

# The Chemical Composition of PM2.5

*to support PM Implementation*

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AQAG/AQAD USEPA

For Presentation at  
EPA State / Local / Tribal Training Workshop: PM 2.5 Final Rule Implementation and 2006 PM 2.5  
Designation Process  
June 20-21

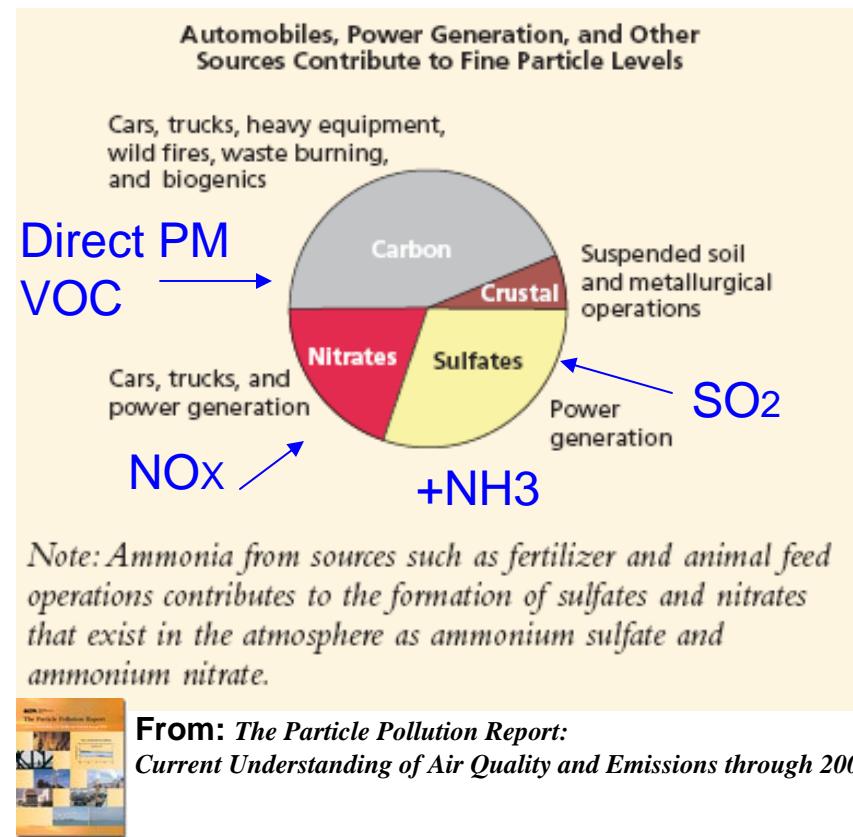
# Topics

- How do we derive FRM PM2.5 composition
- How does avg composition vary by region, by season and over time
- Variation within urban areas
- What are the local vs regional components and how does this relate to potential emission sources
- Differences between peak day and average composition

# What is the composition of PM2.5 and where does it come from?

## Major components

- Ammonium Sulfate
- Ammonium Nitrate
- Organic Carbonaceous Mass
- Elemental Carbon
- Crustal Material

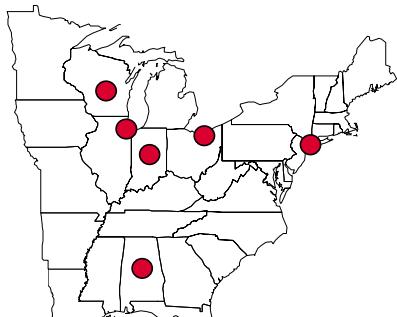


The chemistry is complicated and particle formation is dependent on other pollutants and atmospheric conditions

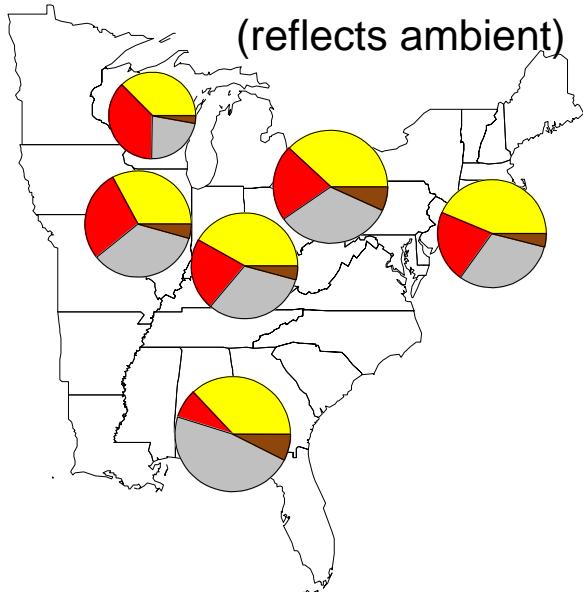
# To estimate urban PM2.5 composition

- Use measurements from routine monitoring networks
  - STN, SLAMS (=CSN)
- Make adjustments to represent FRM mass
- *FRM mass does not equal the simple sum of the measured components*  
*[i.e.  $PM2.5 \neq AmmSul + AmmNitr + OCM + EC + Crustal$ ]*

## 6 Nitrate Study Sites, 2003

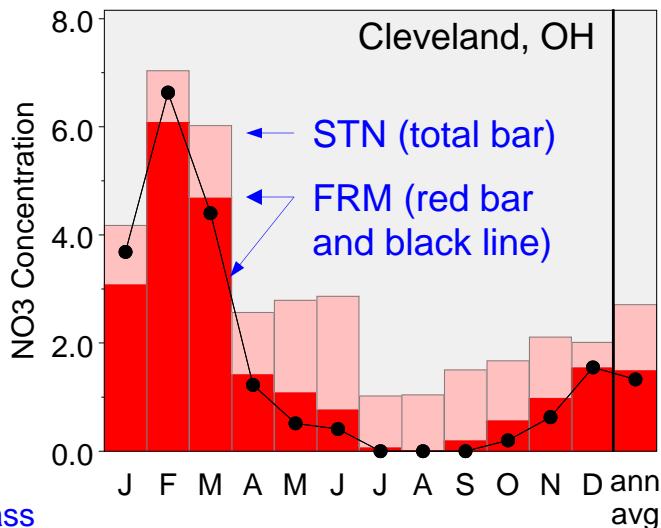


Reconstructed Fine Mass  
**RCFM**



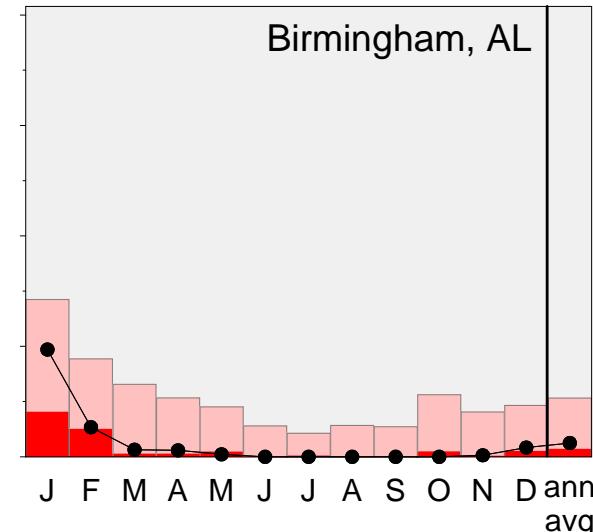
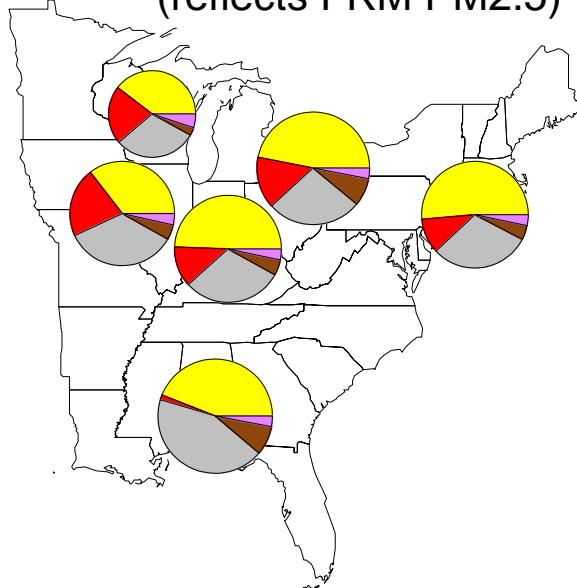
## FRM doesn't retain all ambient nitrates

Monthly and Annual Average NO<sub>3</sub>, 2003



**SANDWICH**

(reflects FRM PM<sub>2.5</sub>)



PM<sub>2.5</sub> mass also includes  
particle bound water  
(at mass weighing conditions)

### FRM Compared to Speciation Network Measurements

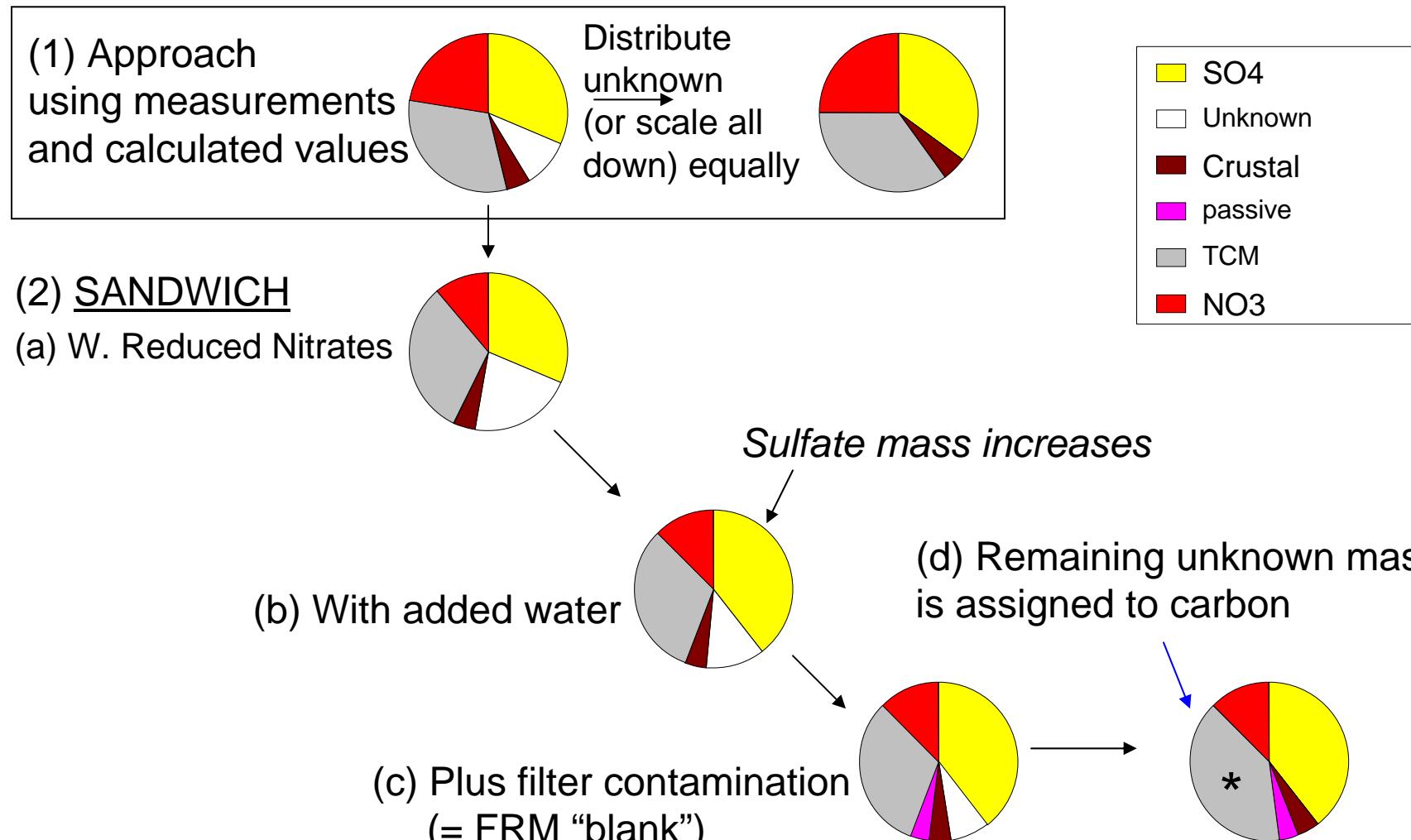
- Less Nitrate
- Includes particle bound water
- Carbon achieves mass balance and reflects all needed adjustments

# SANDWICH

## more than a cute acronym

- What is the **SANDWICH Approach?**
  - Sulfate, Adjusted Nitrate, Derived Water, Inferred Carbon Hybrid material balance approach
    - for estimating PM2.5 mass composition as if it was measured by the PM2.5 FRM.
  - The approach uses a combination of speciation measurements and modeled speciation estimates to represent FRM PM2.5.
- Why is it needed?
  - The FRM defines the regulatory indicator of PM2.5.
  - FRM mass may not retain all nitrate, and includes particle bound water and other components not estimated directly with STN measurements.
  - To estimate FRM PM2.5 composition including FRM carbonaceous mass without “fudge” factors.
  - To help QC speciation measurements
- SANDWICH is the default method in EPA modeling guidance to define baseline PM2.5
  - for SMAT (speciated modeled attainment test)
  - “FRM” composition with the peer-reviewed “*SANDWICH*” technique used in CAIR and PM2.5 RIA

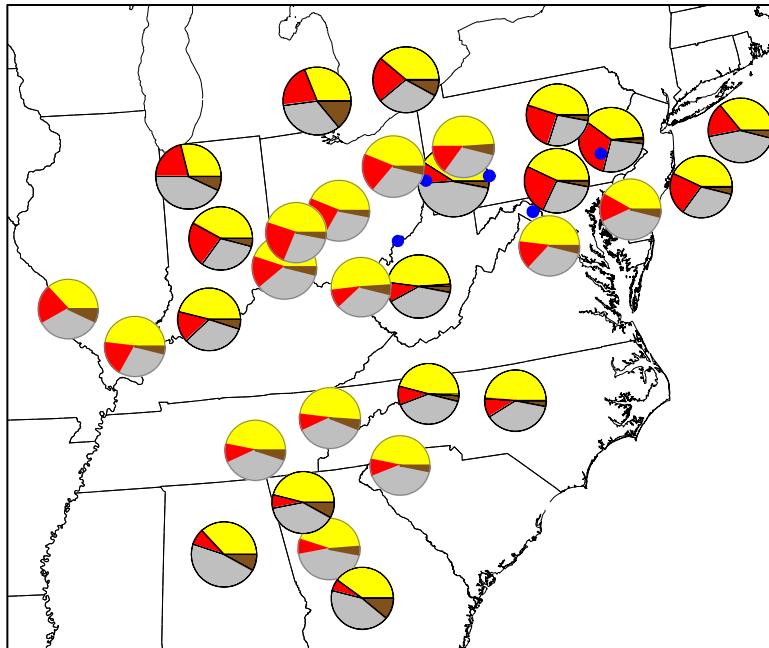
# Conceptual Overview of Mass Balance Approaches



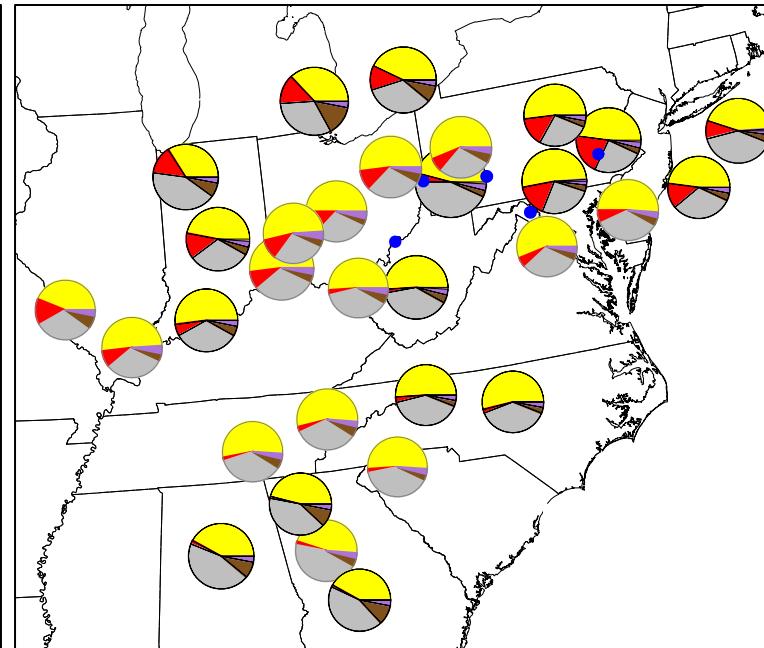
# Annual Average Composition (2002-04) in East NA areas

Less nitrate and more sulfate mass with SANDWICH

RCFM



SANDWICH



area	area_annual_dv
NA area: Johnstown, PA	15.3
NA area: Martinsburg, WV-Hagerstown, MD	16.1
NA area: Parkersburg-Marietta, WV-OH	15.2
NA area: Reading, PA	16.1
NA area: Steubenville-Weirton, OH-WV	17
NA area: Wheeling, WV-OH	15.1

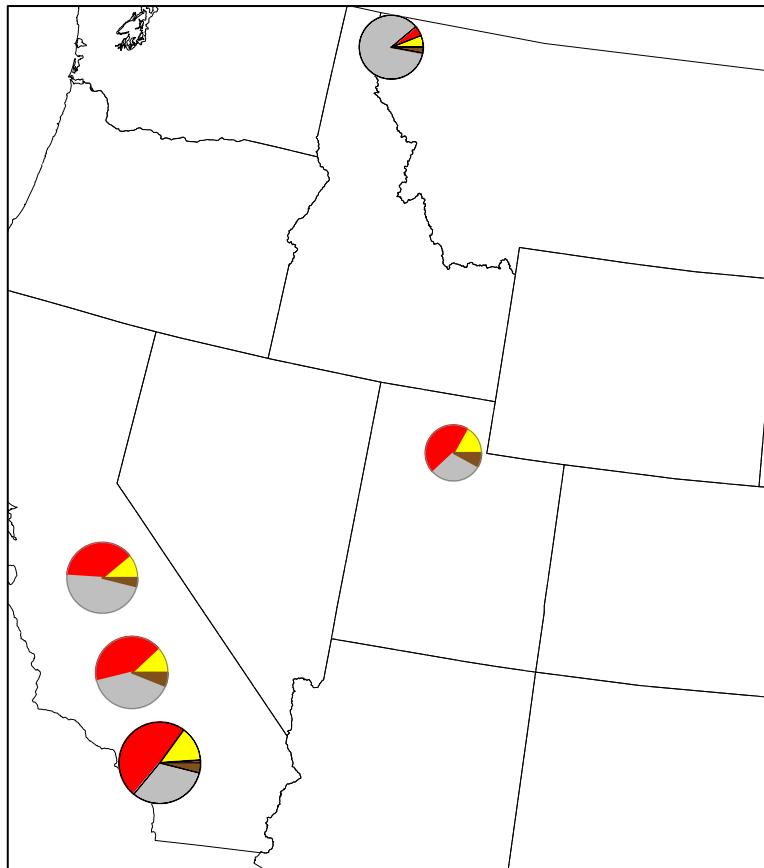
- NA area without STN data (02-04)

