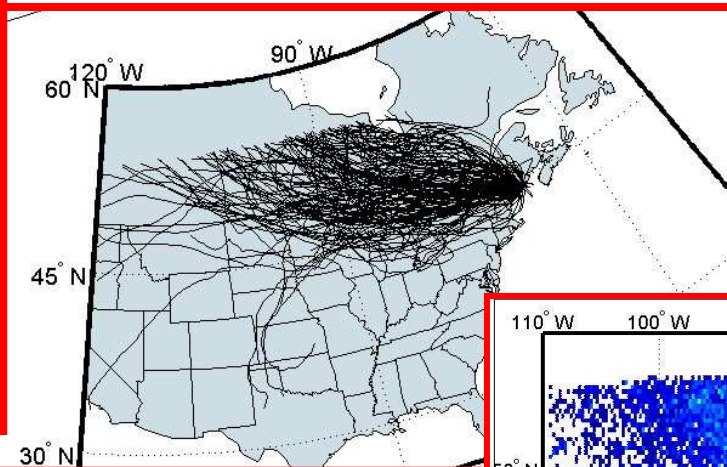
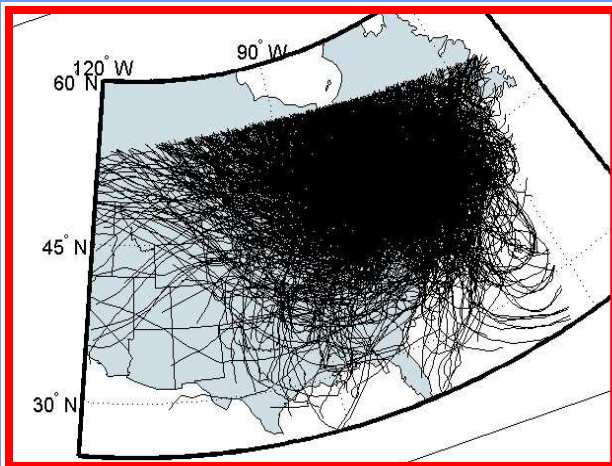