Black outlined pies had collocated FRM and speciation

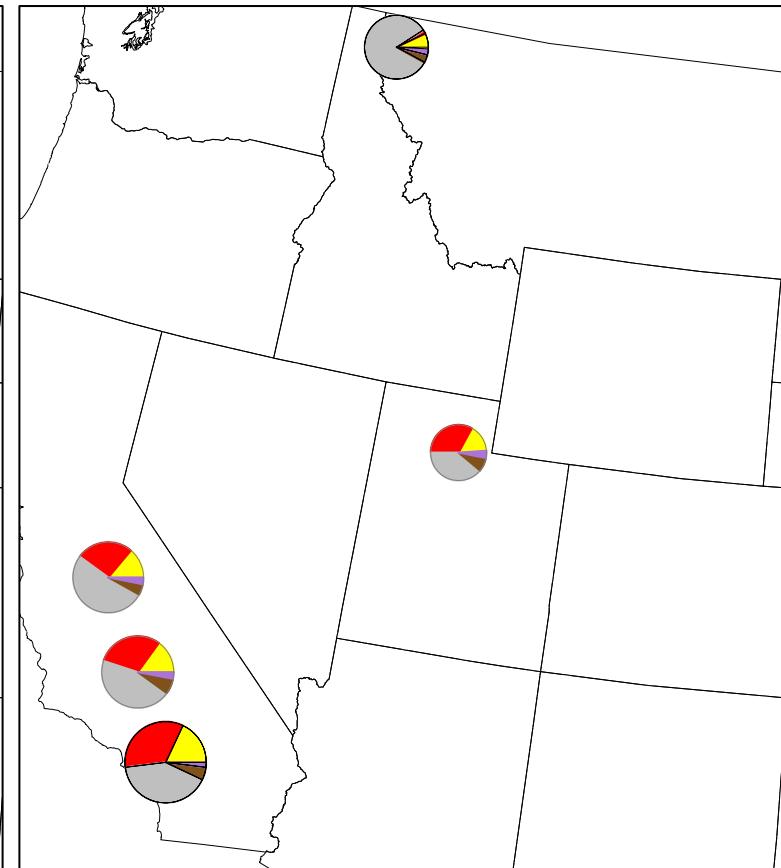
# Annual Average Composition (2002-04) in West NA areas

Less nitrate and more carbon mass with SANDWICH

RCFM

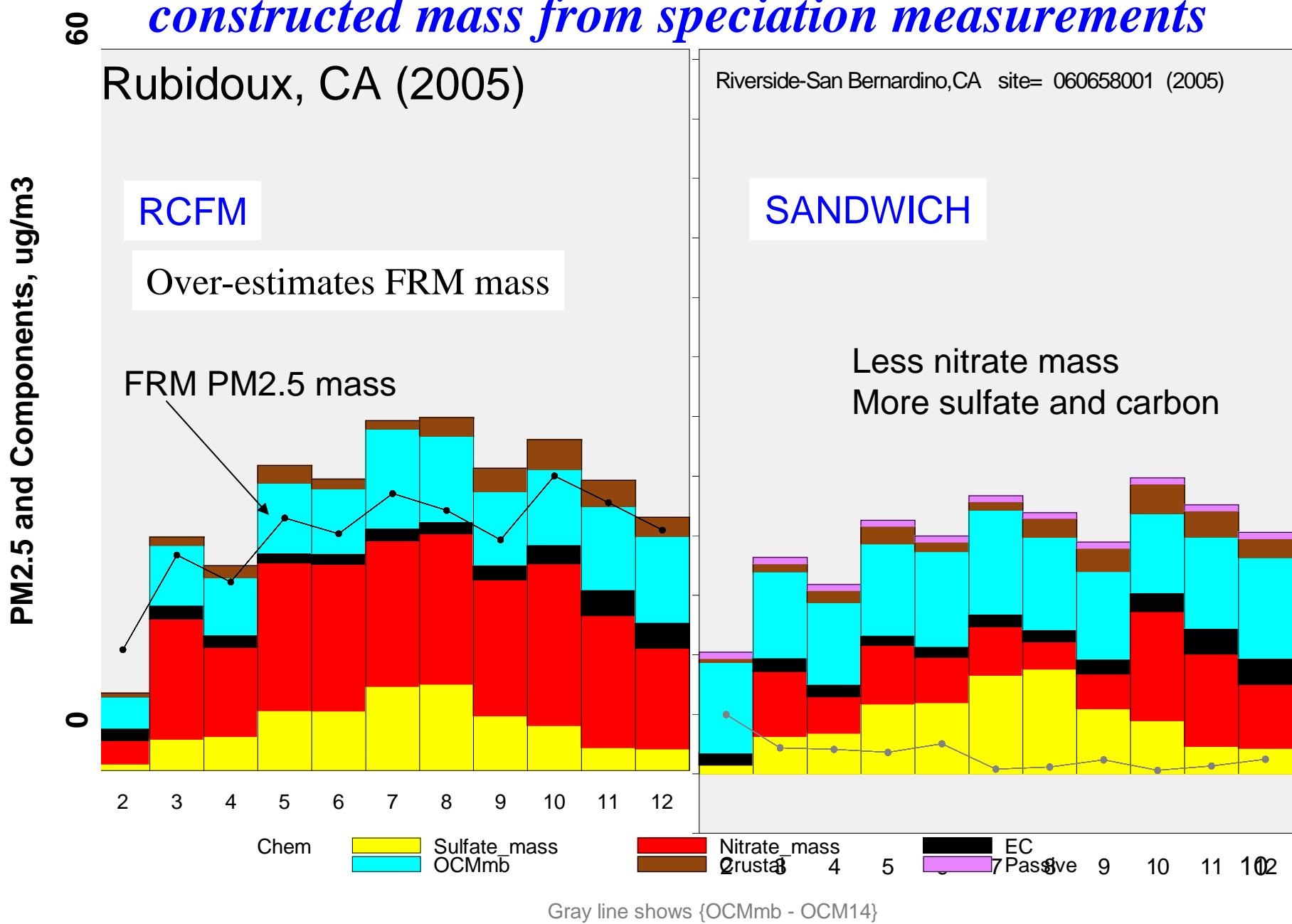


SANDWICH

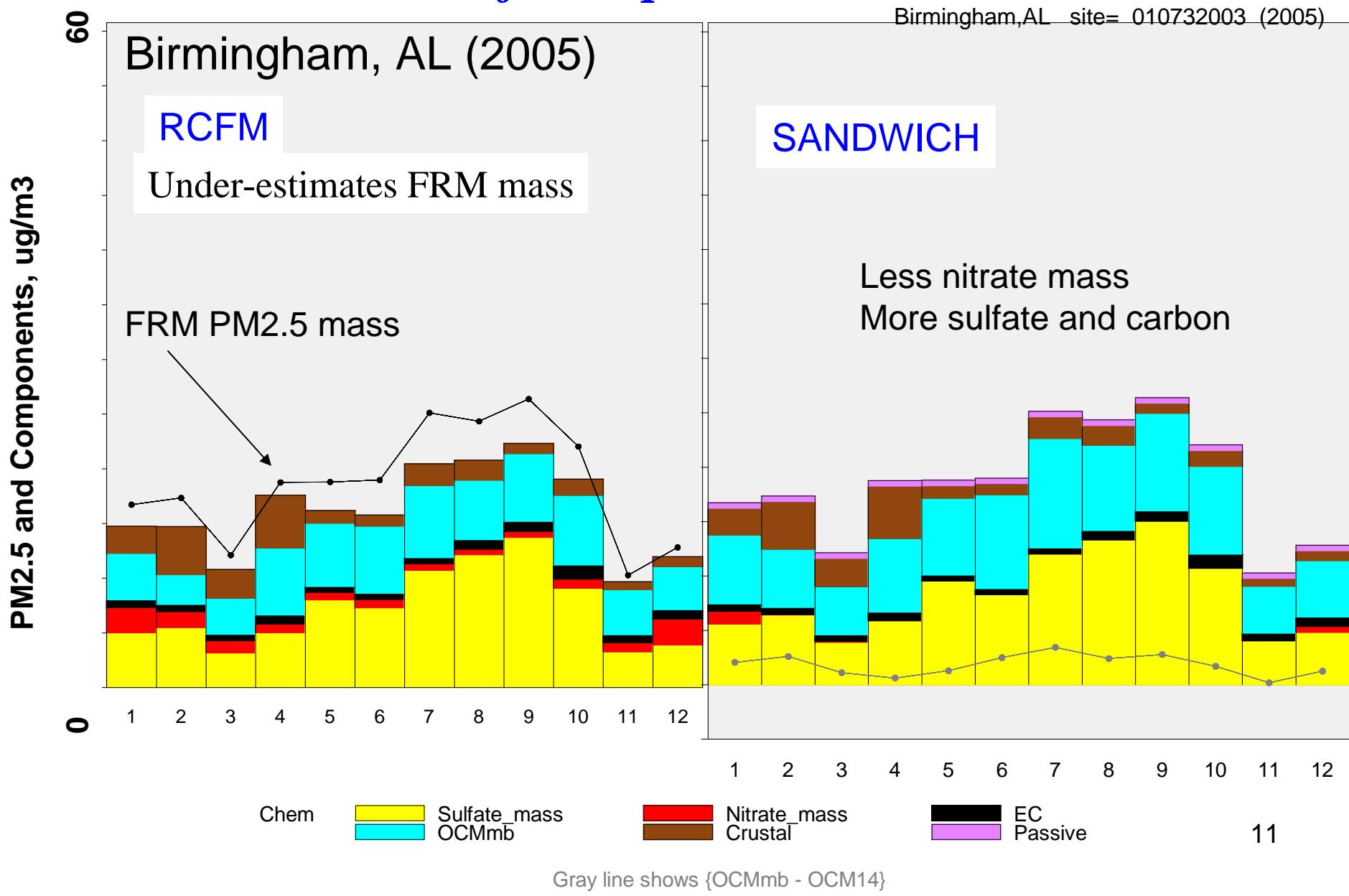


Black outlined pies have collocated FRM and speciation

# *FRM composition can be very different than constructed mass from speciation measurements*



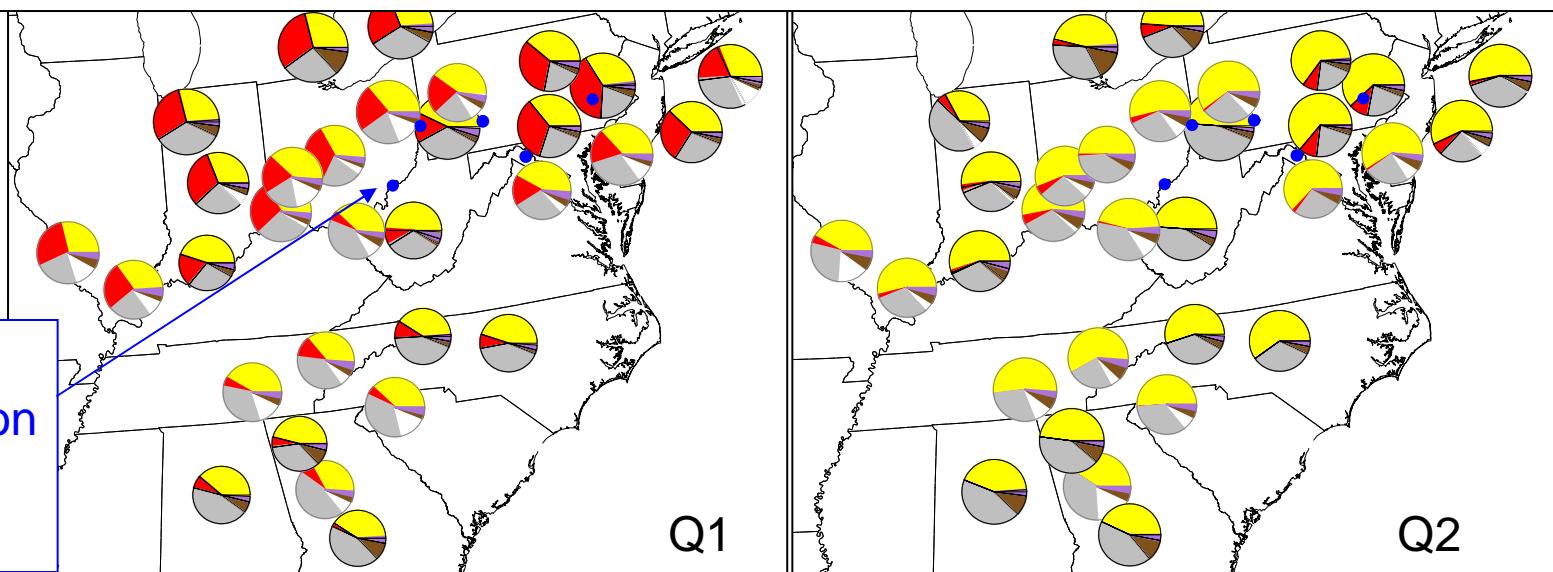
# *FRM composition can be very different than constructed mass from speciation measurements*