Geese
Brigantine
New Jersey

Emissions/Distance Analysis



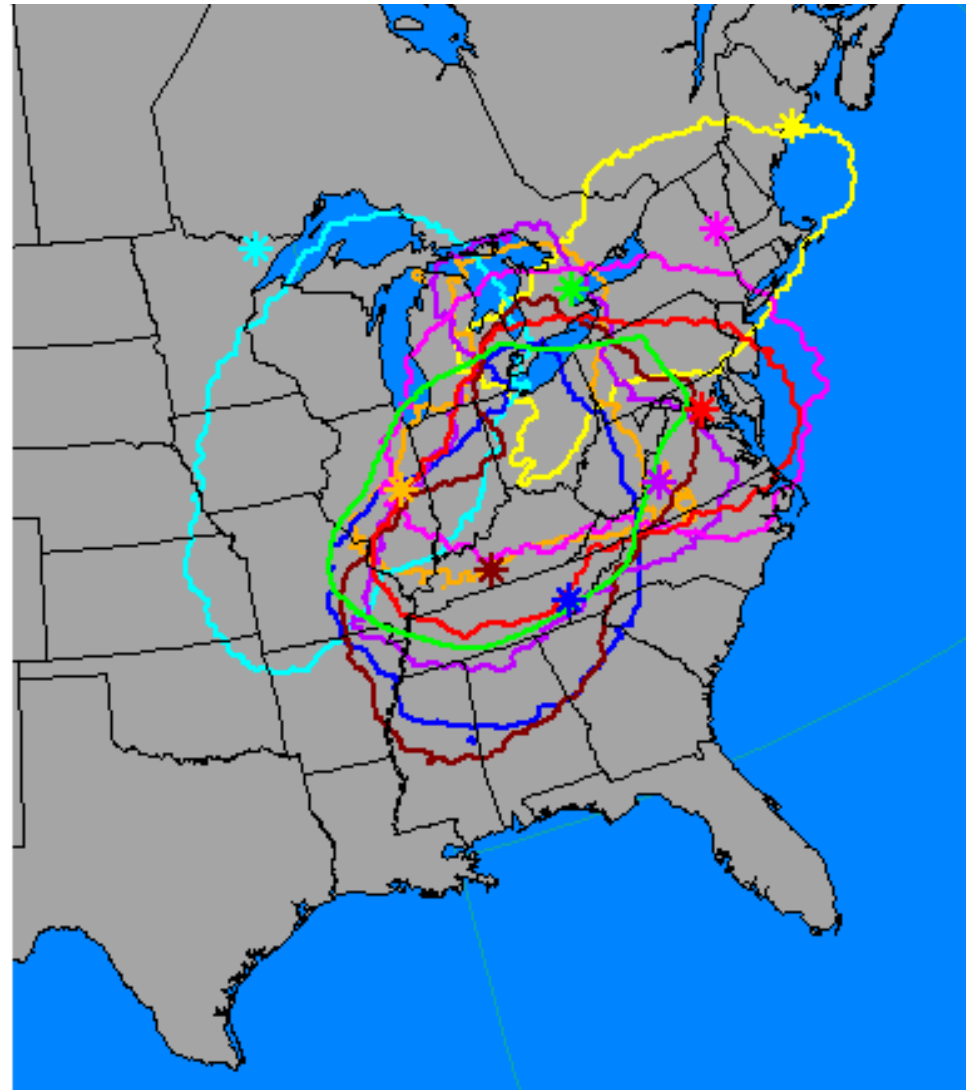
Trajectory Analysis: Best Day/Worst Day



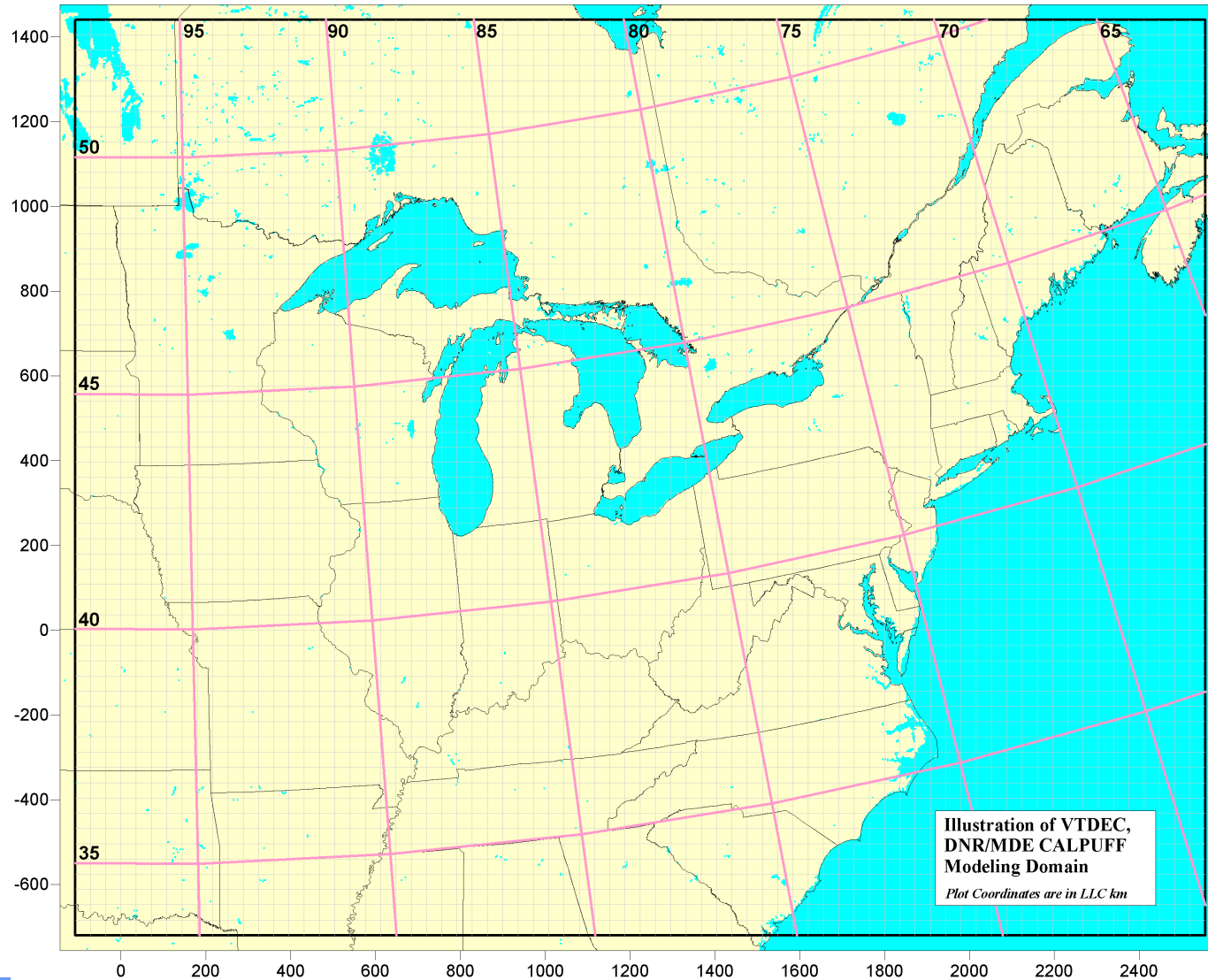
Source Apportionment Results

Upwind Probability Fields
($P > 0.001$) for
"Secondary Sulfate" Source(s)
at 9 Eastern Sites

- * Boundary Waters, MN
- * Bondville, IL
- * Mammoth Cave, KY
- * Great Smokey Mtns., TN
- * Toronto, Canada
- * James River Face, VA
- * Washington, DC
- * Lye Brook, VT
- * Acadia, ME

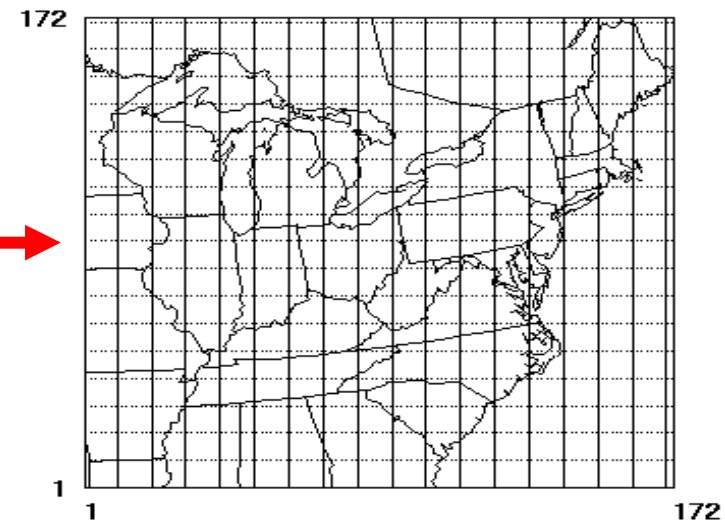
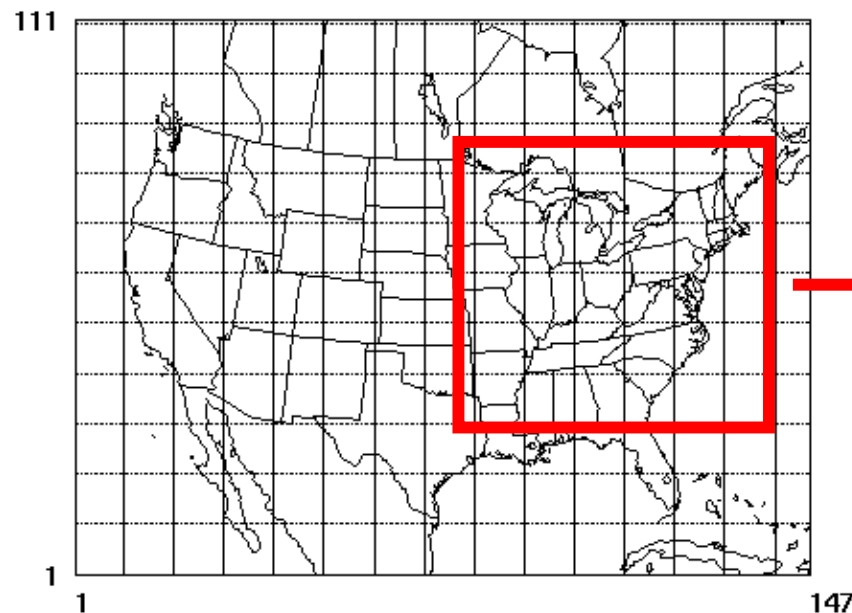


CALPUFF Domain



CMAQ & REMSAD

- 36km National Domain/12km Northeast Subdomain
- MM5 Met from UMD
- MANE-VU 2002 Emissions Inventory