# Quarterly PM<sub>2.5</sub> Composition in Eastern NA areas, 2002-04

Note: Many areas do not have speciation data and some at a different site

No  
speciation  
data in  
2002-04

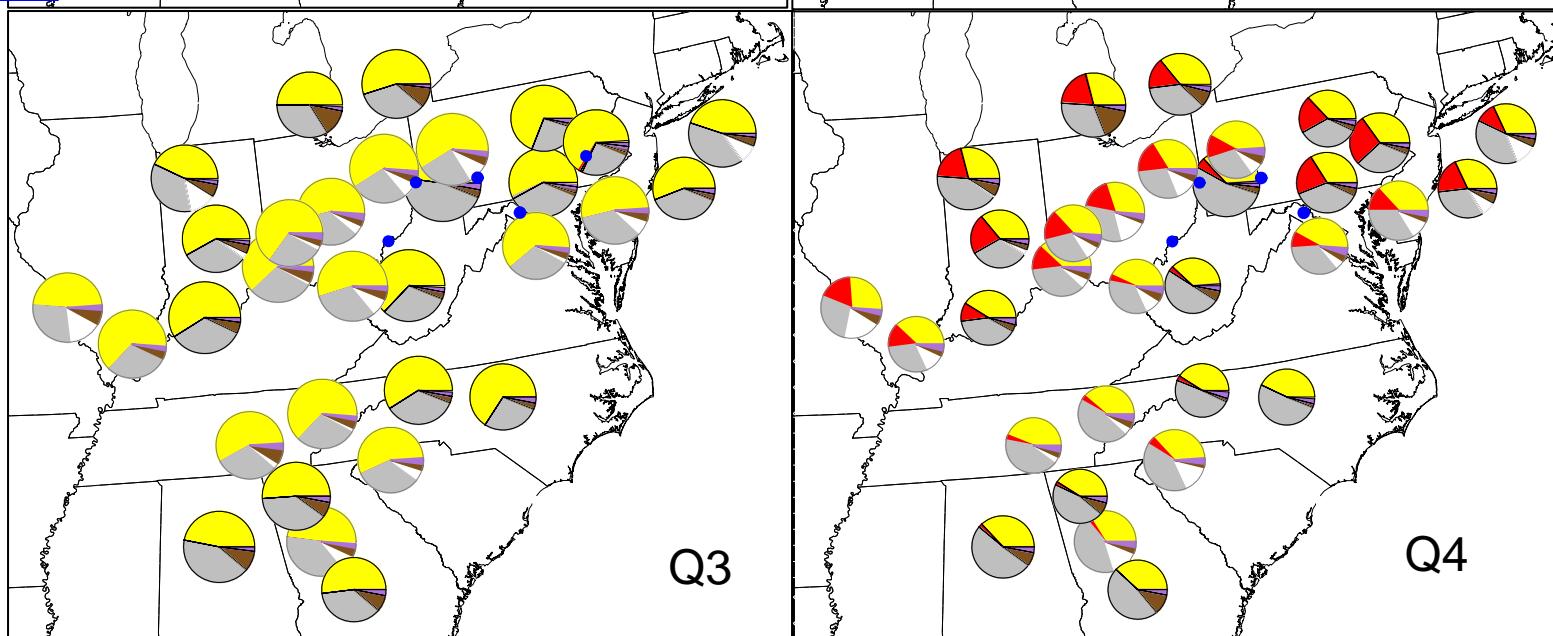


Q1

Q2

Q3

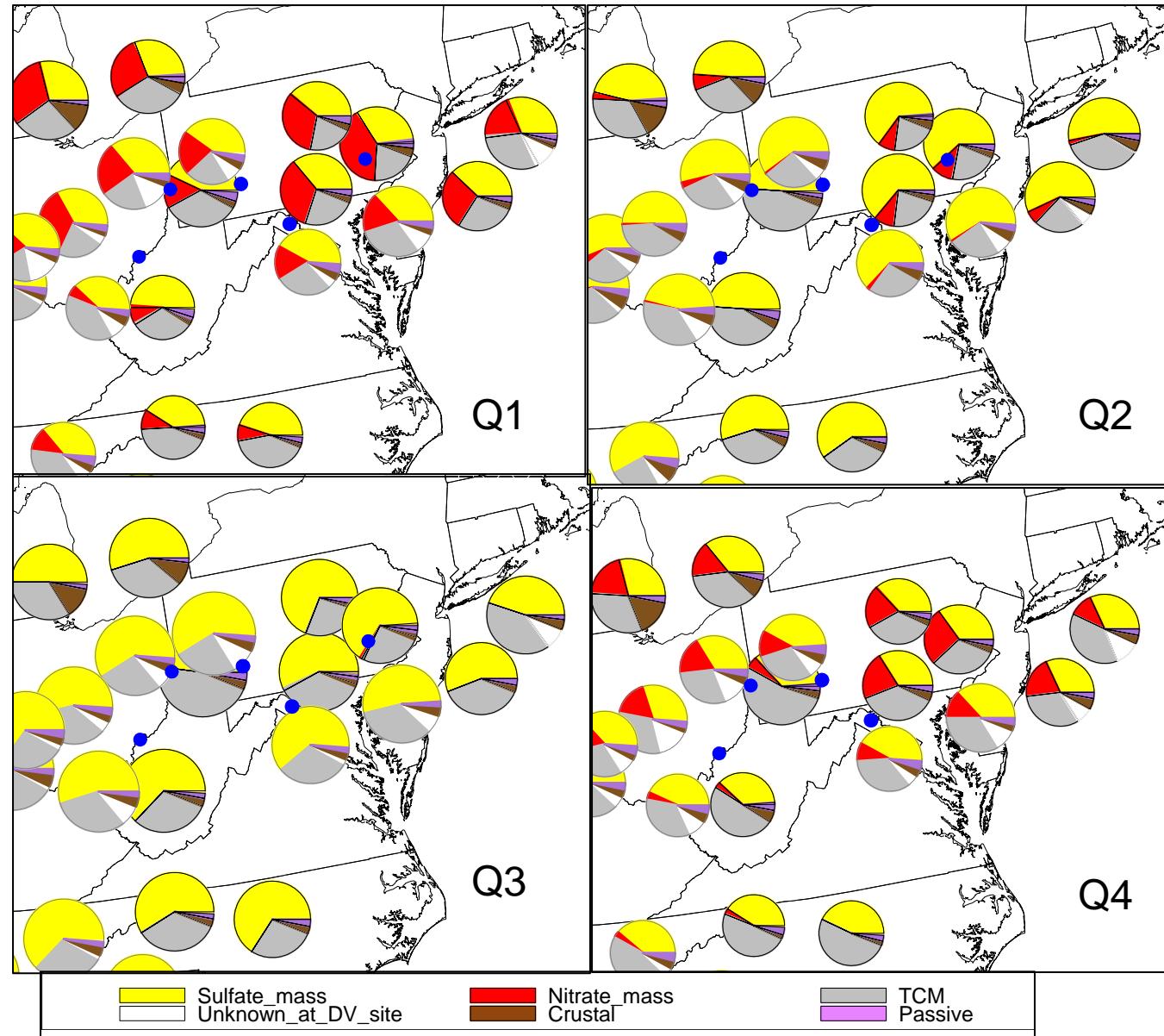
Q4



ZOOM

## Quarterly PM<sub>2.5</sub> Composition in NA areas, 2002-04

*Many areas do not have speciation data and some at a different site*



# Quarterly PM<sub>2.5</sub> Composition in Western NA areas, 2002-04

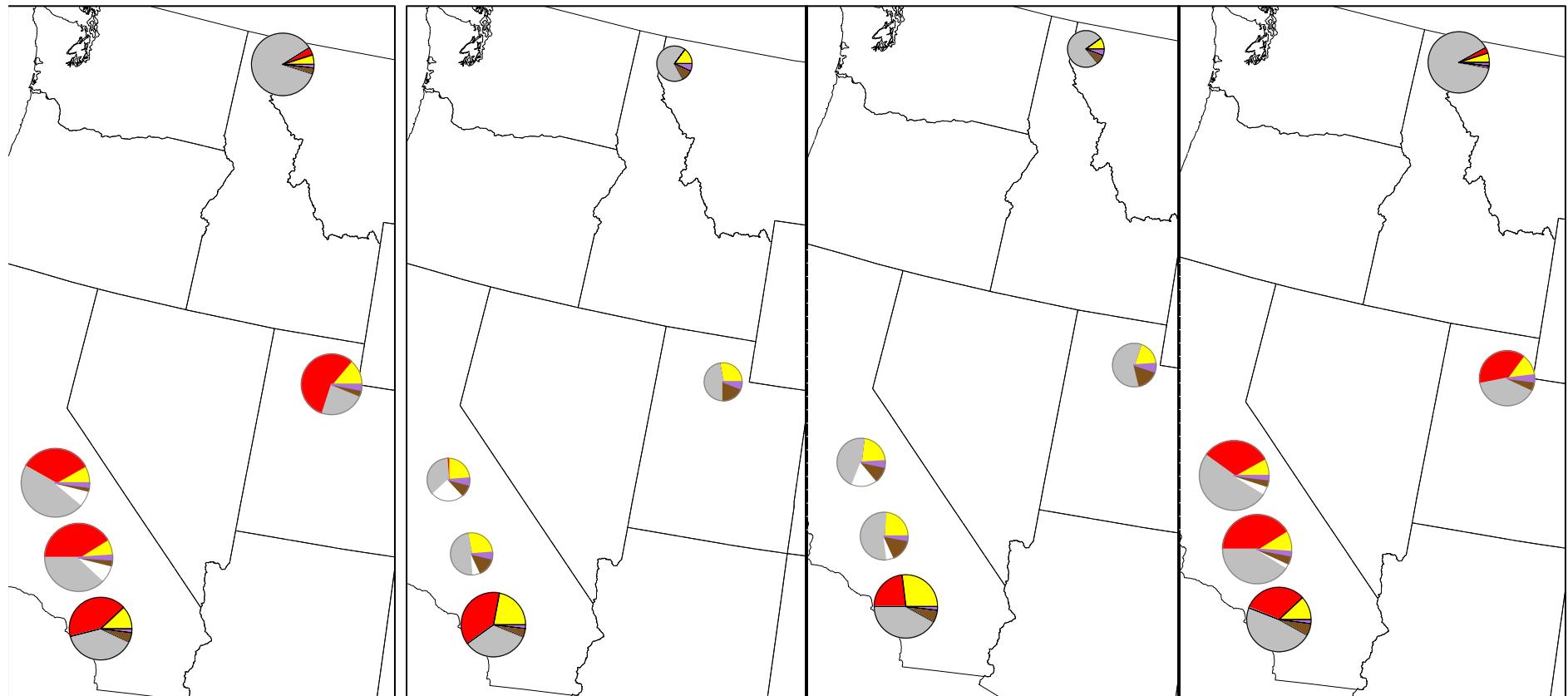
1<sup>st</sup> and 4<sup>th</sup> quarters have higher concentrations (except LA)

Q1

Q2

Q3

Q4



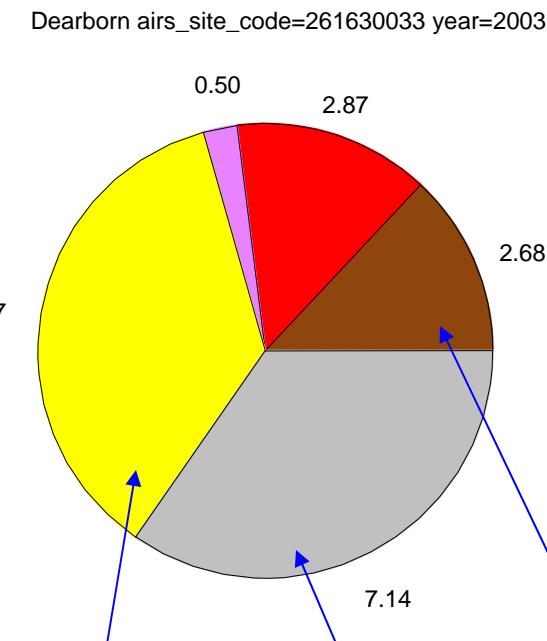
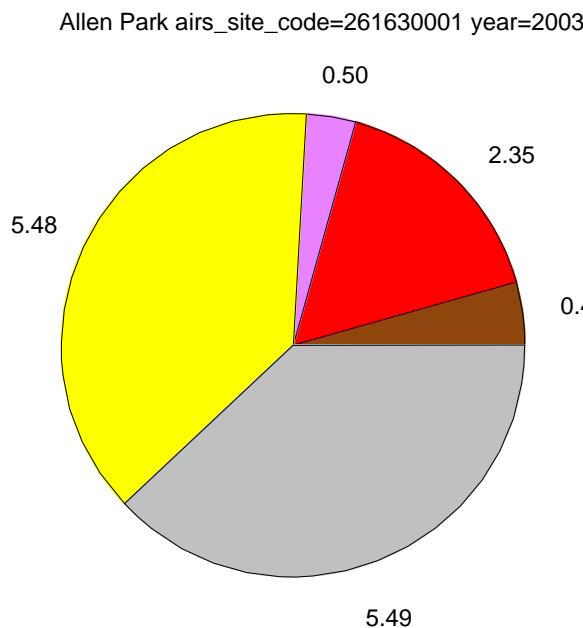
Sulfate\_mass  
Unknown\_at\_DV\_site

Nitrate\_mass  
Crustal

TCM  
Passive

# Composition Can Vary Within the NA Area

“Generally” the extra component is carbon



More sulfate, carbon and crustal

For some cities, there are gradients in non-C components

	Allen Pk	Dearborn
Sulfate Mass	5.5	7.4
Carbonaceous Mass	5.5	7.1
Nitrate	2.4	2.9
Crustal Material	0.4	2.7
PM2.5	14.22	20.56

# What to do if speciation is not at the DV site?

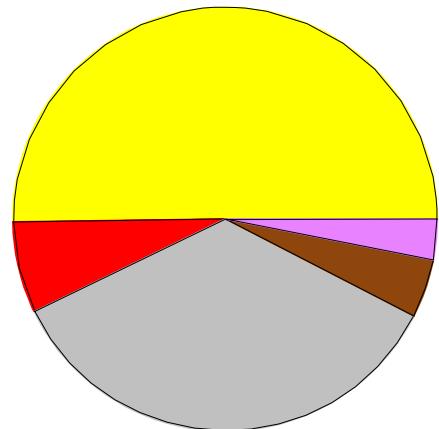
*Accounting for differences in within-area speciation profiles*

Speciation location (Ann Avg=14.9 ug/m<sup>3</sup>)

SANDWICH  
↓

7.98

1.11



DV site (16.3 ug/m<sup>3</sup>)

SANDWICH\_PacMan  
↓

7.98

1.11

5.60

0.49

0.71

1.40

1.4 ug/m<sup>3</sup> is unknown

NA area: Baltimore, MD - 240053001(2002-04)

Sulfate\_mass  
 Unknown\_at\_DV\_site

Nitrate\_mass  
 Crustal

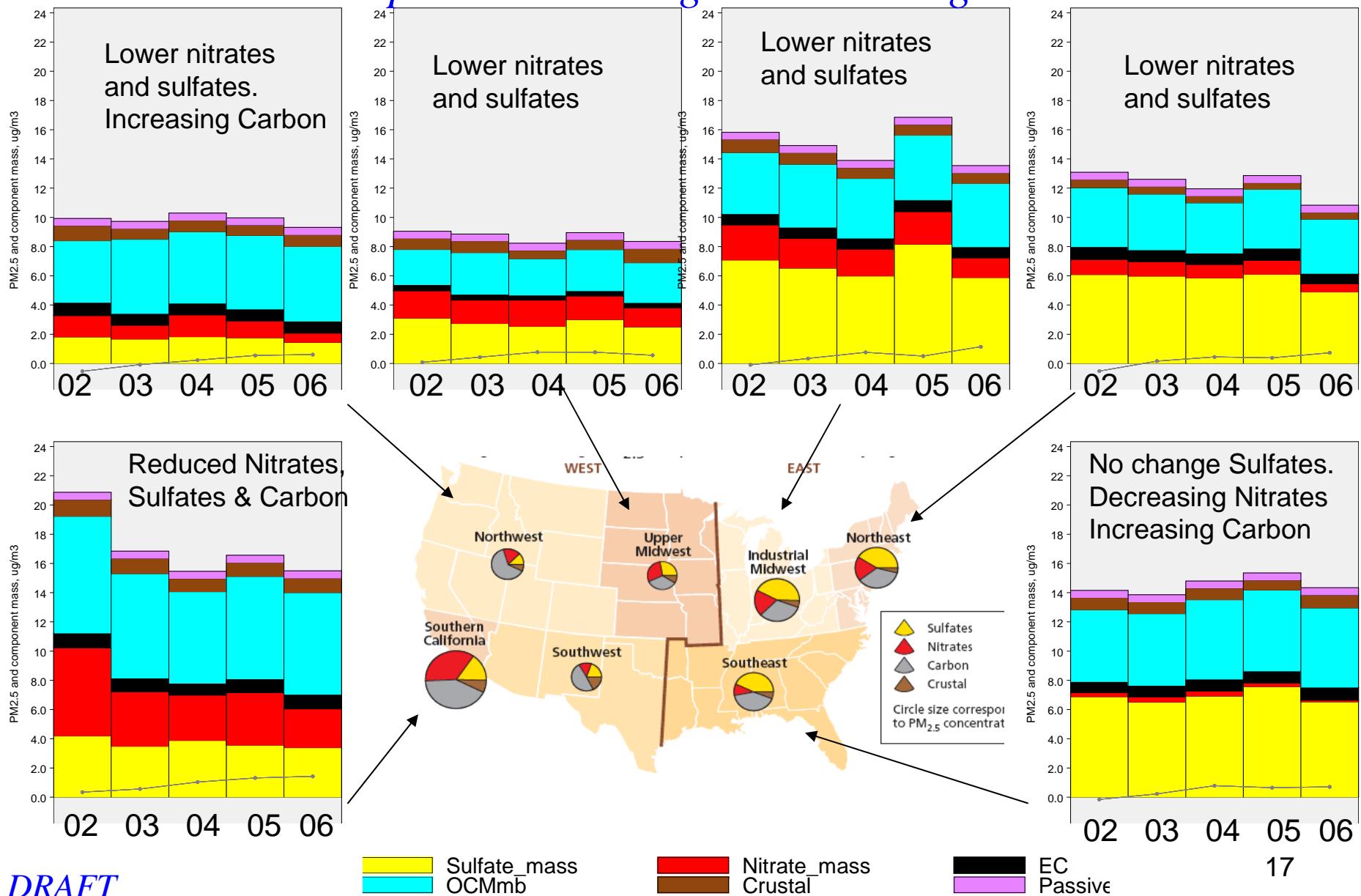
TCM  
 Passive

Baltimore (Essex speciation site) is not at DV site, 2002 speciation data

When DV site does not have speciation data, the unknown mass may or may not be TCM  
It could be crustal material (as we observe in Birmingham and Detroit) or possibly Nitrate

# Regional Trends in PM<sub>2.5</sub> Composition, 2002-2006

*Compositional changes in some regions*



DRAFT

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# SANDWICH data are now available on Air Explorer

<http://www.epa.gov/airexplorer/>

**AIR Explorer - Microsoft Internet Explorer**

File Edit View Favorites Tools Help

Back Favorites Go Links

Address: <http://www.epa.gov/airexplorer/>

**U.S. Environmental Protection Agency**

**AIR Explorer**

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EPA Home > AIR Explorer

AIR Explorer is a collection of user-friendly visualization tools for air quality analysts. The tools generate maps, graphs, and data tables dynamically. Currently, the tools access ambient concentration data from EPA's [Air Quality System \(AQS\)](#). The criteria pollutant data were updated on March 2, 2006. The PM2.5 speciation data were updated on March 8, 2006. The benzene data were updated on February 25, 2005. This is a developmental site. We are continually designing and implementing innovative tools for analyzing and communicating air quality information.

UPDATE (3/8/2006) The PM2.5 speciation data were updated.  
UPDATE (3/2/2006) The criteria pollutant data were updated.

**MAPS**

**Map One Day**  
Generate a three-dimensional, interactive map of daily pollutant concentrations

**Map Several Days**  
Generate an animated series of daily concentration maps for a specific time period

**Title AQI Values**  
Plot daily AQI values for a specific location and time period

**GRAPHS**

**Plot Concentrations**  
Generate a time series plot for a specific location and time period

**Plot AQI Values**  
Plot PM2.5 and Ozone AQI values for a specific location and time period

**Plot Speciation Data**  
Plot daily PM2.5 speciation data for a specific location and time period

**DATA**

**Query Concentrations**  
View or download daily concentrations for a specific location and time period

**Query Speciation Data**  
View or download daily PM2.5 speciation data for a specific location and time period

**Query Benzene Data**  
View or download benzene data for a specific location

**Red circles highlight the following links:**

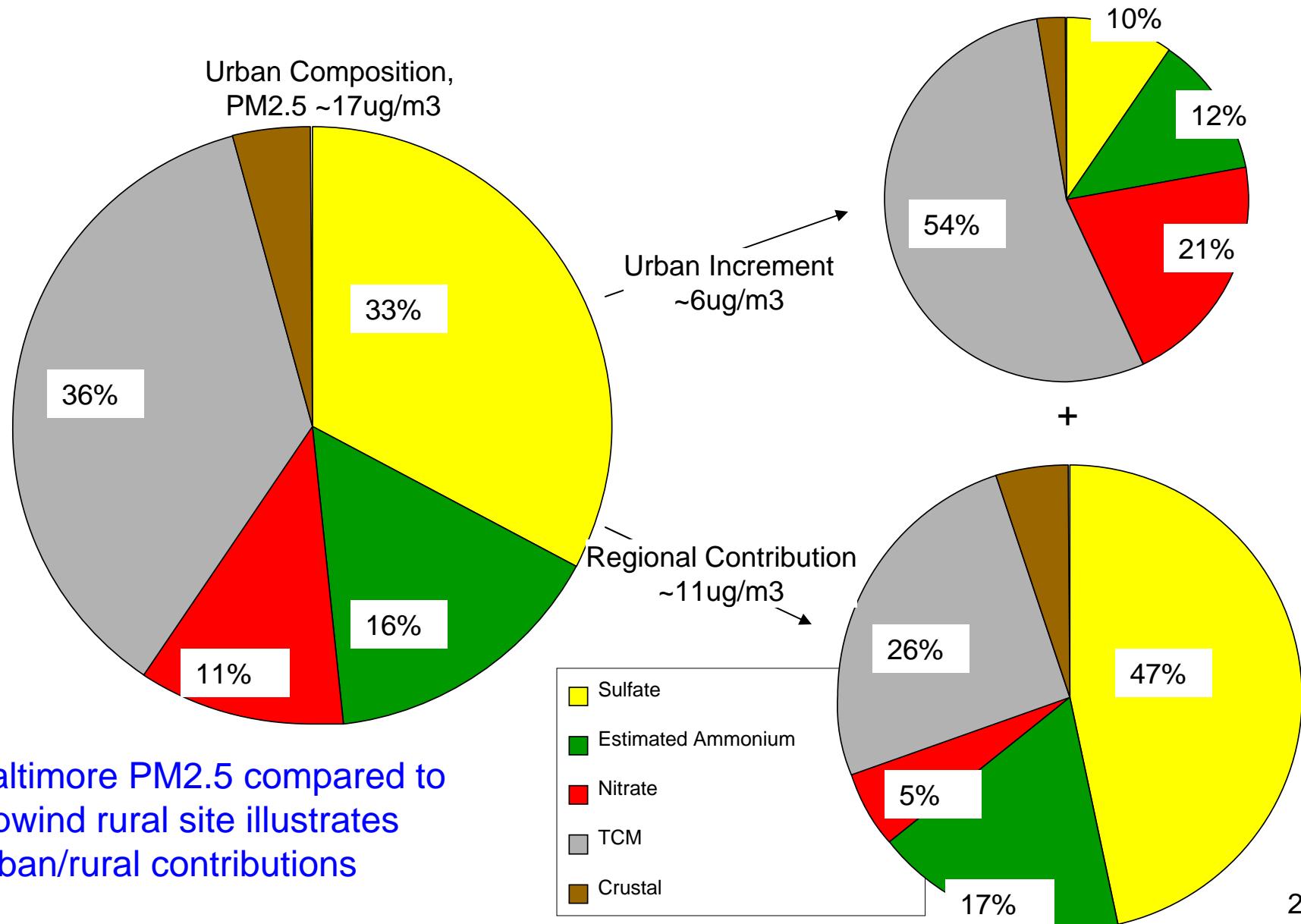
- Query Concentrations
- Query Speciation Data
- Query Benzene Data

Internet

start Neil Frank - Inbox - L... Microsoft PowerPoint ... AIR Explorer - Micro... 11:23 AM

# The Urban Excess

# Urban PM2.5 is Composed of Urban and Regional Components



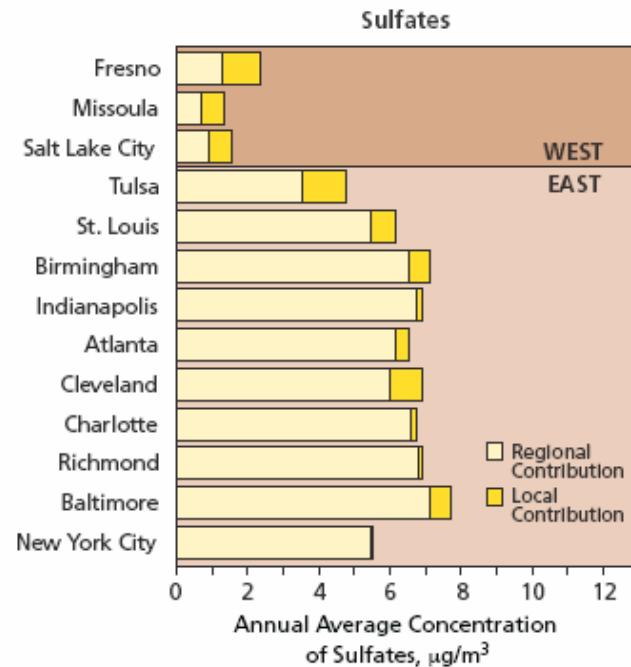
Baltimore PM2.5 compared to  
Upwind rural site illustrates  
urban/rural contributions

Based on constructed mass (not SANDWICH), March 01 – Feb 02

# Urban PM2.5 is Composed of Urban and Regional Components

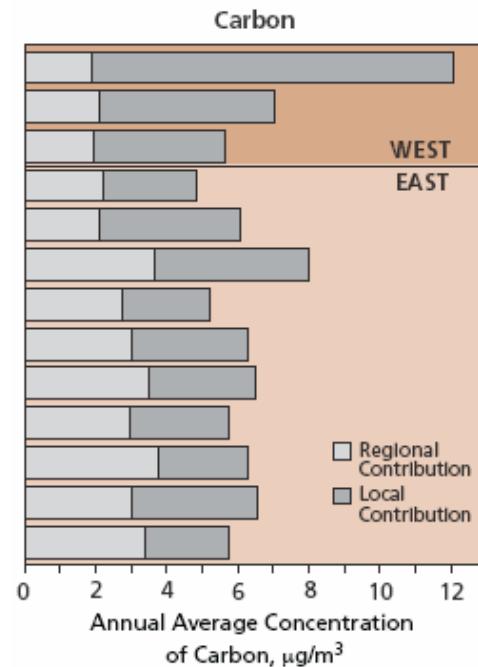
## Sulfates

- Most from regional sources



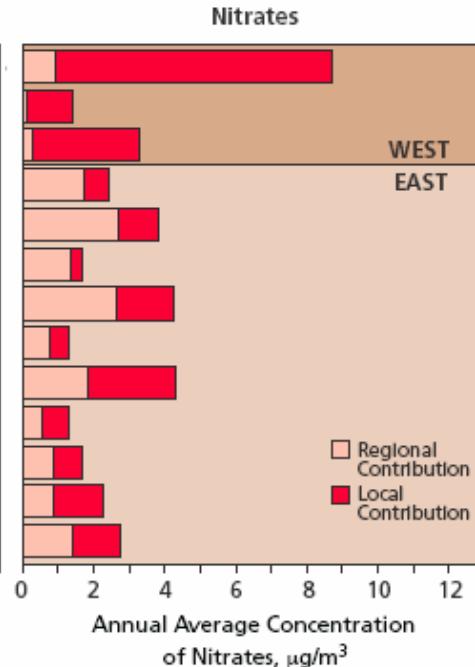
## Carbon

- Large PM2.5 component
- Local contribution (40-70%)



## Nitrates

- 10-30% of PM2.5
- Some east avg. ambient nitrates ~4  $\mu\text{g}/\text{m}^3$
- Local contribution  $\geq 50\%$

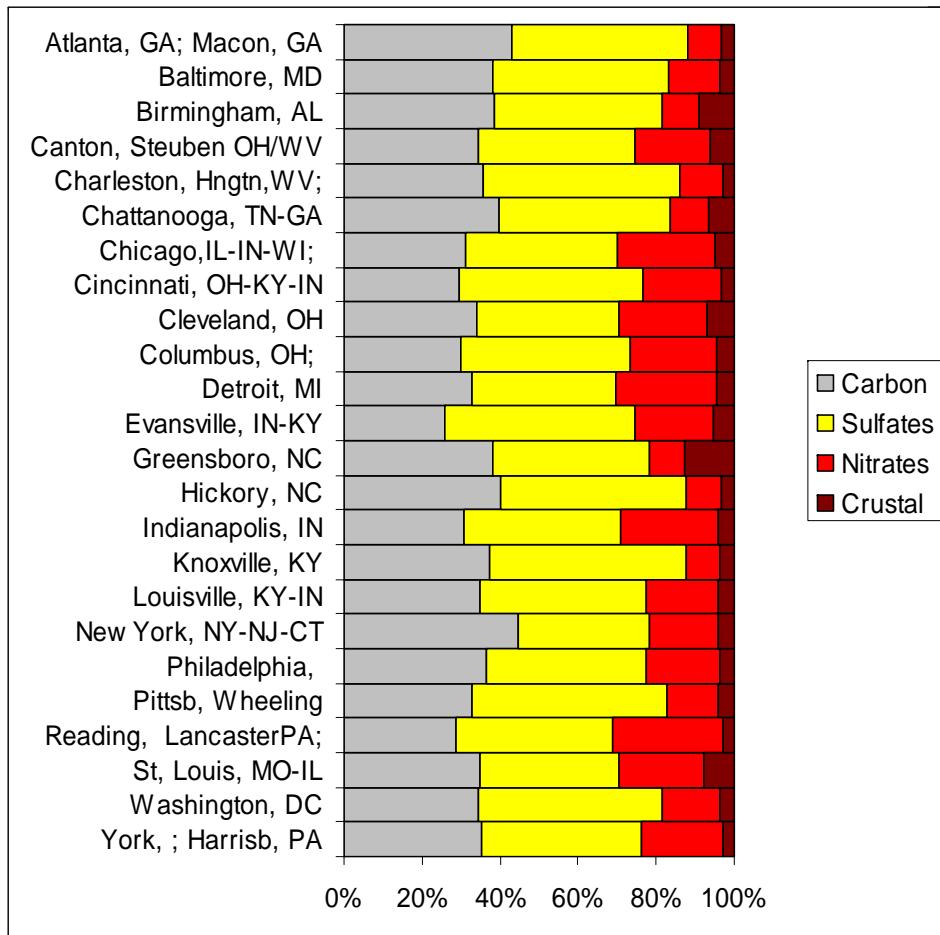


*From Particle Pollution Report, 2003  
Comparing single urban and rural locations*

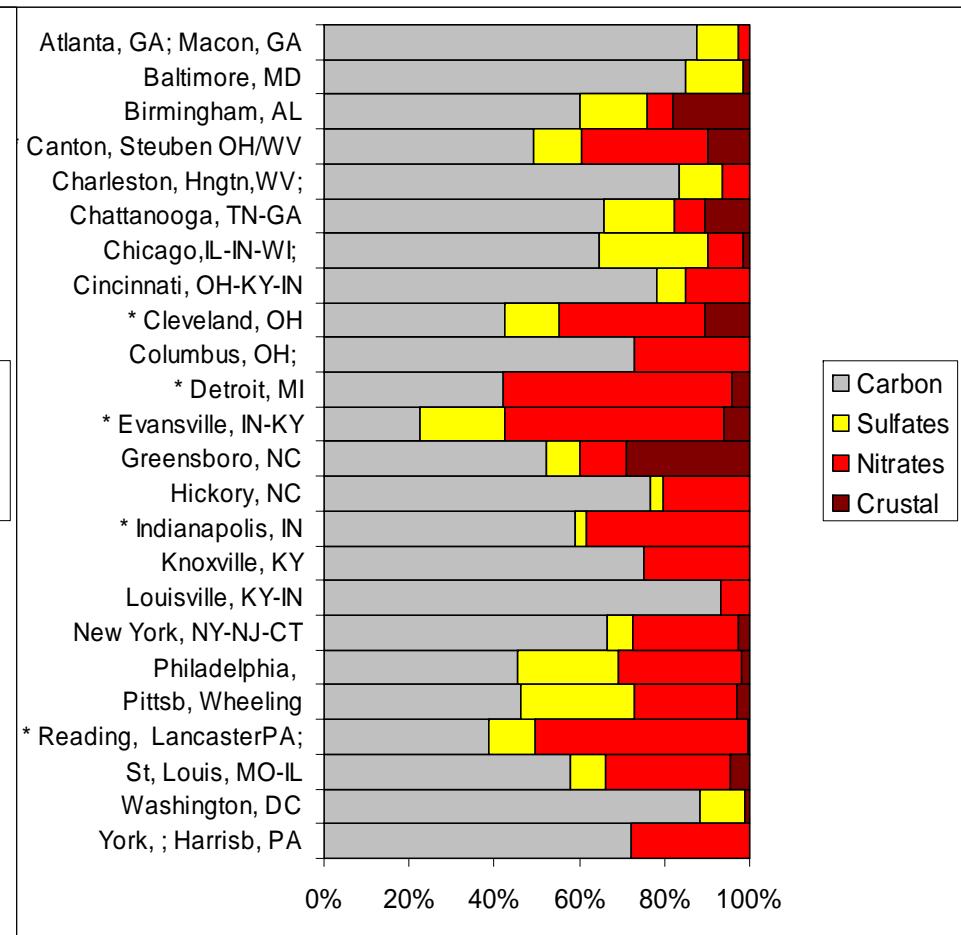
# Carbon and Nitrates dominate the average local urban excess

## Composition of Eastern PM2.5 Non-Attainment Areas

Estimated PM2.5 Composition



Estimated Urban Excess



22  
\* Indicates areas with > 30% UE nitrates

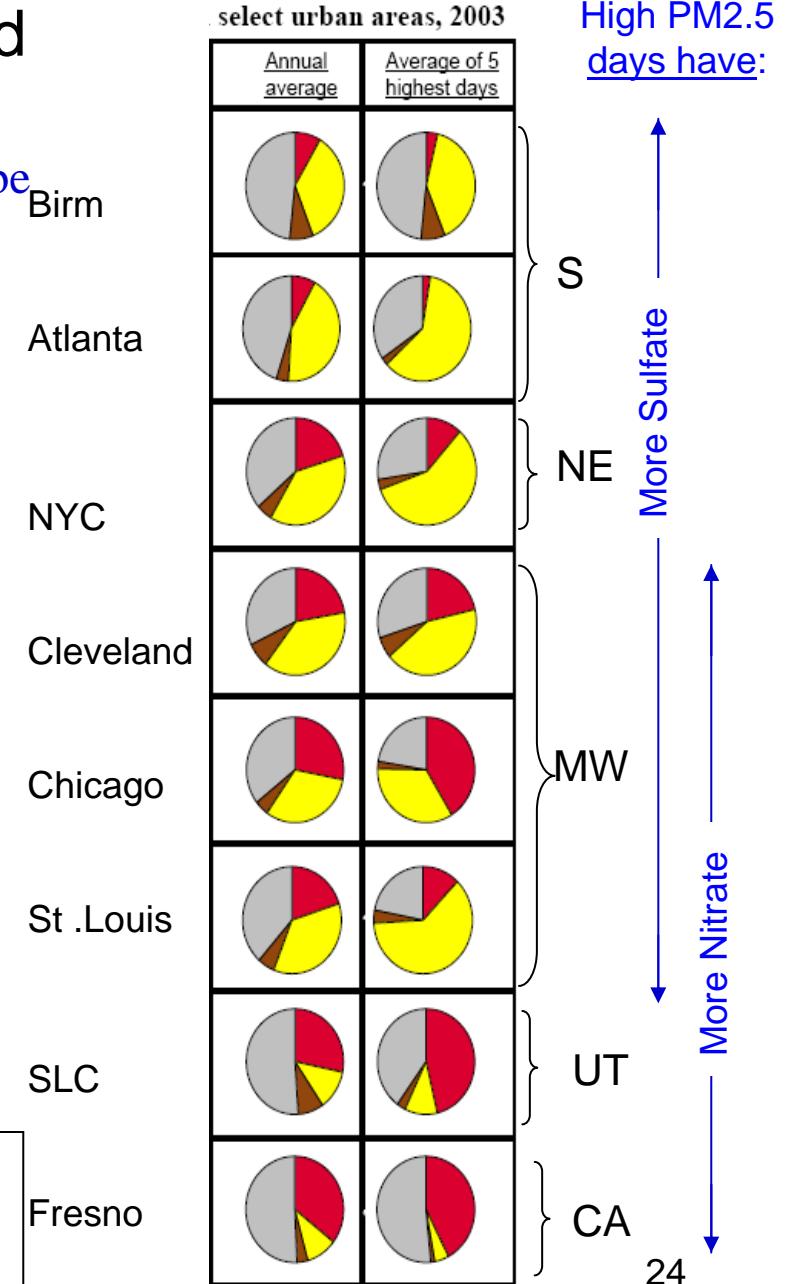
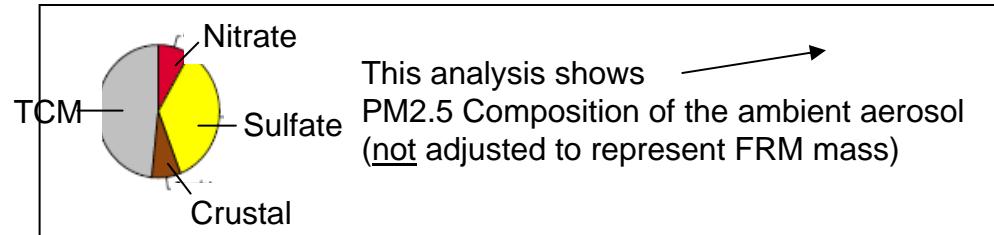
## High Day vs. Average Composition

*Average Concentration is based on all days but is strongly influenced by the highest concentration days*

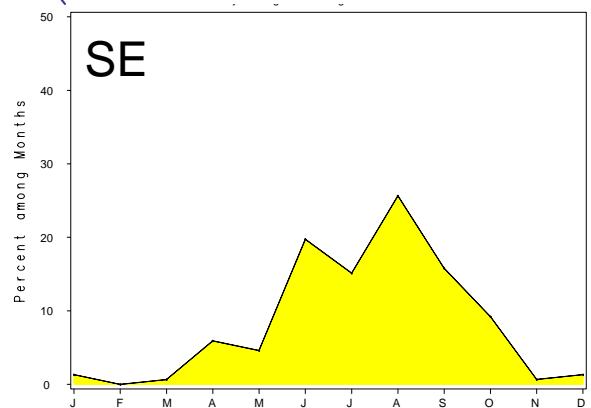
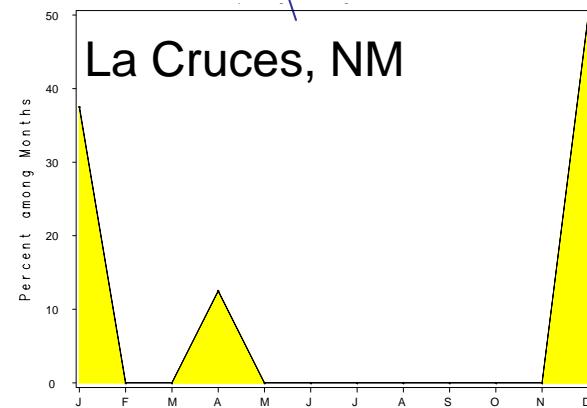
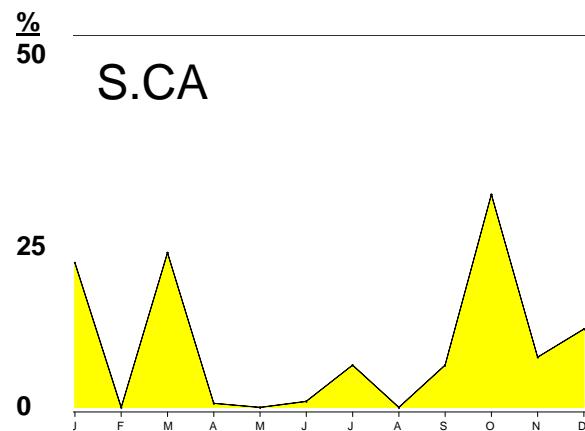
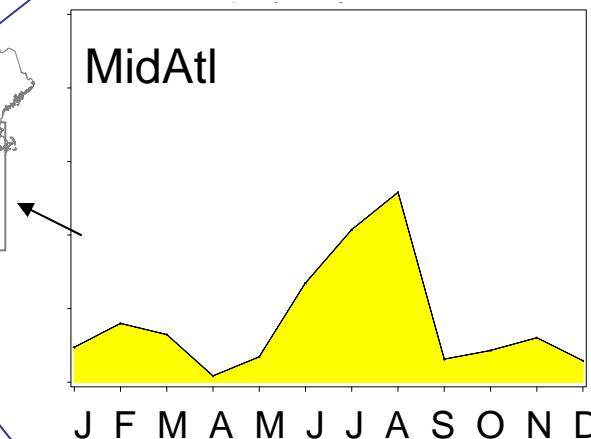
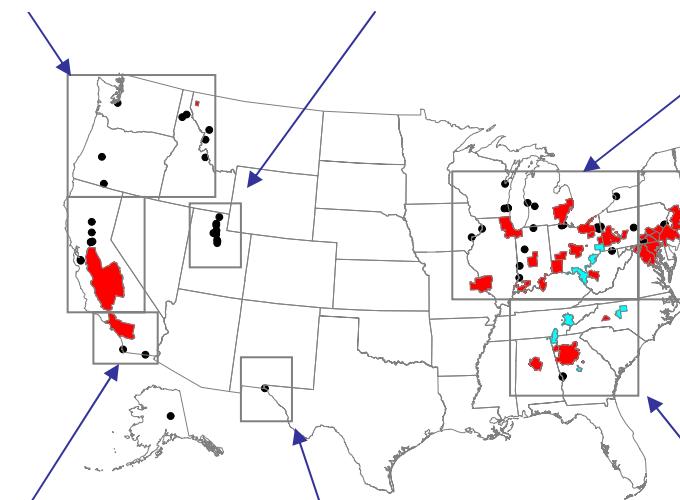
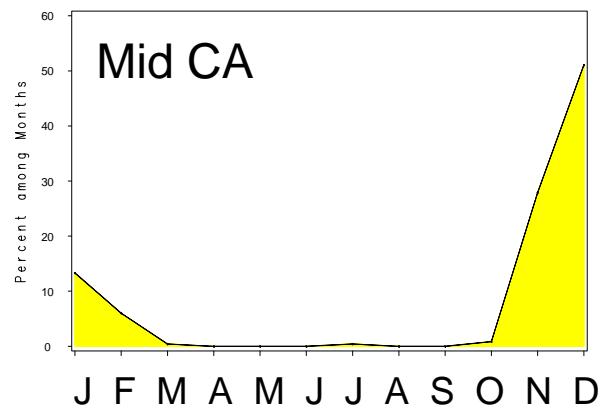
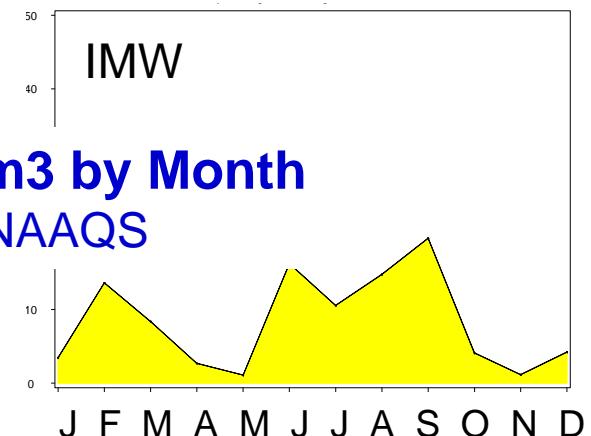
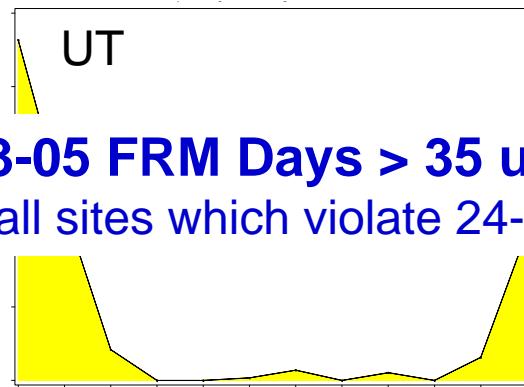
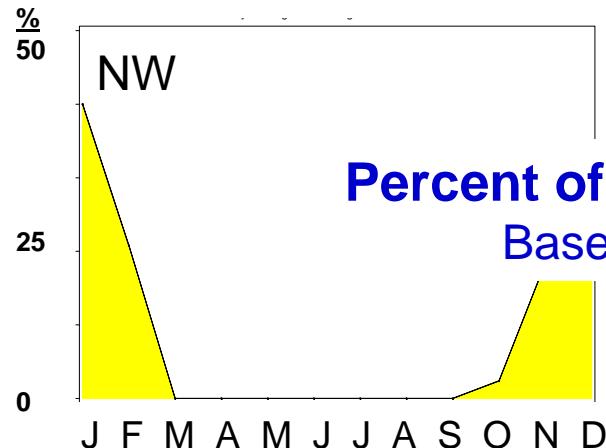
# Composition on Annual Average and High PM2.5 Days