Preliminary REMSAD results

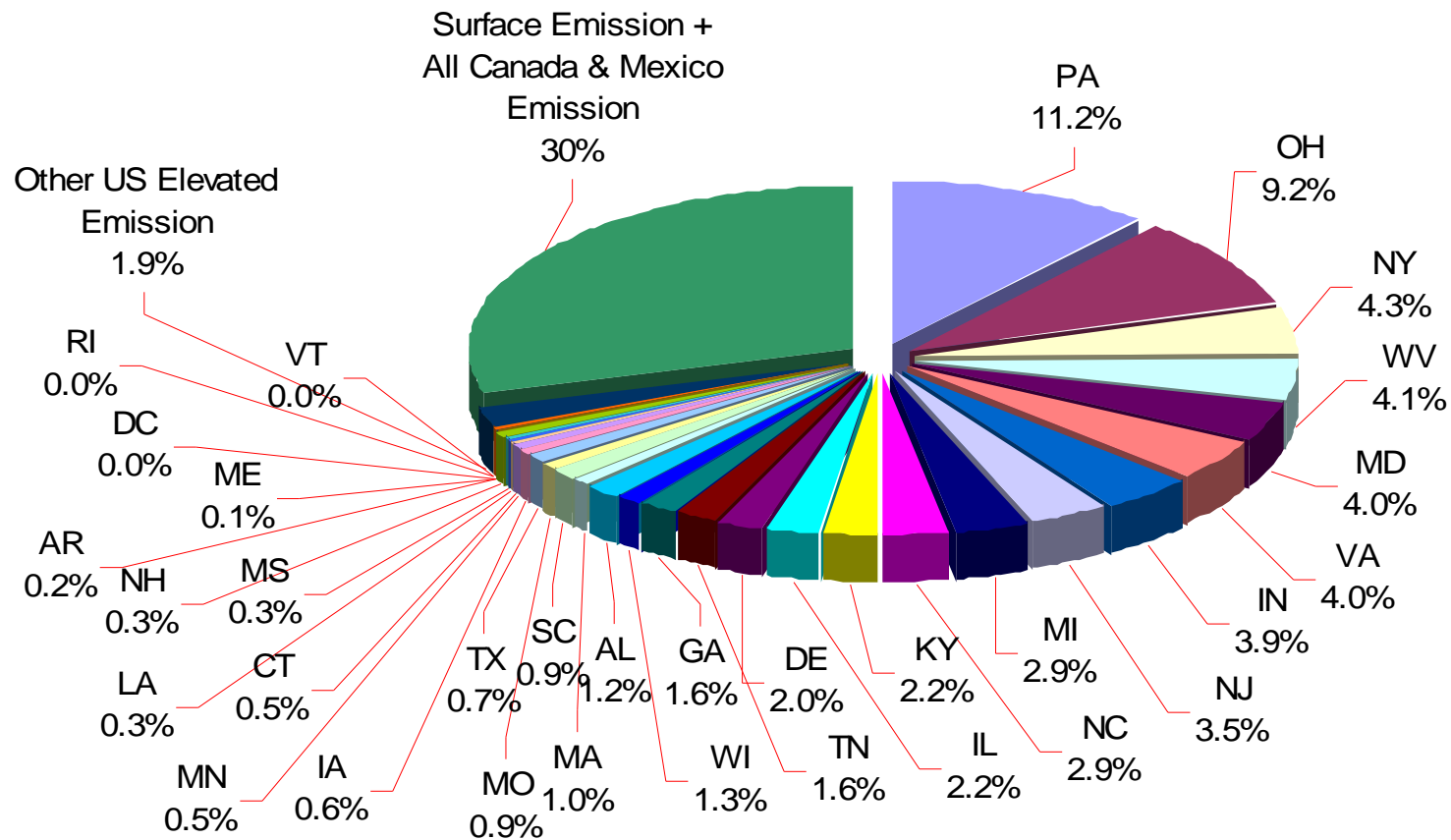
- SO₂ tagging: Elevated point sources from 32 eastern states only
- USEPA Clear Skies [2003] 2001 “proxy” inventory
- USEPA 1996 MM5 meteorology