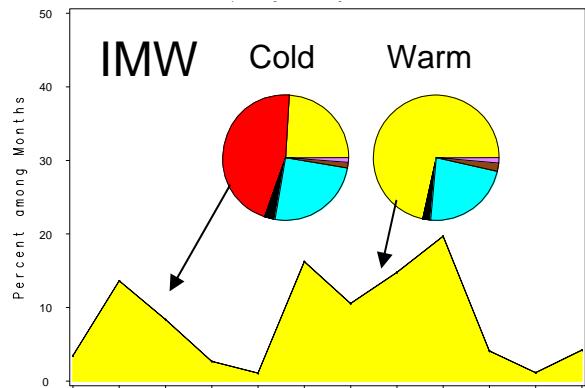
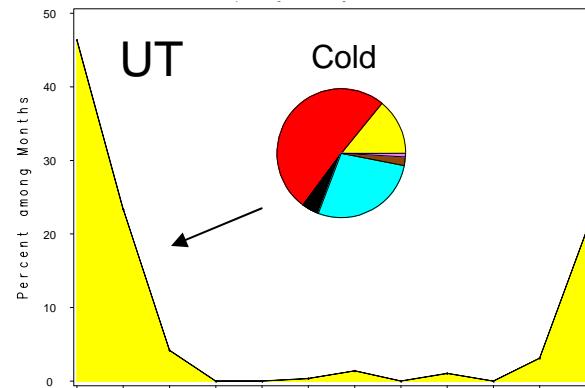
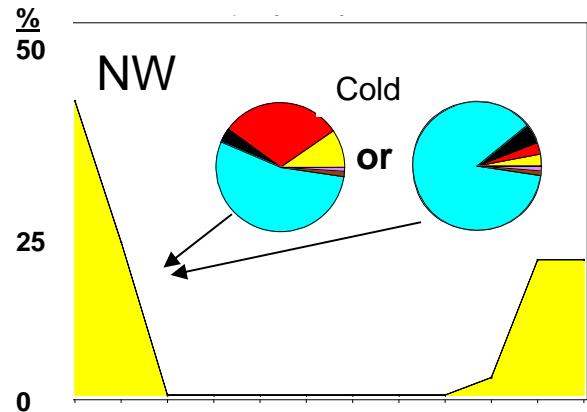
Some source categories and regional influences may be more important for high concentration days

- Comparing average of 5 highest days during 2003, regional sources of sulfates and nitrates are larger contributors to peak day concentrations than to annual average (selected city analysis)
- Composition can vary from high day to high day
- Carbon can be smaller as % -- but still larger in absolute concentration values -- compared to the average

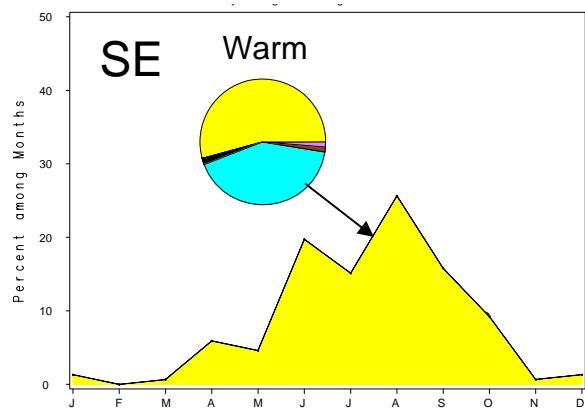
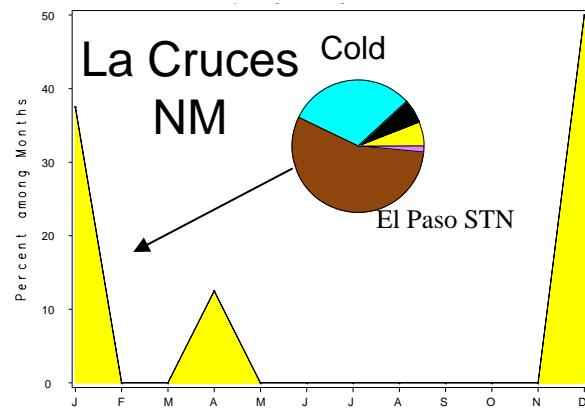
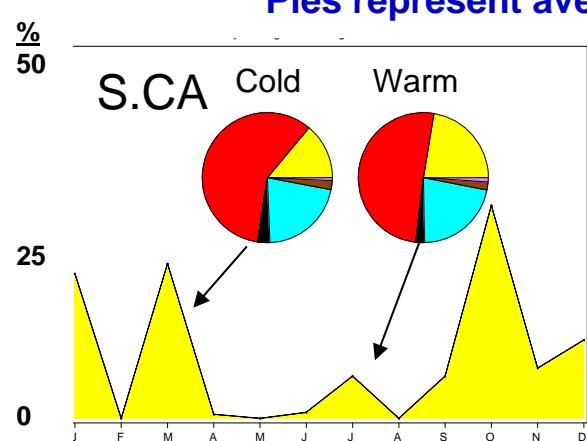
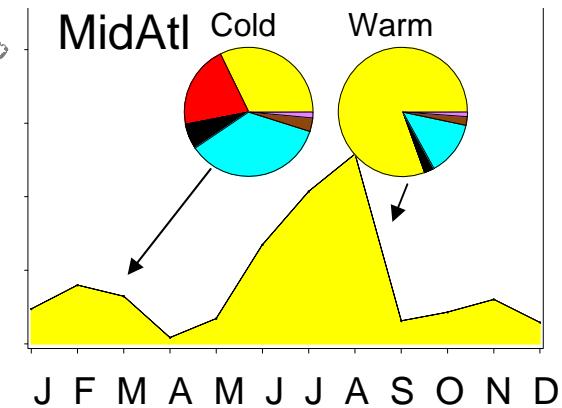
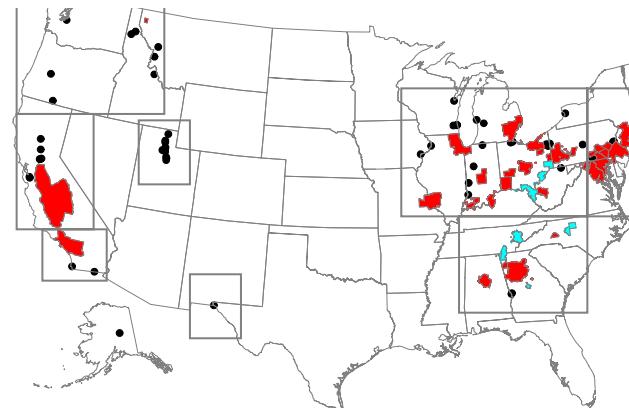
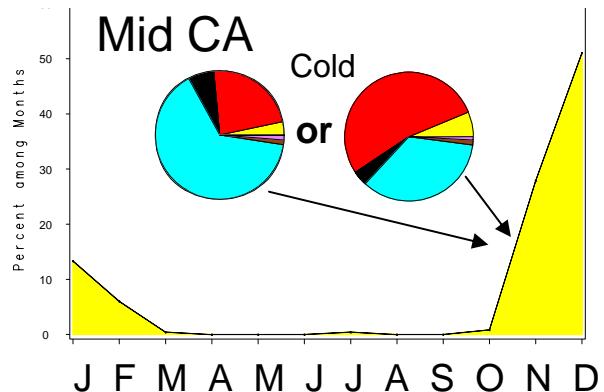


From PM Staff Paper (Rao et al)



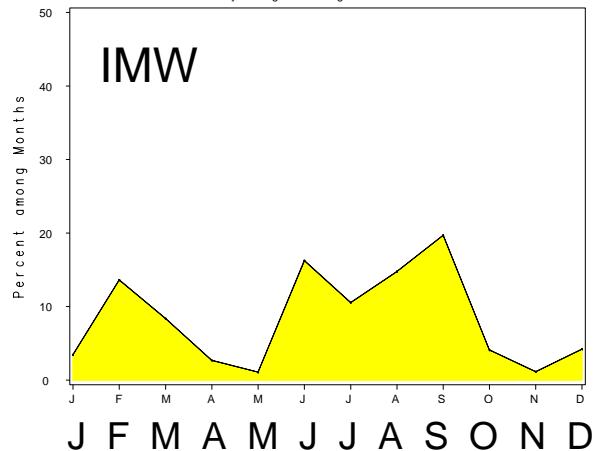


**"Example" Composition for High Days ["Warm" Season (May-Sept) & "Cold"]**  
 But sites can be different within each "domain"

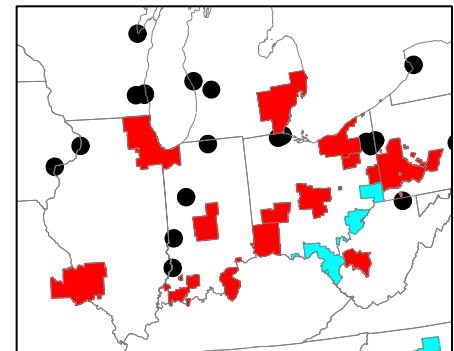


Pies represent average of 3 highest days per year per season, using SANDWICH

Percent of 2003-05 Days > 35 ug/m<sup>3</sup>, by Month, (IMW)  
Based on all FRM Site-days throughout the Regional Domain

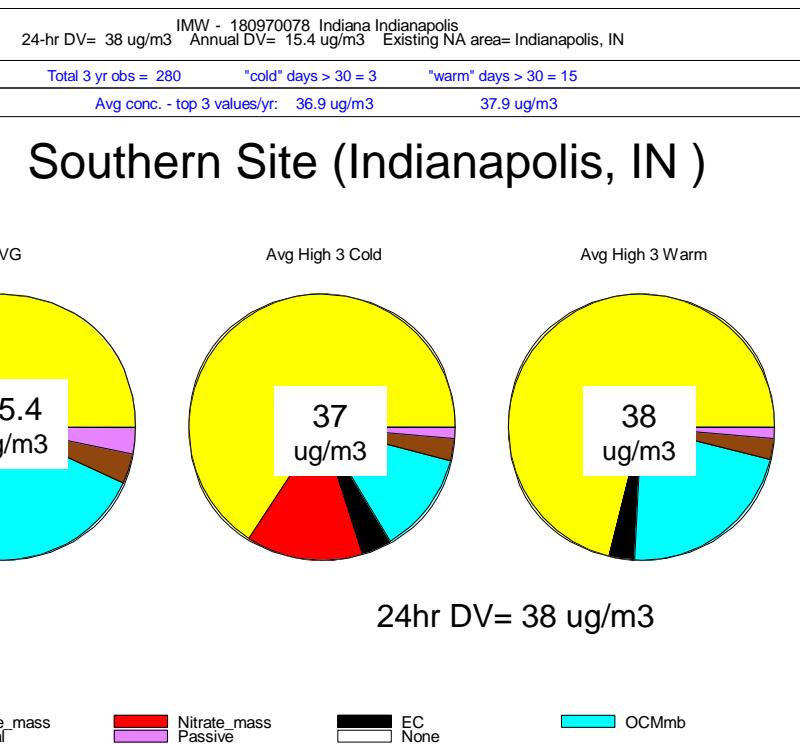
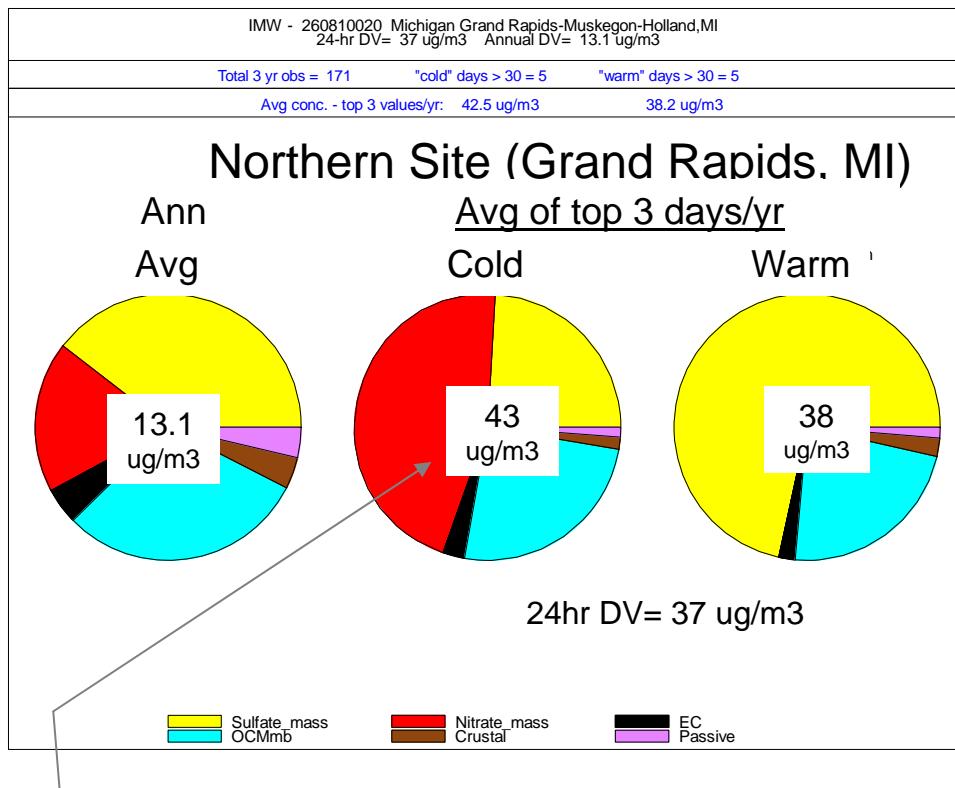


## More Details about PM2.5 Chemical Composition for the IMW



### Industrial Midwest

- Generally nitrate dominated winter-time values in northern areas
- Sulfate dominated episodes in summer (region-wide)



Number inside pie is the "top 3" average concentration, ug/m<sup>3</sup>

Note: Passive is PM2.5 unrelated to emissions

IMW - 551380022 Wisconsin Milwaukee-Waukesha,WI
24-hr DV= 36 ug/m3 Annual DV= 13.5 ug/m3
Total 3 yr obs = 161 "cold" days > 30 = 5 "warm" days > 30 = 1
Avg conc. - top 3 values/yr: 39.0 ug/m3 41.1 ug/m3



Milwaukee, WI

IMW - 261630030 Michigan Grand Rapids-Muskegon-Holland,MI
24-hr DV= 37 ug/m3 Annual DV= 13.1 ug/m3
Total 3 yr obs = 171 "cold" days > 30 = 5 "warm" days > 30 = 5
Avg conc. - top 3 values/yr: 42.5 ug/m3 38.2 ug/m3



Grand Rapids, MI

IMW - 261630033 Michigan Detroit,MI
24-hr DV= 41 ug/m3 Annual DV= 18.2 ug/m3
Total 3 yr obs = 139 "cold" days > 30 = 12 "warm" days > 30 = 9
Avg conc. - top 3 values/yr: 38.0 ug/m3 43.2 ug/m3



Detroit (Dearborn), MI

IMW - 261630001 Michigan-Detroit-Northern Indiana
24-hr DV= 40 ug/m3 Annual DV= 15.1 ug/m3
Total 3 yr obs = 327 "cold" days > 30 = 8 "warm" days > 30 = 11
Avg conc. - top 3 values/yr: 44.2 ug/m3 38.5 ug/m3



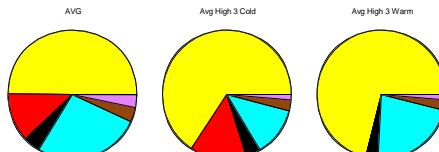
Detr (Allen Park), MI

IMW - 180390003 Indiana Elkhart
24-hr DV= 36 ug/m3 Annual DV= 14.8 ug/m3 Existing NA area=
Total 3 yr obs = 47 "cold" days > 30 = 2 "warm" days > 30 = 1
Avg conc. - top 3 values/yr: 41.8 ug/m3 40.8 ug/m3



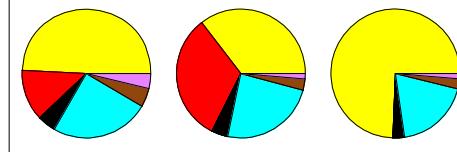
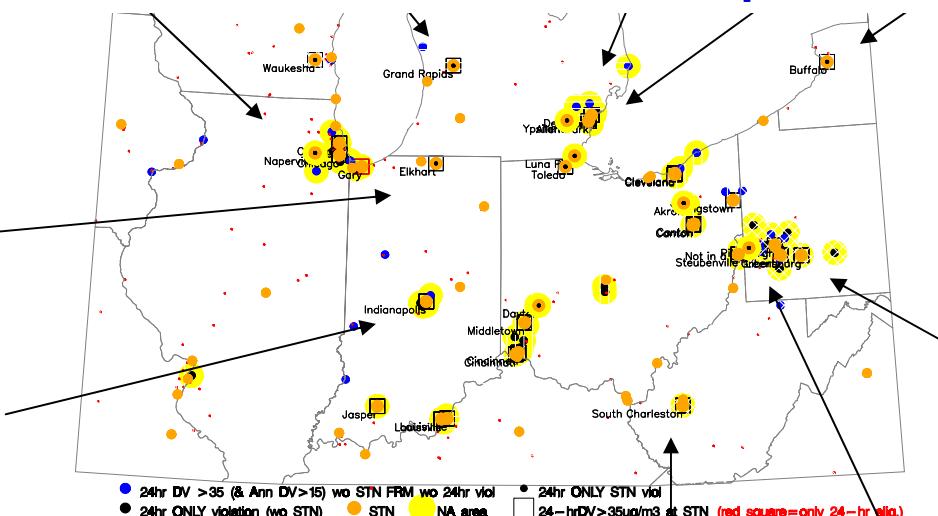
Elkhart, IN

IMW - 180390078 Indiana Indianapolis
24-hr DV= 38 ug/m3 Annual DV= 15.4 ug/m3 Existing NA area= Indianapolis, IN
Total 3 yr obs = 280 "cold" days > 30 = 3 "warm" days > 30 = 15
Avg conc. - top 3 values/yr: 36.9 ug/m3 37.9 ug/m3



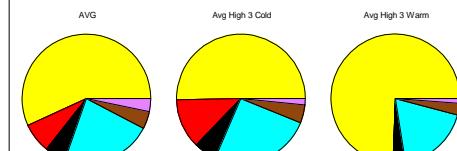
Indianapolis, IN

## Nitrates - important in the N. sub-Region Sulfates and warm season in S. portion



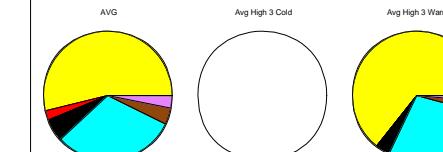
Buffalo, NY

IMW - 420390008 Pennsylvania Pittsburgh
24-hr DV= 39 ug/m3 Annual DV= 15.5 ug/m3 Existing NA area= Pittsburgh-Beaver Valley, PA
Total 3 yr obs = 291 "cold" days > 30 = 2 "warm" days > 30 = 10
Avg conc. - top 3 values/yr: 31.8 ug/m3 40.8 ug/m3