Bar Harbor,
Maine

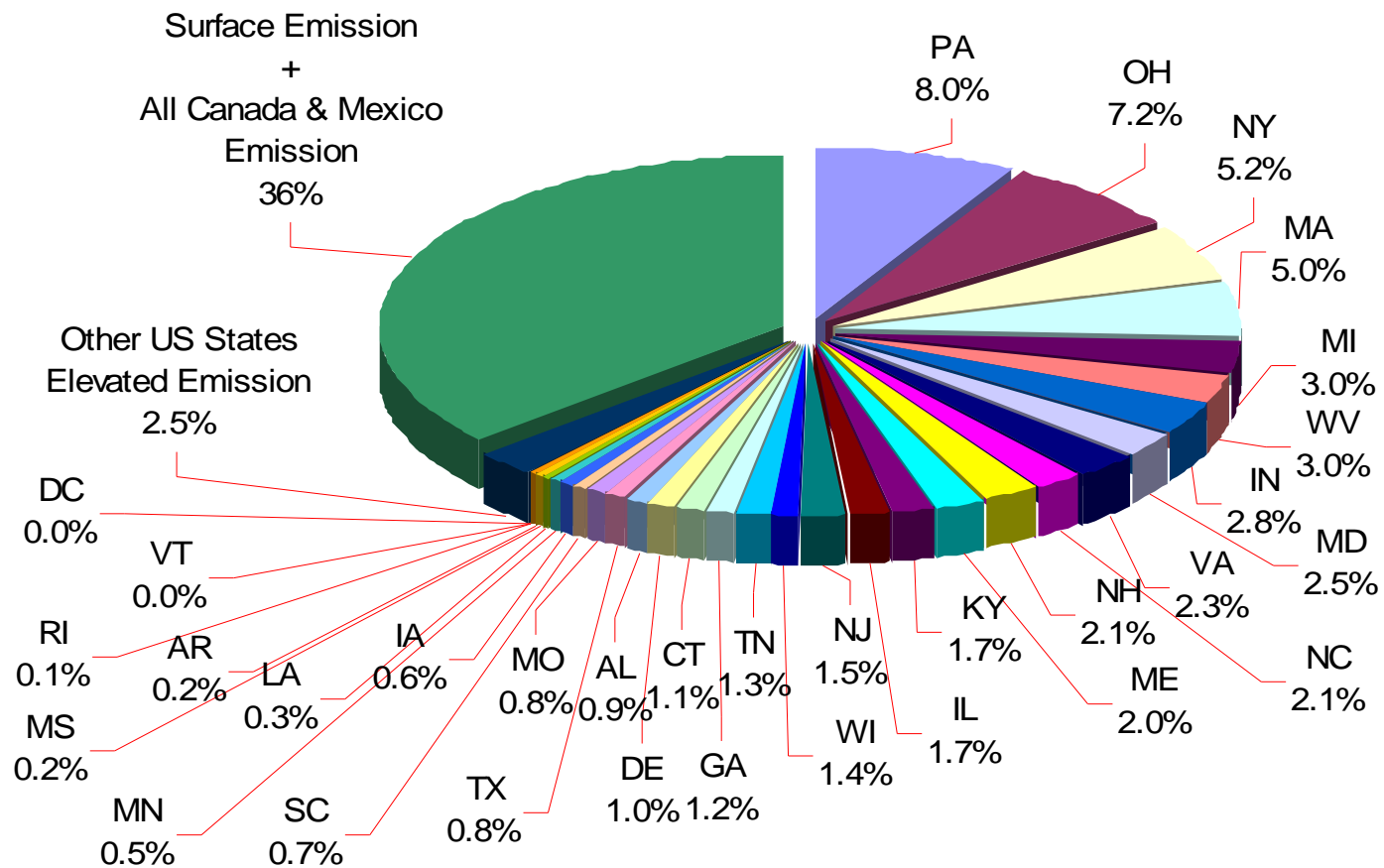
REMSAD: Tagging Results

Contribution to PM Sulfate in Brigantine, NJ



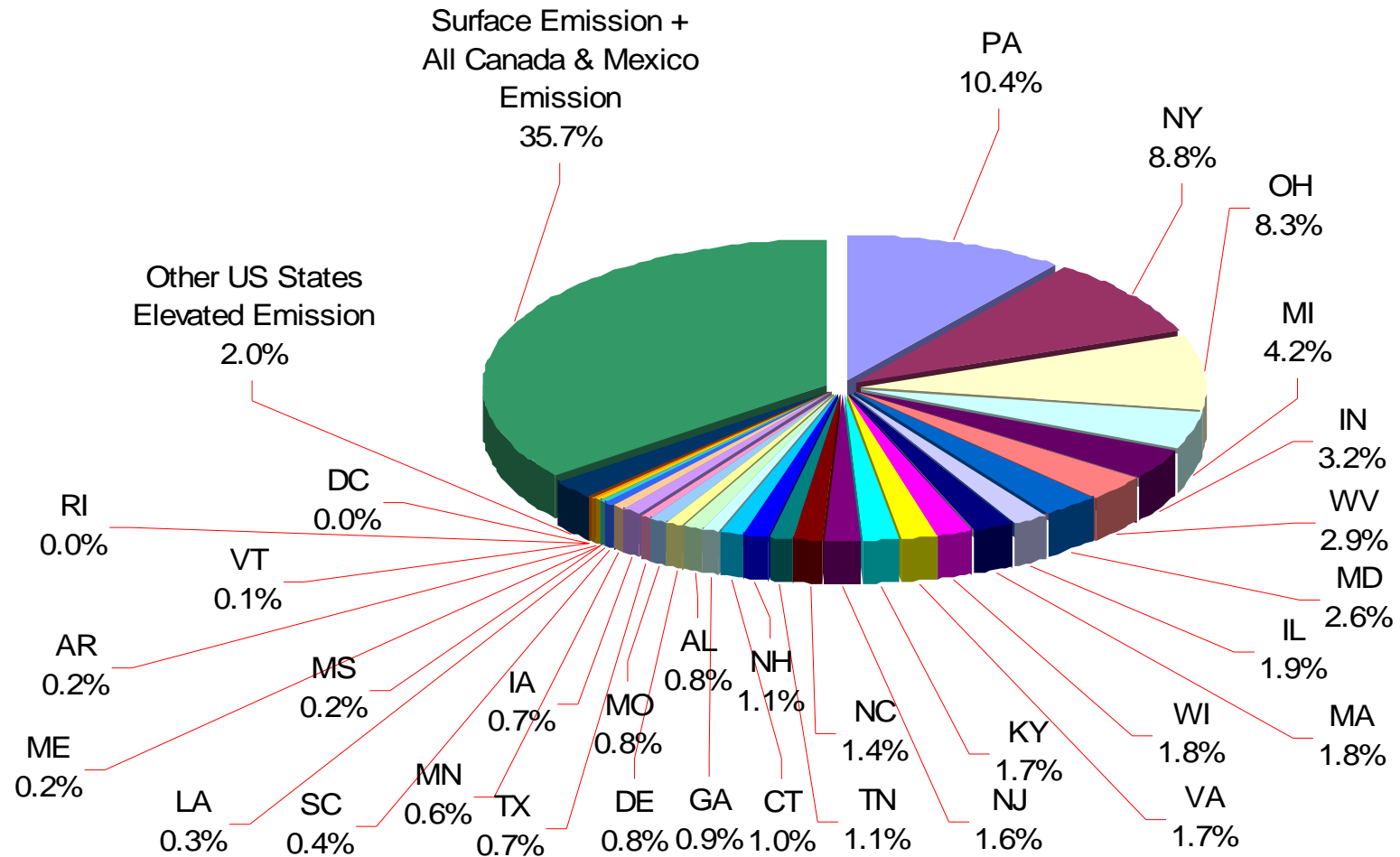
REMSAD: Tagging Results

Contribution to PM Sulfate in Acadia, ME



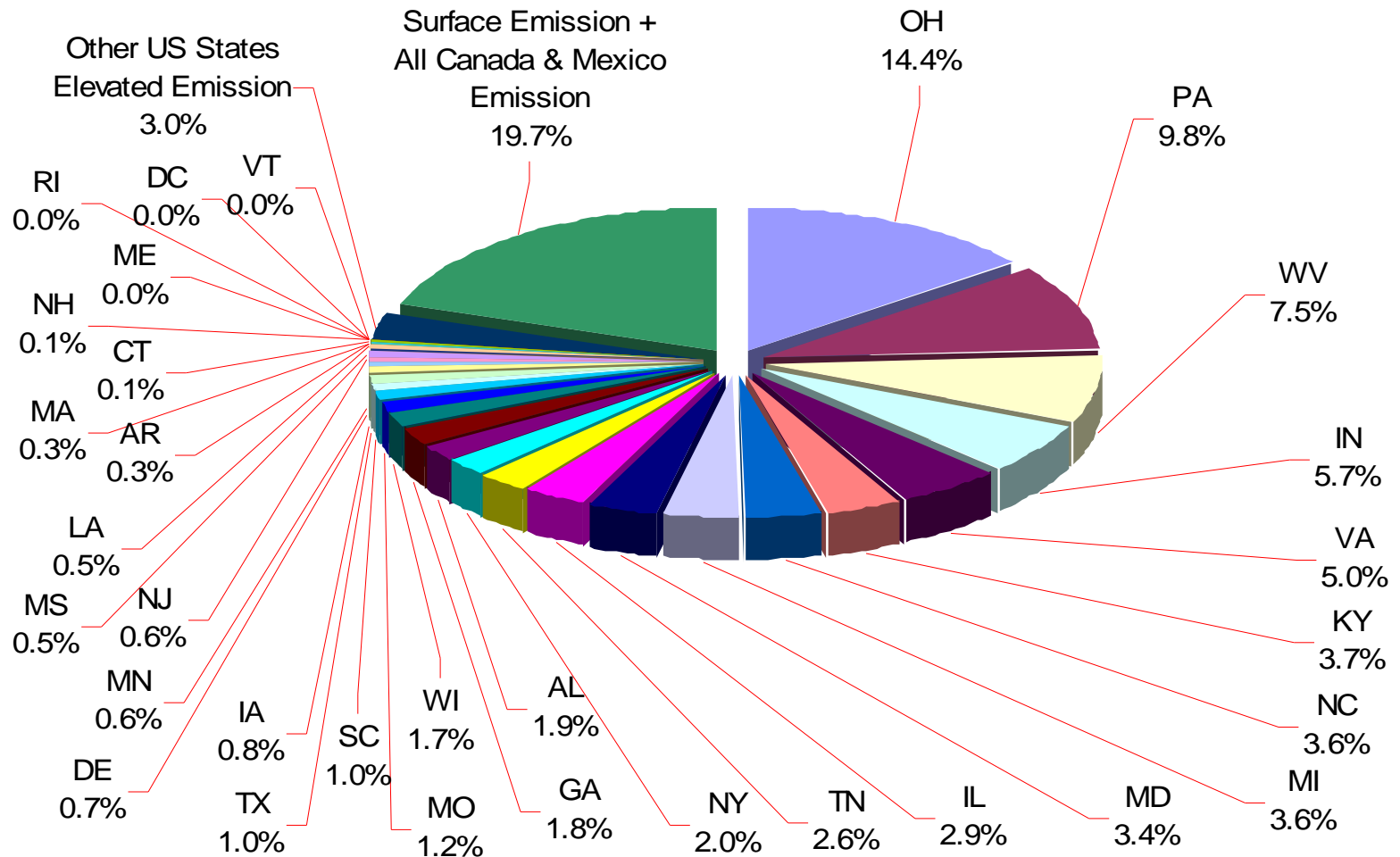
REMSAD: Tagging Results

Contribution to PM Sulfate in Lye Brook, VT



REMSAD: Tagging Results