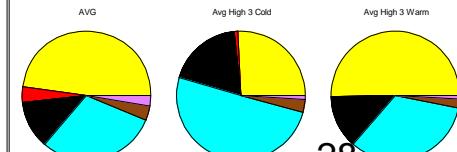
Pittsburgh, PA

IMW - 240391000 West Virginia South Charleston
24-hr DV= 36 ug/m3 Annual DV= 16.8 ug/m3 Existing NA area= Charleston, WV
Total 3 yr obs = 49 "cold" days > 30 = 0 "warm" days > 30 = 9
Avg conc. - top 3 values/yr: 0.0 ug/m3 35.9 ug/m3



Charleston, WV

IMW - 420390064 Pennsylvania Liberty
24-hr DV= 68 ug/m3 Annual DV= 20.8 ug/m3 Existing NA area= Pittsburgh-Beaver Valley, PA
Total 3 yr obs = 109 "cold" days > 30 = 7 "warm" days > 30 = 11
Avg conc. - top 3 values/yr: 50.5 ug/m3 55.7 ug/m3



Liberty, PA

Note: Map show existing NA areas  
& new violation sites

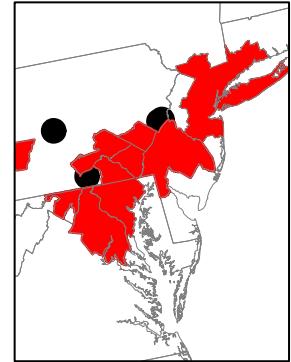
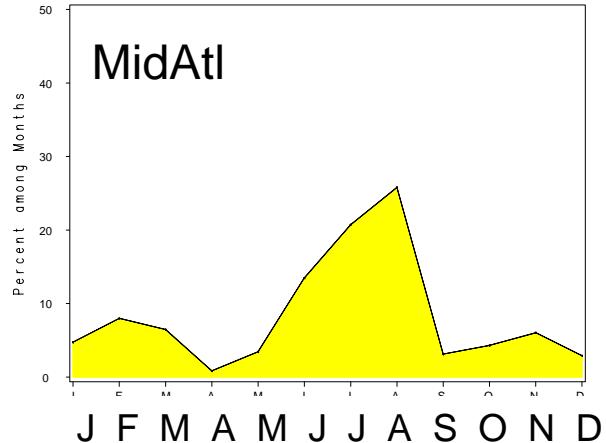
Sulfate mass  
OCMmb

Nitrate mass  
Crustal

EC  
Passive

28

Percent of 2003-05 Days > 35 ug/m<sup>3</sup>, by Month (N.Eng-MidAtl)  
Based on all FRM Site-days throughout the Regional Domain



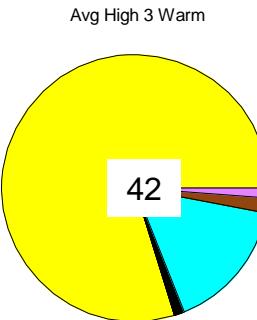
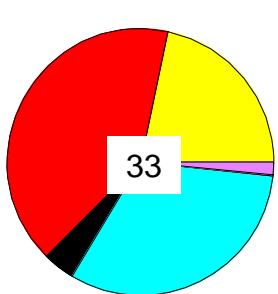
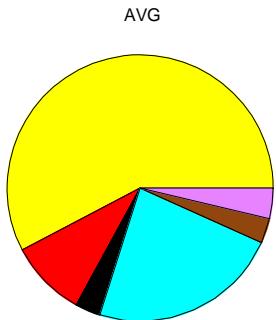
## Mid\_Atlantic Region

Generally Sulfate dominated episodes  
everywhere in summer  
Fewer Nitrate contributed winter-time values  
(except in SE. PA)

N.Eng-MidAtl - 420270100 Pennsylvania State College  
24-hr DV= 38 ug/m<sup>3</sup> Annual DV= 13.4 ug/m<sup>3</sup> Existing NA area=

Total 3 yr obs = 165 "cold" days > 30 = 1 "warm" days > 30 = 7  
Avg conc. - top 3 values/yr: 32.7 ug/m<sup>3</sup> 42.0 ug/m<sup>3</sup>

### Western Mid-Atl site: State College, PA



24hr DV= 37 ug/m<sup>3</sup>

Sulfate mass  
OCMmb

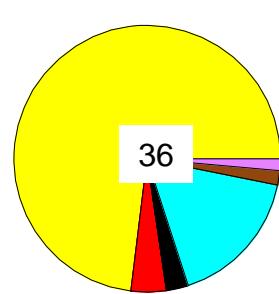
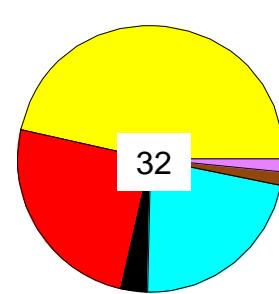
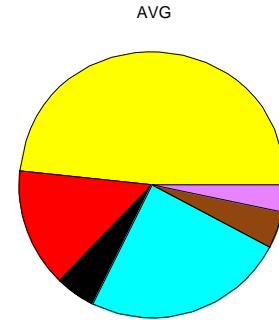
Nitrate mass  
Crustal

EC  
Passive

N.Eng-MidAtl - 100032004 Delaware/Wilmington-Newark, DE-MD  
24-hr DV= 37 ug/m<sup>3</sup> Annual DV= 15.1 ug/m<sup>3</sup>

Total 3 yr obs = 94 "cold" days > 30 = 3 "warm" days > 30 = 2  
Avg conc. - top 3 values/yr: 31.7 ug/m<sup>3</sup> 35.5 ug/m<sup>3</sup>

### Eastern Mid-Atl site: Wilmington, DE

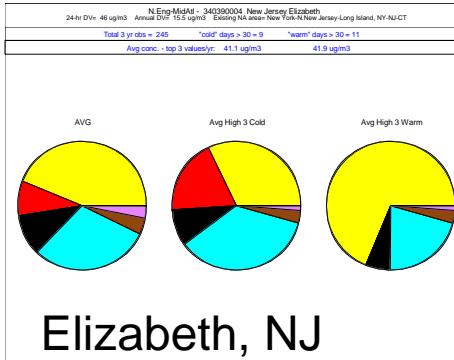


24hr DV= 37 ug/m<sup>3</sup>

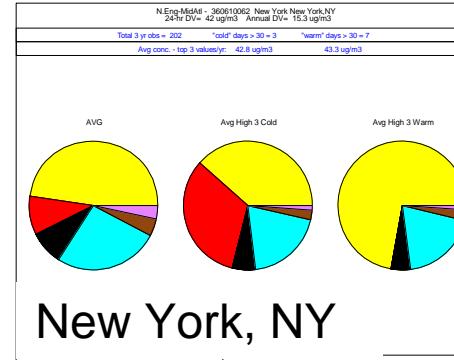
Sulfate mass  
OCMmb

Nitrate mass  
Crustal

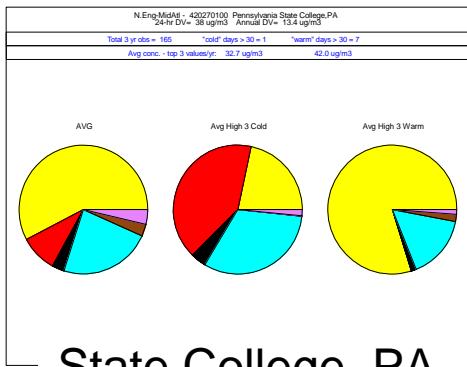
EC  
Passive



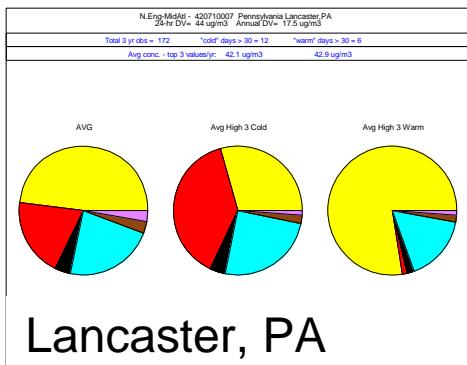
Elizabeth, NJ



New York, NY

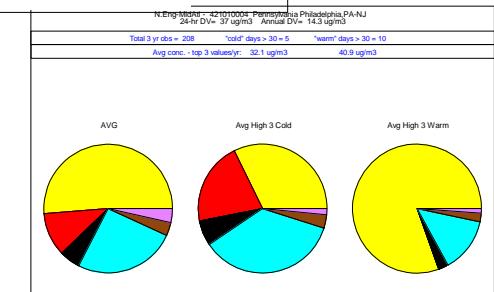
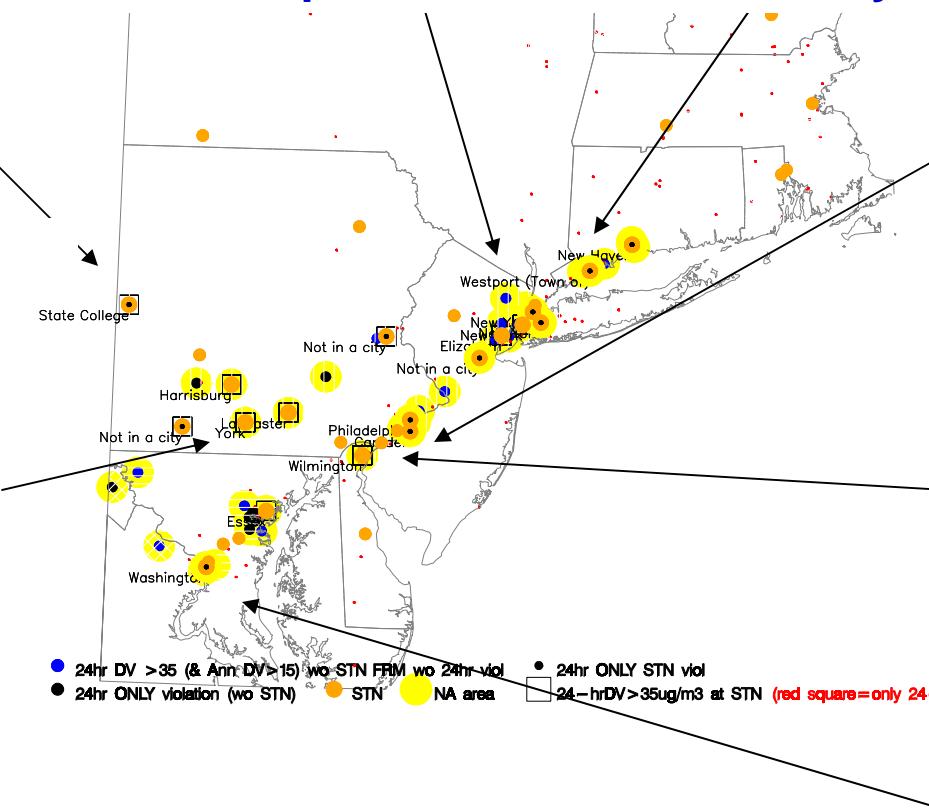


# State College, PA

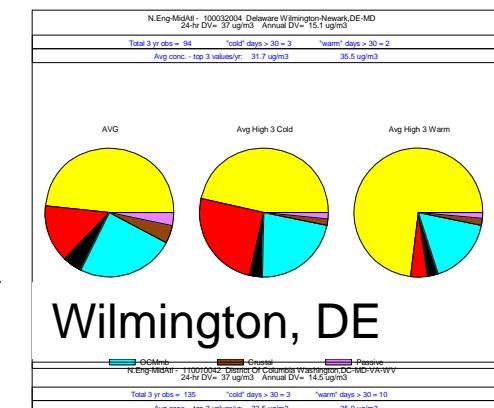


# Lancaster, PA

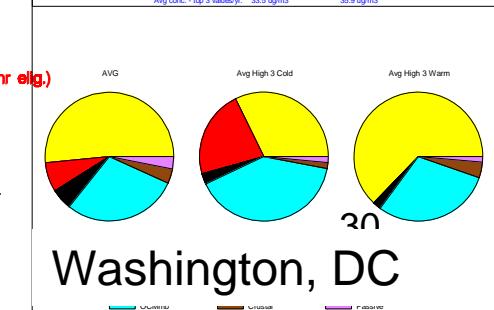
**Sulfates dominate high Summer days  
Nitrates - important on fewer cold days**



Philadelphia, PA

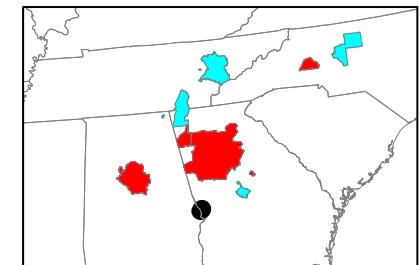


Wilmington, DE



Washington, DC

Percent of 2003-05 Days > 35 ug/m<sup>3</sup>, by Month, (SE)  
Based on all FRM Site-days throughout the Regional Domain



## South East Region

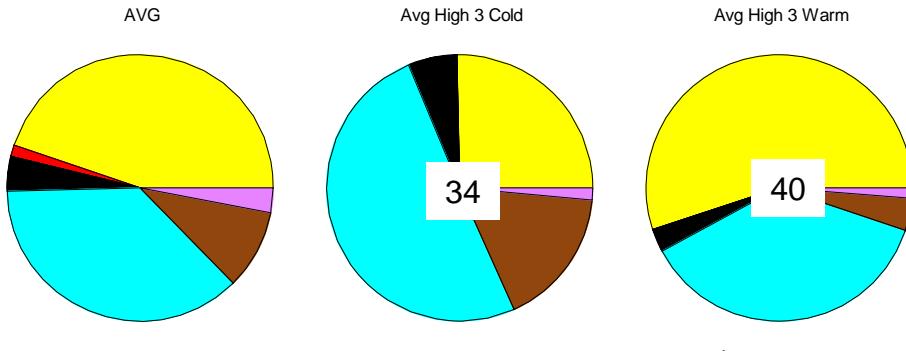
Mostly sulfate dominated + OC episodes, in summer

-- shows influence of biogenics and other SOA

Fewer cold-season exceedances (& are driven by carbon)

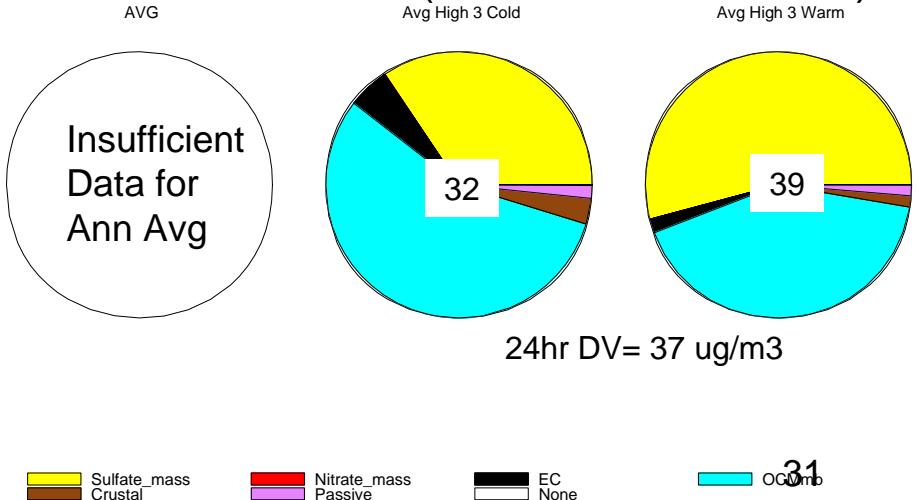
24-hr DV= 39 ug/m <sup>3</sup>	SE - 010732003, Alabama Birmingham
Annual DV= 16.5 ug/m <sup>3</sup>	
Total 3 yr obs = 173	Existing NA area= Birmingham, AL
"cold" days > 30 = 3	
"warm" days > 30 = 9	
Avg conc. - top 3 values/yr: 34.1 ug/m <sup>3</sup>	
	39.9 ug/m <sup>3</sup>

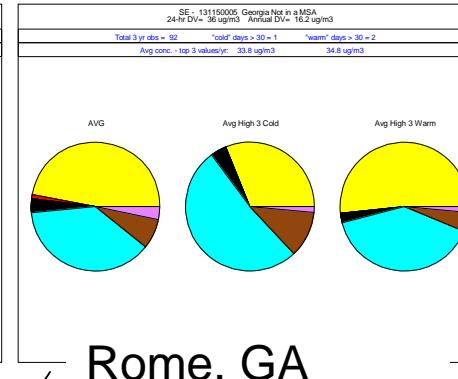
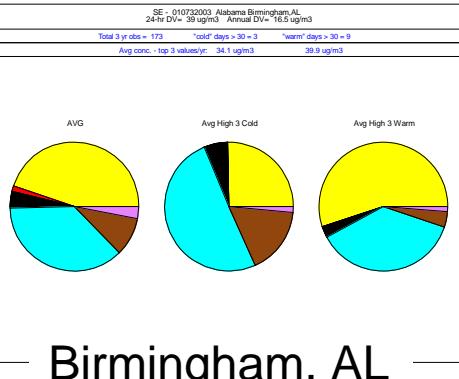
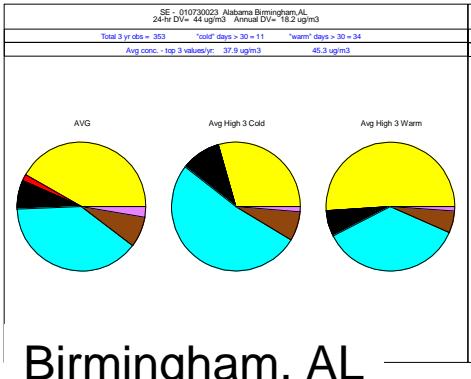
### Existing NA: Birmingham, AL



24-hr DV= 37 ug/m <sup>3</sup>	SE - 011130001, Alabama Phenix City
Annual DV= 15.7 ug/m <sup>3</sup>	
Total 3 yr obs = 39	Existing NA area=
"cold" days > 30 = 1	
"warm" days > 30 = 3	
Avg conc. - top 3 values/yr: 31.8 ug/m <sup>3</sup>	
	39.3 ug/m <sup>3</sup>

### New 24hr Violation: Phenix City, AL (Columbus, GA area)



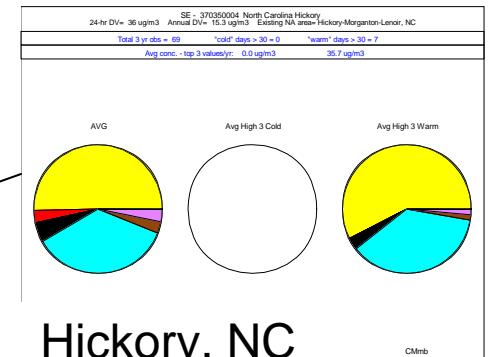
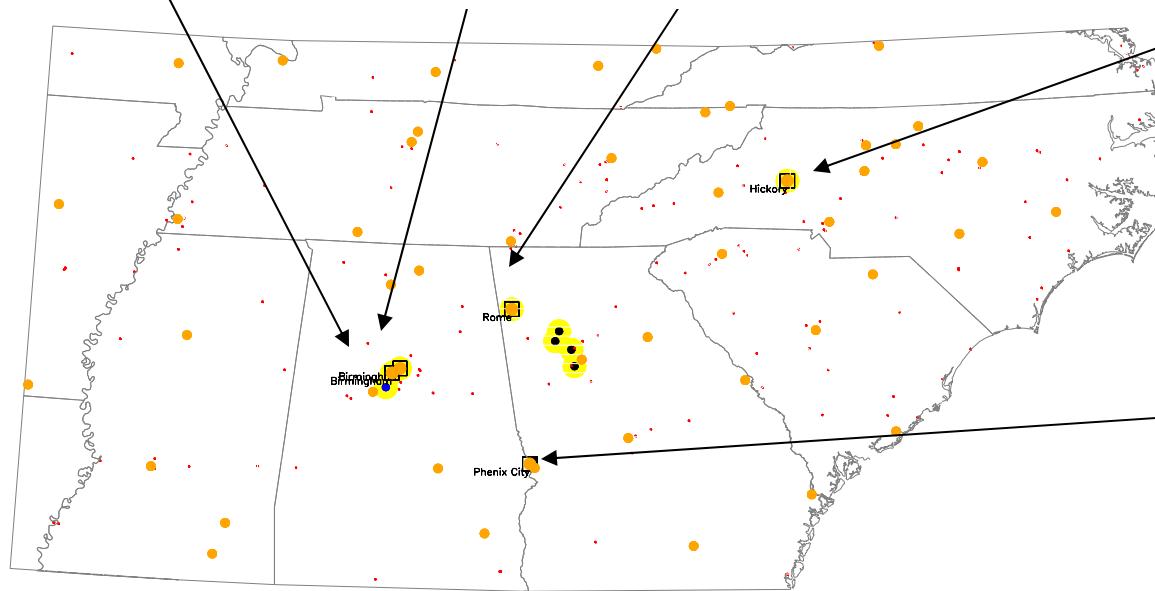