Contribution to PM Sulfate in Shenandoah, VA

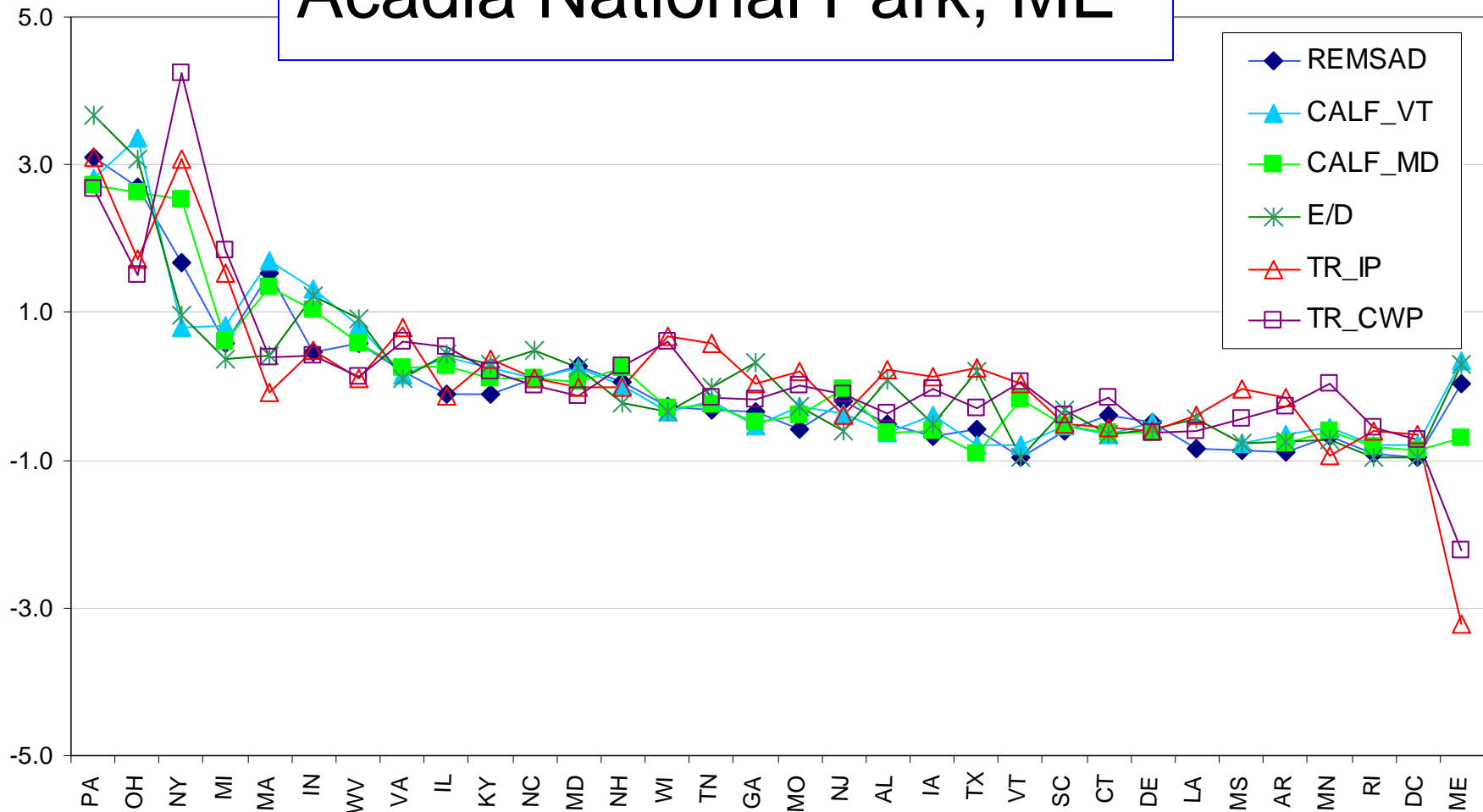


Synthesis

- Goal is to provide the basis for the pollution apportionment component of state and tribal implementation plans
- Synthesis of monitoring, emissions, modeling and data analysis will provide a framework for developing control strategies focused on the root problems for our region