Birmingham, AL

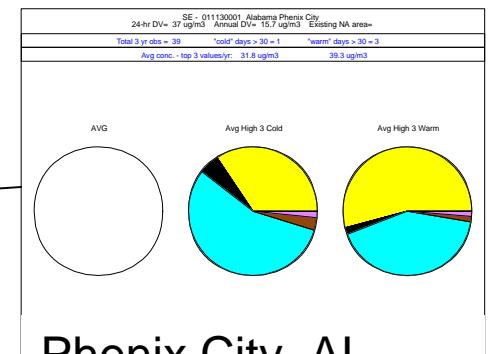
Birmingham, AL

Rome, GA

## Sulfates and carbon during summer Carbon more important on fewer cold days



Hickory, NC

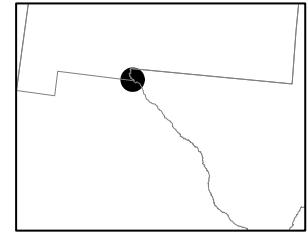
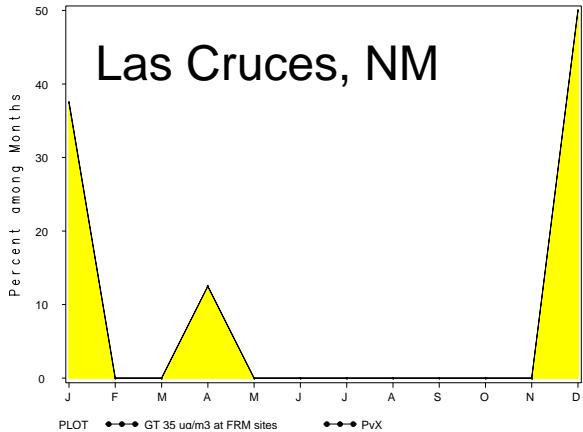


Phenix City, AL  
(Columbus, GA area)

- 24hr DV > 35 (& Ann DV>15) wo STN FRM wo 24hr viol
- 24hr ONLY STN viol
- 24hr ONLY violation (wo STN)
- STN
- NA area
- 24-hrDV>35ug/m<sup>3</sup> at STN (red square=or)

Note: Columbus area designated Attainment in 2005 on basis of spatial averaging.

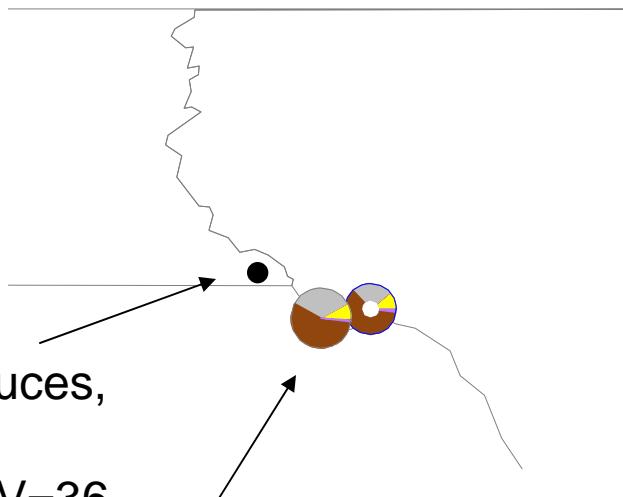
Percent of 2003-05 Days > 35 ug/m<sup>3</sup>, by Month (Las Cruces)  
Based on all FRM Site-days throughout the Regional Domain



## Southwestern US

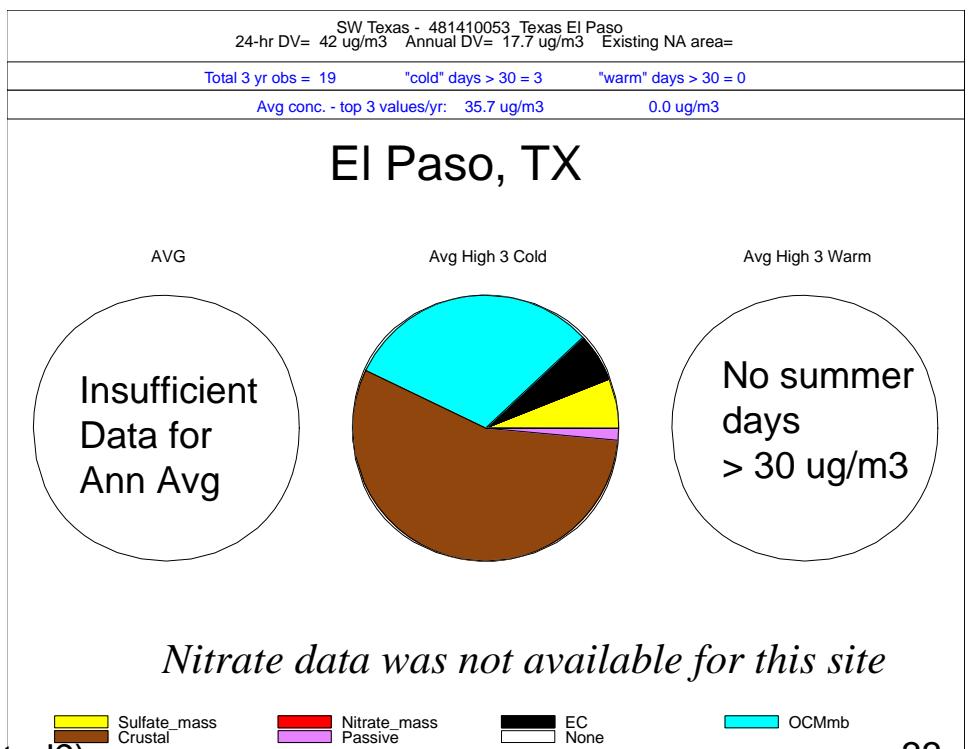
- Speciation data (from El Paso) suggest emission sources creating crustal and carbon
- Shows effect of aridity and wind

PM2.5 speciation - 02/02/2003

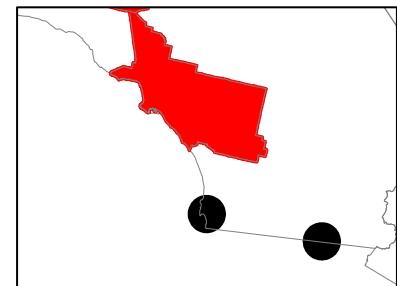
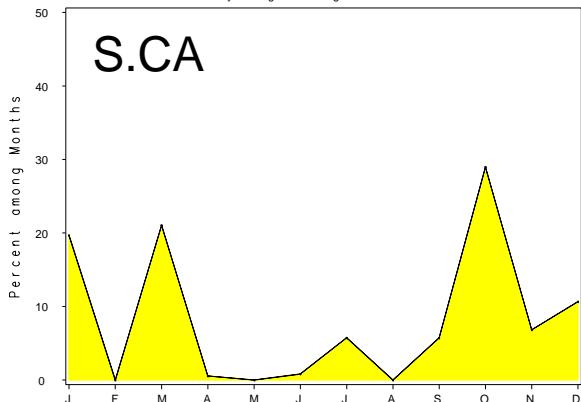


Las Cruces,  
NM  
24hr DV=36  
Ann DV=10.4

24hr DV=42 (not pop- oriented?)  
Ann DV=17.3



Percent of 2003-05 Days > 35 ug/m<sup>3</sup>, by Month (S. Cal)  
Based on all FRM Site-days throughout the Regional Domain



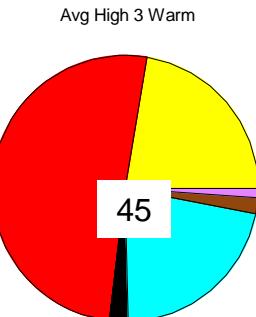
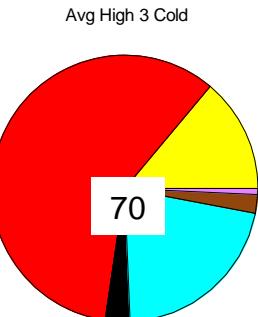
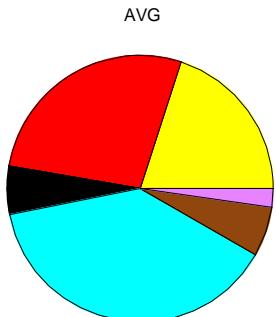
## Southern California

- Nitrates dominate High PM<sub>2.5</sub> in LA.
- Carbon (summer) and also nitrates (winter) in Calexico
  - Lower % crustal on high days

S. Cal - 060658001 California Riverside-San Bernardino, CA  
24-hr DV= 65 ug/m<sup>3</sup> Annual DV= 22.6 ug/m<sup>3</sup>

Total 3 yr obs = 326	"cold" days > 30 = 43	"warm" days > 30 = 29
Avg conc. - top 3 values/yr: 69.9 ug/m <sup>3</sup>		44.8 ug/m <sup>3</sup>

### Downwind of LA: Rubidoux, CA



24hr DV= 65 ug/m<sup>3</sup>

Sulfate mass  
OCM<sup>b</sup>

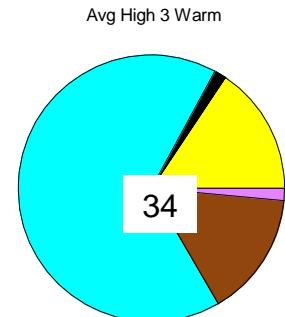
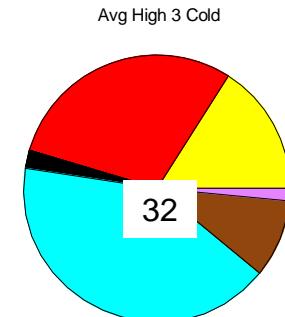
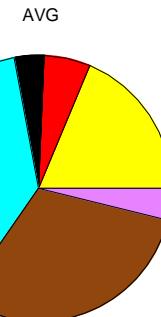
Nitrate mass  
Crustal

EC  
Passive

S. Cal - 060250005 California Calexico  
24-hr DV= 39 ug/m<sup>3</sup> Annual DV= 12.7 ug/m<sup>3</sup> Existing NA area=

Total 3 yr obs = 66	"cold" days > 30 = 2	"warm" days > 30 = 1
Avg conc. - top 3 values/yr: 31.9 ug/m <sup>3</sup>		34.2 ug/m <sup>3</sup>

### Border Site: Calexico, CA



24hr DV= 39 ug/m<sup>3</sup>

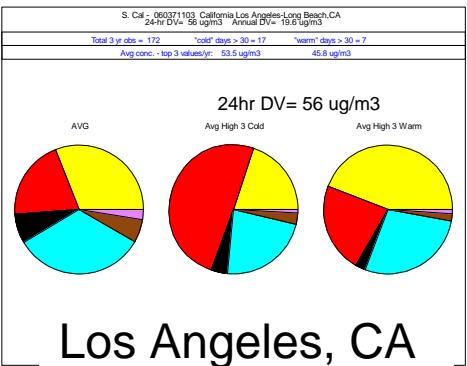
34

Sulfate mass  
OCM<sup>b</sup>

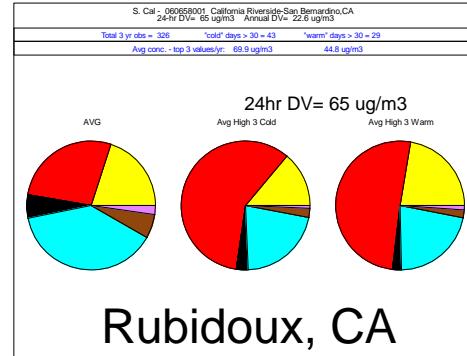
Nitrate mass  
Crustal

EC  
Passive

34

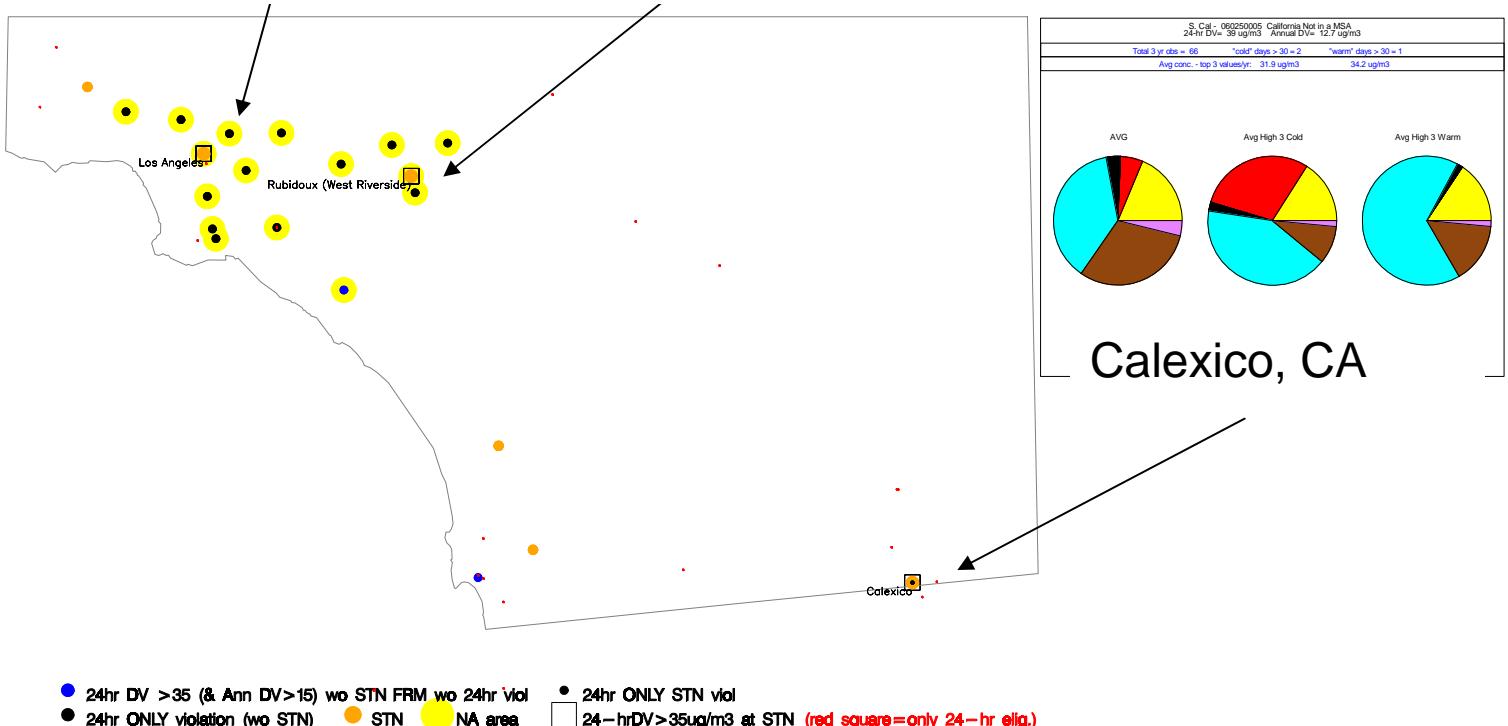


Los Angeles, CA



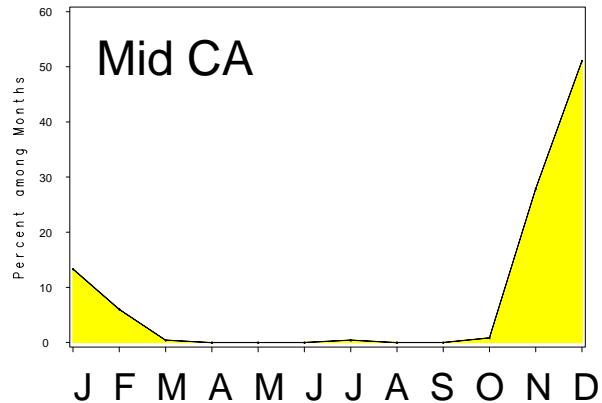
Rubidoux, CA

## Composition Varies Across this Diverse CA Domain



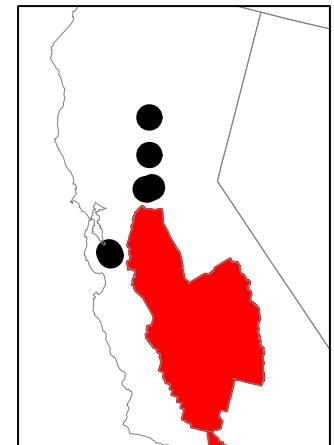
Calexico, CA

Percent of 2003-05 Days > 35 ug/m<sup>3</sup>, by Month (Mid. Cal)  
Based on all FRM Site-days throughout the Regional Domain



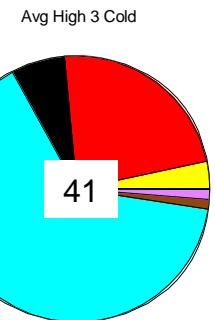
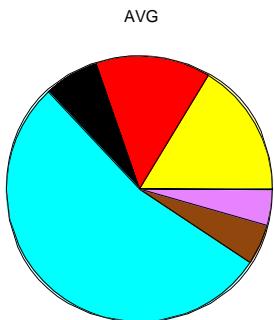
## Middle California

- Carbon in Northern Central Valley  
• from RWC?
- Nitrates dominate High PM2.5 in lower SJV



Mid. Cal - 060670006 California Sacramento 24-hr DV= 45 ug/m <sup>3</sup> Annual DV= 11.8 ug/m <sup>3</sup> Existing NA area=	Total 3 yr obs = 196 "cold" days > 30 = 20 "warm" days > 30 = 0
Avg conc. - top 3 values/yr: 41.4 ug/m <sup>3</sup>	0.0 ug/m <sup>3</sup>

## Northern Central Valley (e.g. Sacramento)



24hr DV= 45 ug/m<sup>3</sup>

Sulfate\_mass  
Crustal

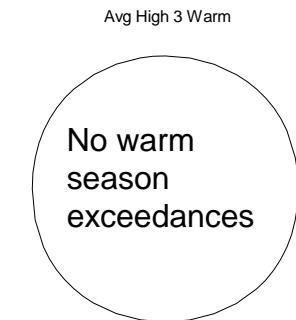
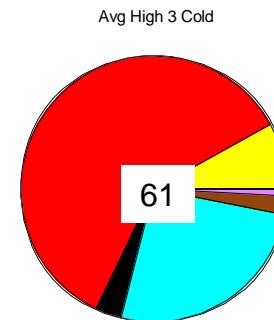
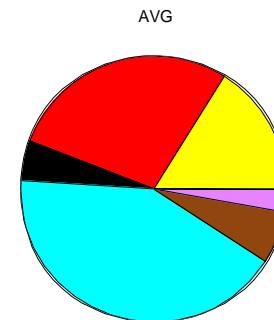
Nitrate\_mass  
Passive