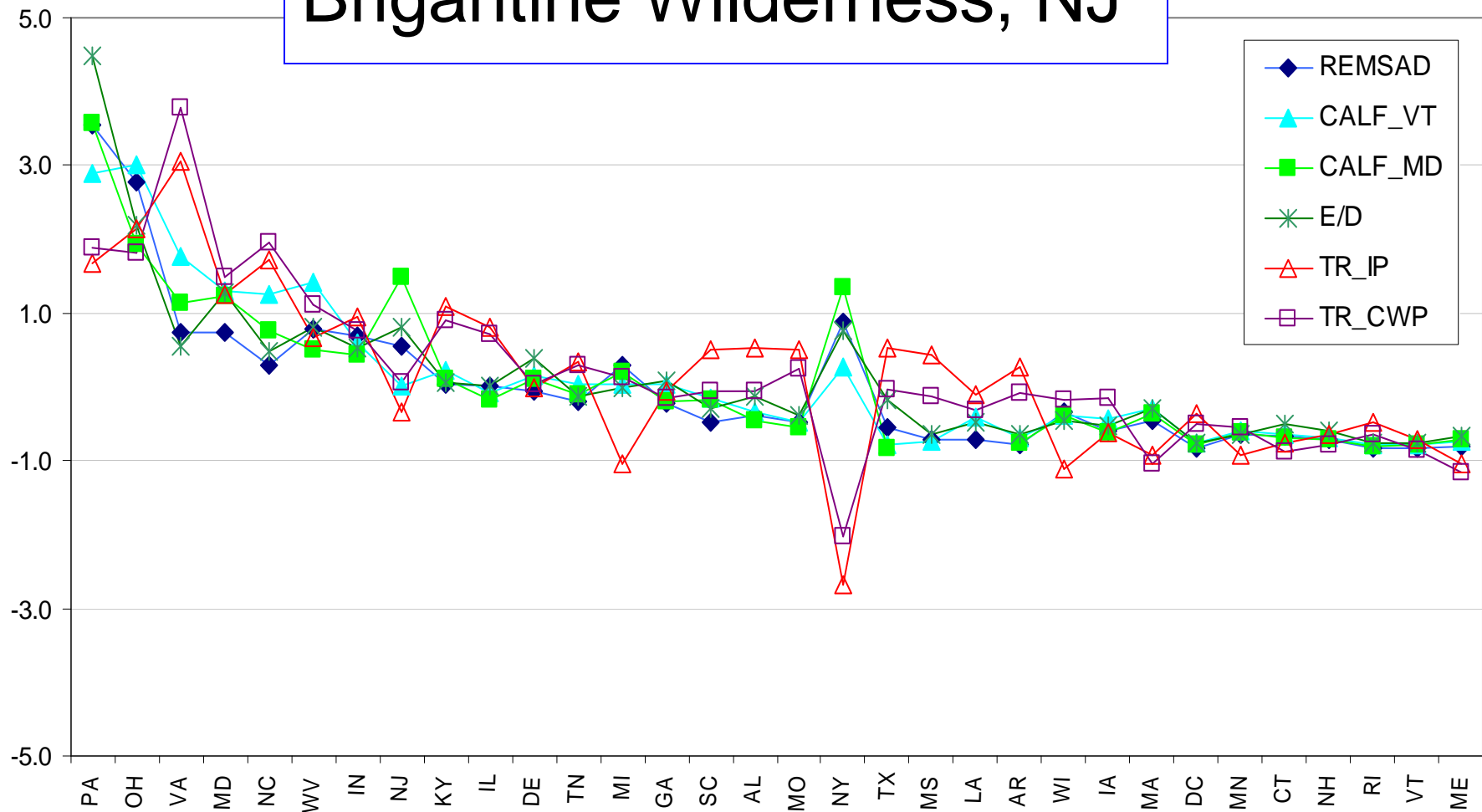
Multiple Ranking Techniques

Acadia National Park, ME



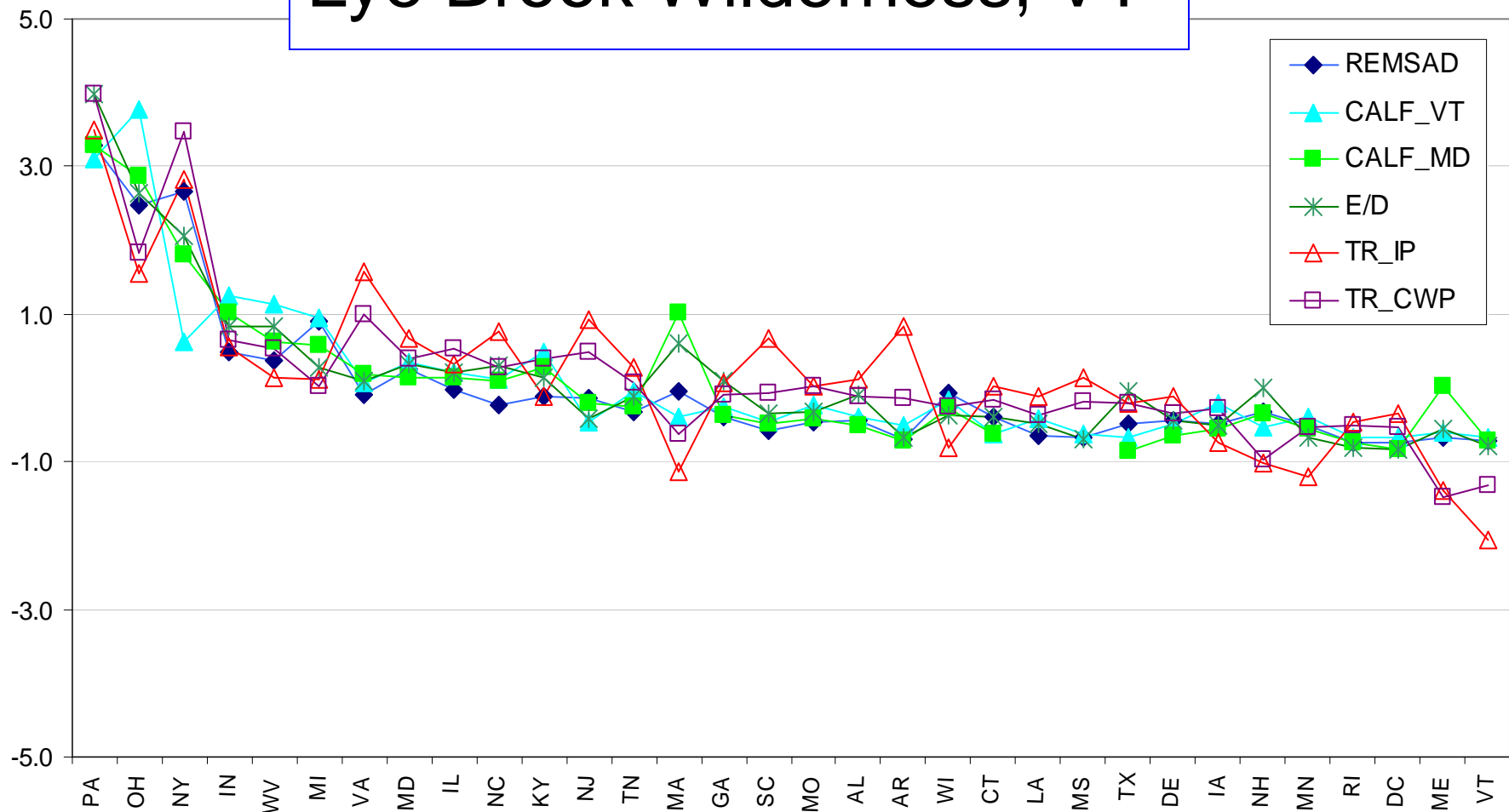
Multiple Ranking Techniques

Brigantine Wilderness, NJ



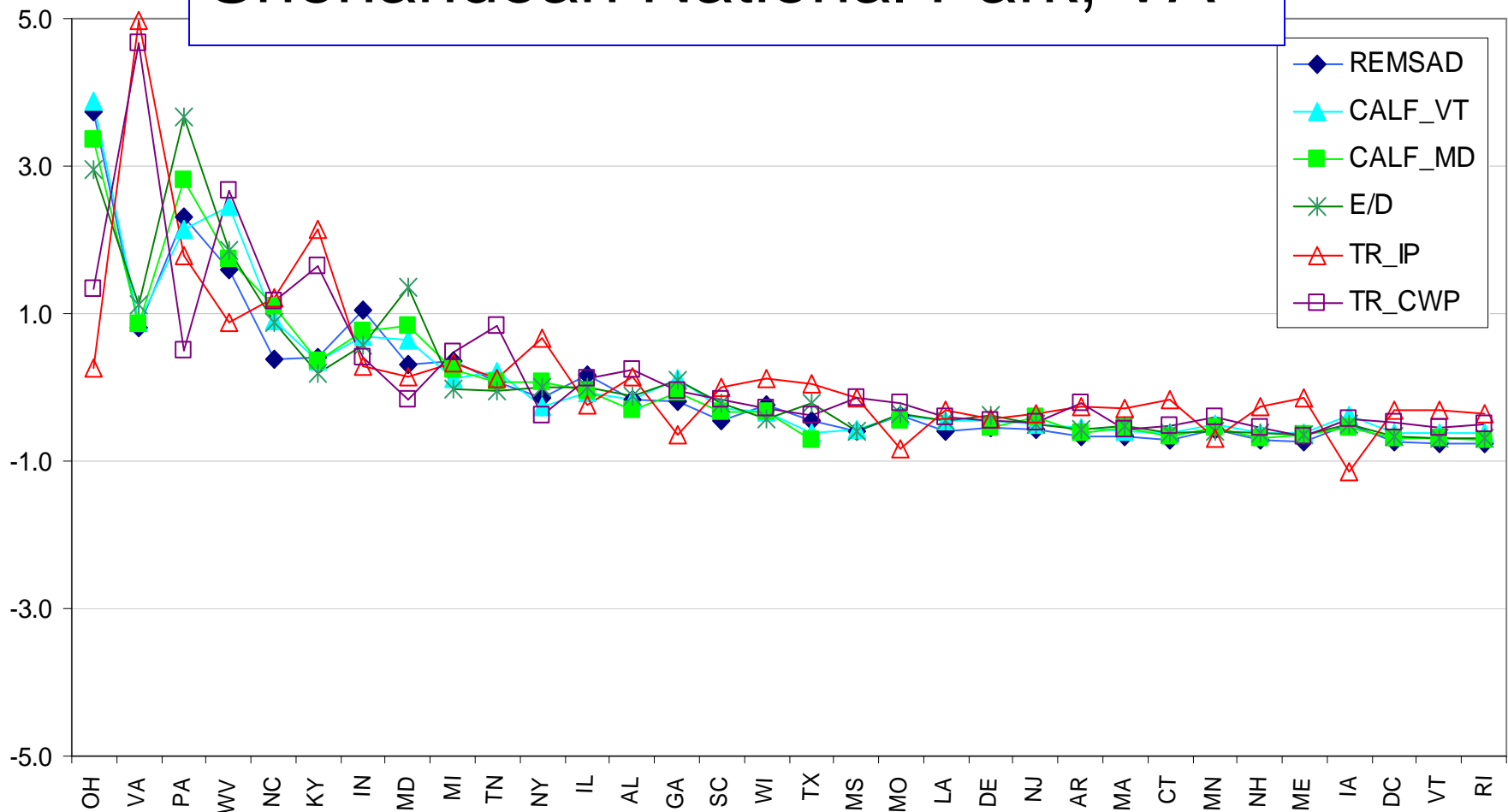
Multiple Ranking Techniques

Lye Brook Wilderness, VT



Multiple Ranking Techniques

Shenandoah National Park, VA



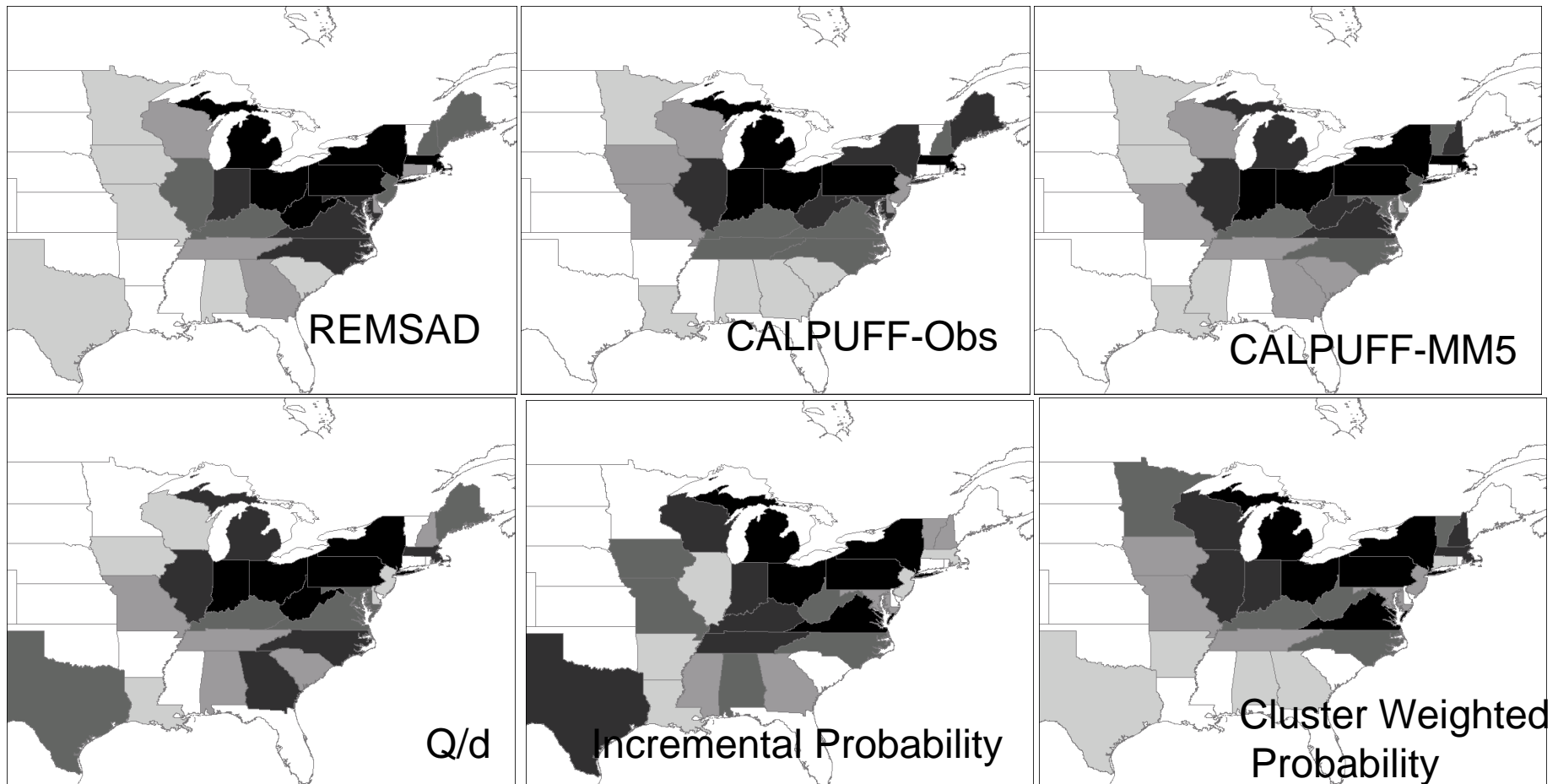
Alternative ways view results

ACADIA:

Ranked contributions to annual average sulfate by multiple techniques

AVG	REMSAD	CALF_VT	CALF_MD	E/D	TR_IP	TR_CWP
PA	PA	OH	PA	PA	PA	NY
OH	OH	PA	OH	OH	NY	PA
NY	NY	MA	NY	IN	OH	MI
MI	MA	IN	MA	NY	MI	OH
MA	MI	MI	IN	WV	VA	VA
IN	WV	WV	MI	NC	WI	WI
WV	IN	NY	WV	IL	TN	IL
VA	MD	IL	IL	MA	IN	IN
IL	VA	ME	NH	MI	KY	MA
KY	NC	MD	VA	GA	TX	NH
NC	NH	KY	KY	ME	AL	KY
MD	ME	VA	NC	KY	MO	WV
NH	IL	NC	MD	MD	IA	VT
WI	KY	NH	NJ	TX	NC	MN
TN	NJ	TN	VT	VA	WV	NC
GA	WI	MO	TN	AL	VT	MO
MO	TN	WI	WI	TN	GA	IA
NJ	GA	NJ	MO	NH	NH	NJ
AL	CT	IA	GA	MO	MD	MD
IA	DE	DE	SC	SC	MS	TN
TX	AT	CA	IA	WI	MA	CT

Alternative ways view results



Ranked contributions to annual average sulfate grouped in quintiles for each technique

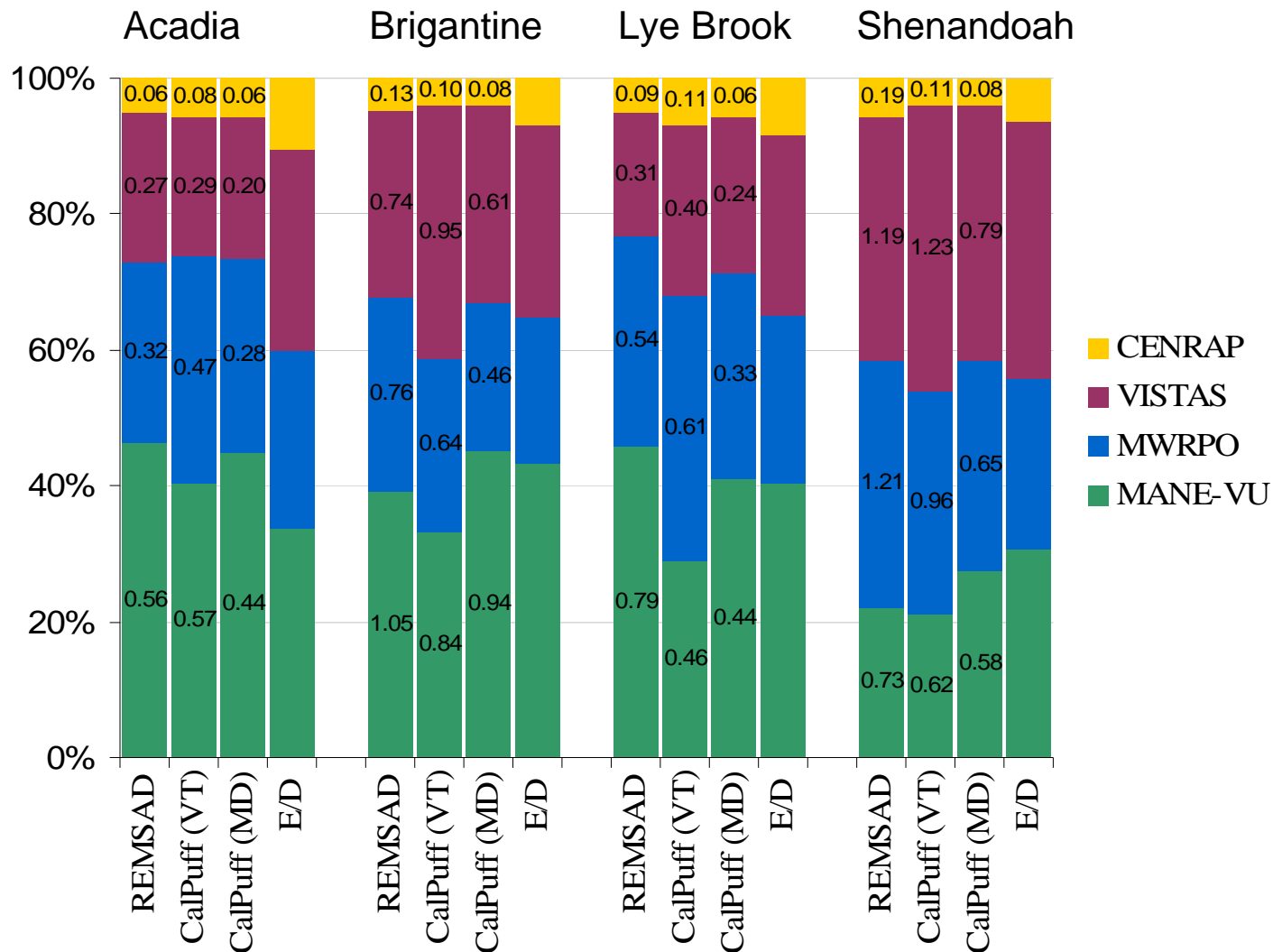
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March 15, 2004

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Relative contribution of RPOs?

(to sulfate only; not including Canada yet)



Timeline for Control Strategy Modeling

- Base Case Inventory: Complete
- Projection Inventories: Sept. 2005
- Control Strategy Inventories: October/November 2005
- Base Case Modeling: June/July 2005
- OTB/OTW modeling: November/December 2005
- Control Strategy Modeling: January 2006



Brigantine
New Jersey