EC  
None

OCMmb

Mid. Cal - 060290014 California Bakersfield 24-hr DV= 58 ug/m <sup>3</sup> Annual DV= 18 ug/m <sup>3</sup> Existing NA area= San Joaquin Valley, CA	Total 3 yr obs = 142 "cold" days > 30 = 37 "warm" days > 30 = 0
Avg conc. - top 3 values/yr: 61.1 ug/m <sup>3</sup>	0.0 ug/m <sup>3</sup>

## Southern SJV (e.g. Bakersfield, CA)



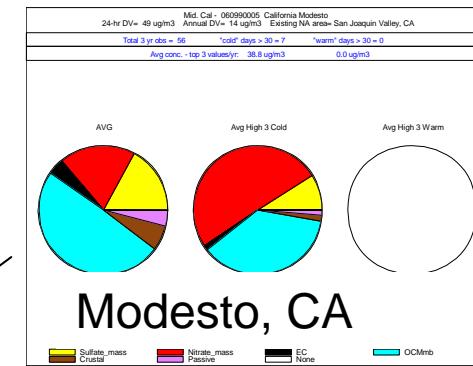
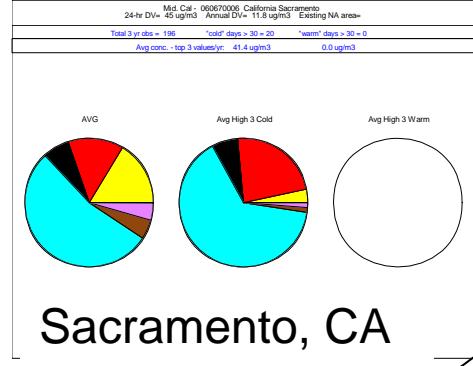
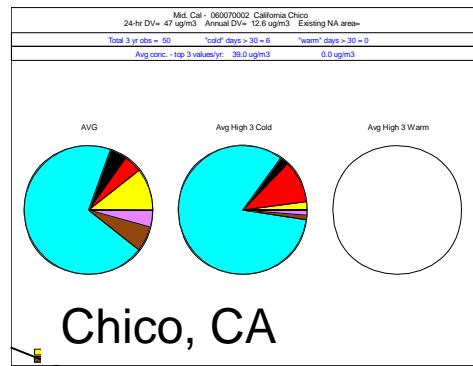
24hr DV= 58 ug/m<sup>3</sup>

Sulfate\_mass  
Crustal

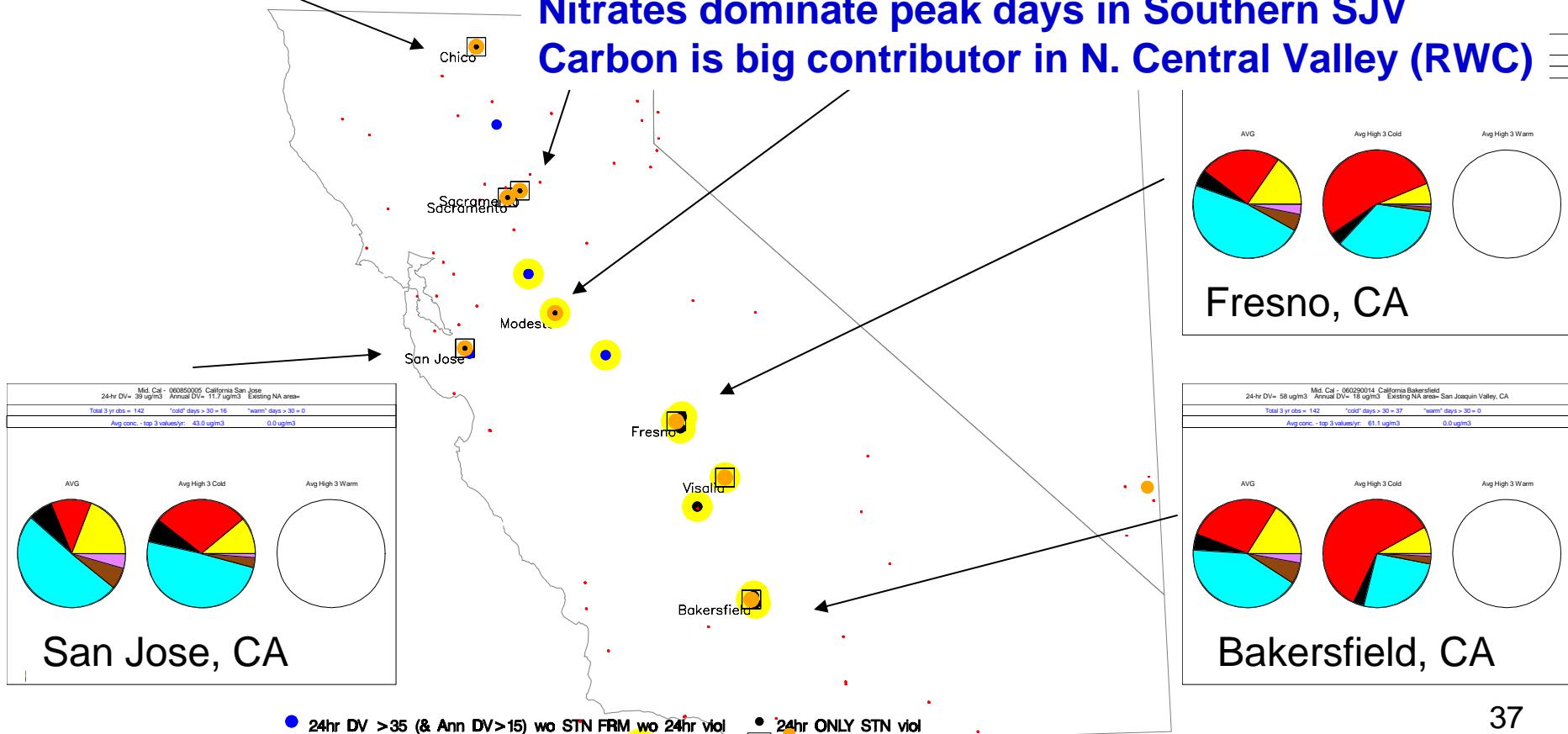
Nitrate\_mass  
Passive

EC  
None

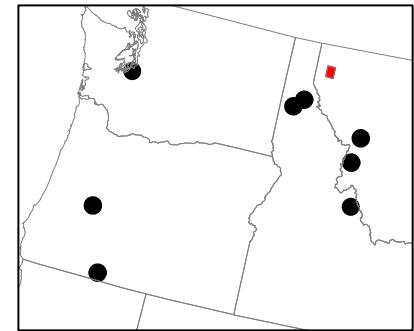
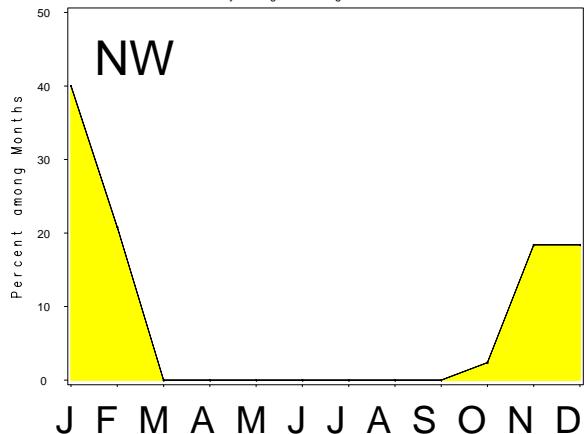
OCMmb



Nitrates dominate peak days in Southern SJV  
Carbon is big contributor in N. Central Valley (RWC)



Percent of 2003-05 Days > 35 ug/m<sup>3</sup>, by Month, (NW)  
Based on all FRM Site-days throughout the Regional Domain

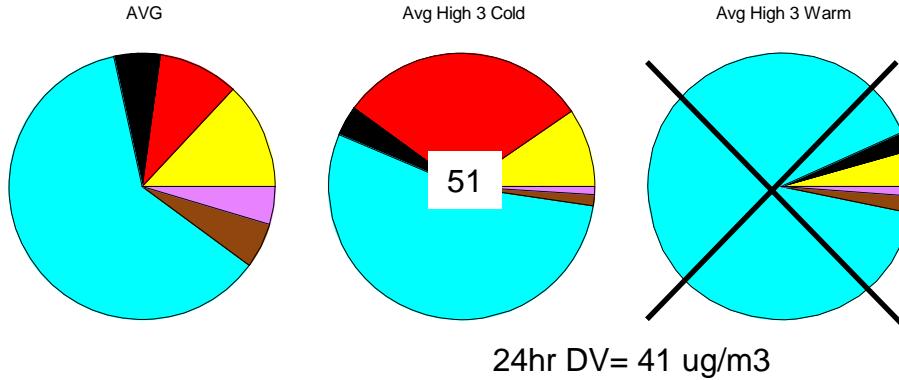


## North West

- Carbon dominates Libby (from RWC?)
- Nitrates are also found on high winter days in Missoula (and elsewhere, e.g. Boise)
  - mobile and valley influence or ?
- Summer days are flagged fires
  - (not concurred?)

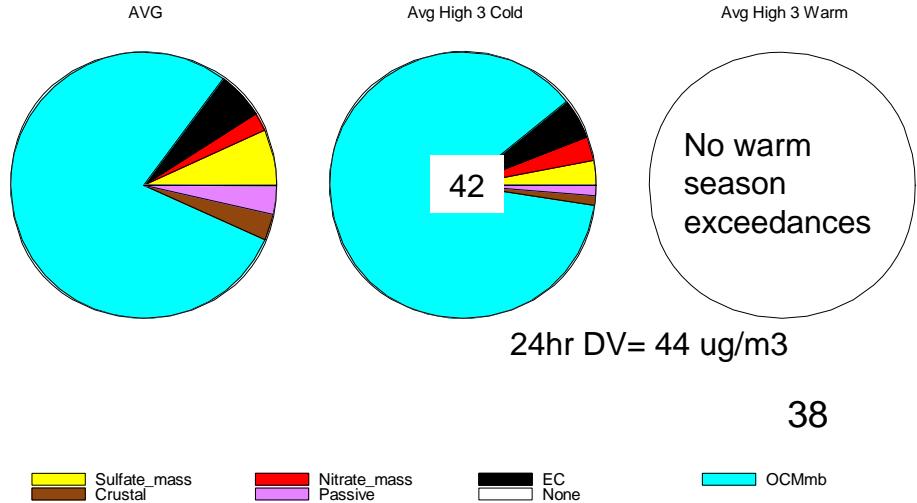
NW - 300630031 Montana Missoula 24-hr DV= 41 ug/m <sup>3</sup> Annual DV= 10.5 ug/m <sup>3</sup> Existing NA area=		
Total 3 yr obs = 310	"cold" days > 30 = 11	"warm" days > 30 = 4
Avg conc. - top 3 values/yr: 50.9 ug/m <sup>3</sup>	42.6 ug/m <sup>3</sup>	

### Missoula, MT (traffic influenced)



NW - 300530018 Montana Libby 24-hr DV= 44 ug/m <sup>3</sup> Annual DV= 15.1 ug/m <sup>3</sup> Existing NA area= Libby, MT		
Total 3 yr obs = 88	"cold" days > 30 = 16	"warm" days > 30 = 0
Avg conc. - top 3 values/yr: 41.6 ug/m <sup>3</sup>	41.6 ug/m <sup>3</sup>	0.0 ug/m <sup>3</sup>

### Libby, MT (RWC)



Sulfate mass  
OCMmb

Nitrate mass  
Crustal

EC  
Passive

Sulfate mass  
Crustal

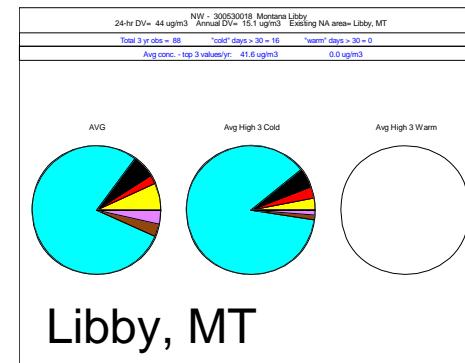
Nitrate mass  
Passive

EC  
None

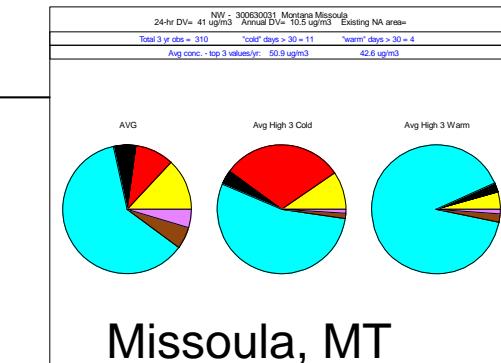
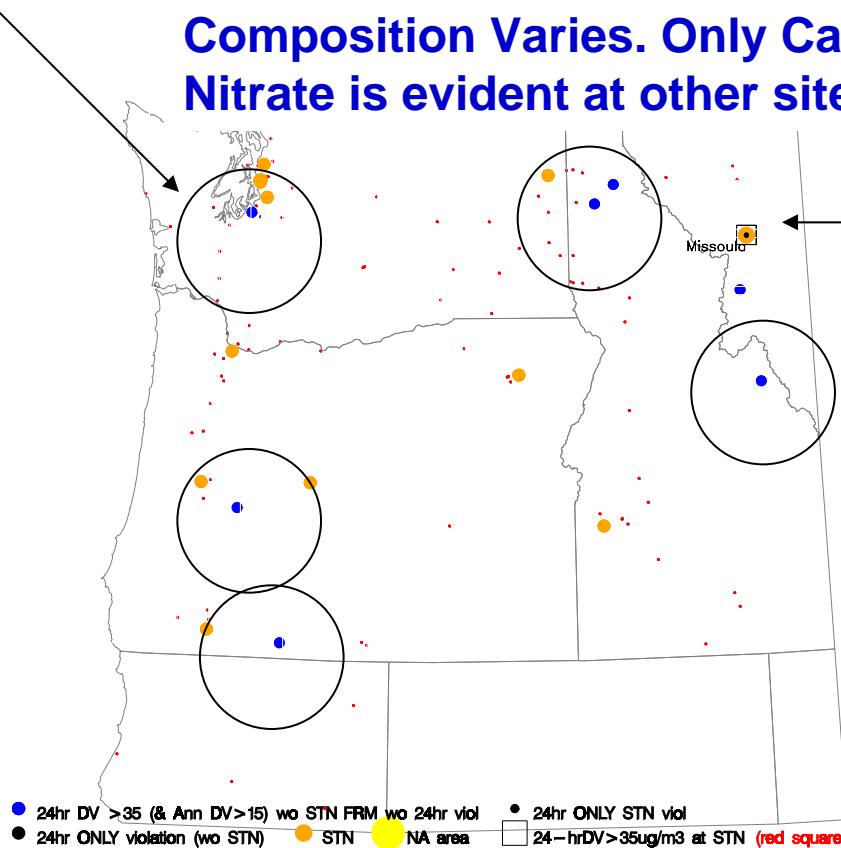
OCMmb

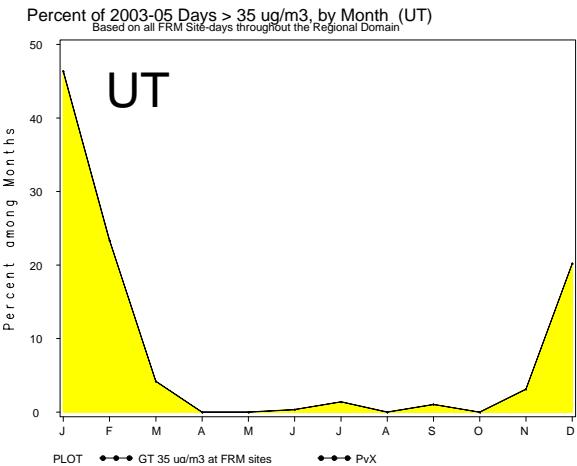
Difficult to predict composition from nearby locations  
 (e.g. Missoula composition is similar to Boise but different than Libby)

New violation locations without STN data



**Composition Varies. Only Carbon at some locations. Nitrate is evident at other sites. Many Viol sites wo STN**



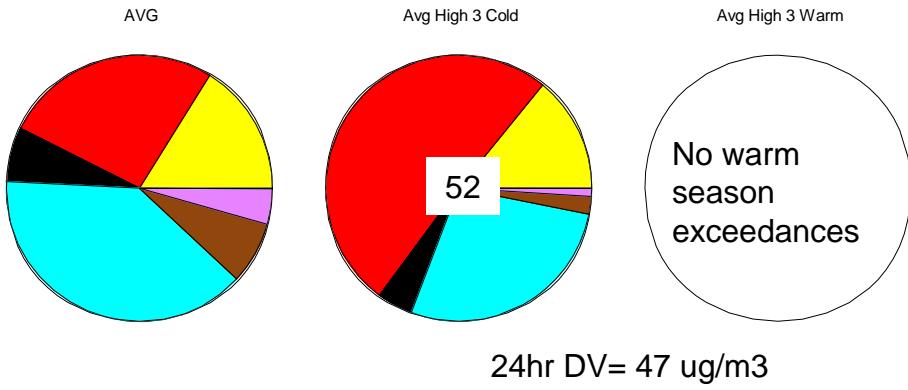


## High PM2.5 in Utah

- Consistently more Nitrates on high days
- SLC has similar % Sulfates as ann avg
- Lindon – one summer exceedance
  - unflagged fire?

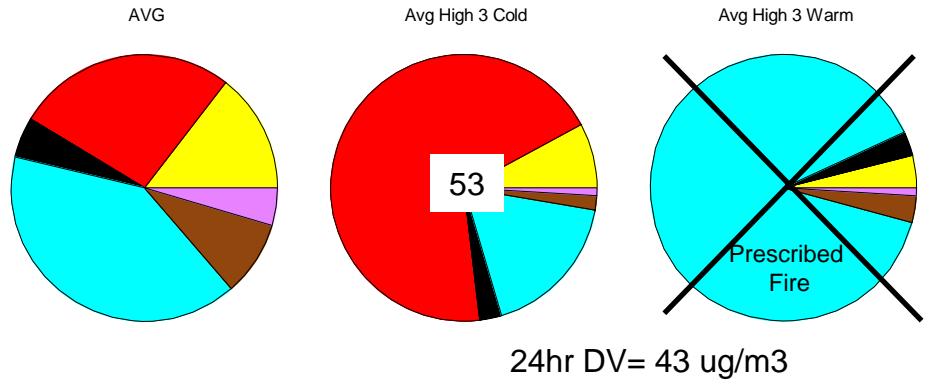
UT - 490353006 Utah Salt Lake City 24-hr DV= 47 ug/m <sup>3</sup> Annual DV= 11.6 ug/m <sup>3</sup> Existing NA area=	Total 3 yr obs = 194 "cold" days > 30 = 24 "warm" days > 30 = 0	Avg conc. - top 3 values/yr: 52.3 ug/m <sup>3</sup> 0.0 ug/m <sup>3</sup>
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## Salt Lake City, UT

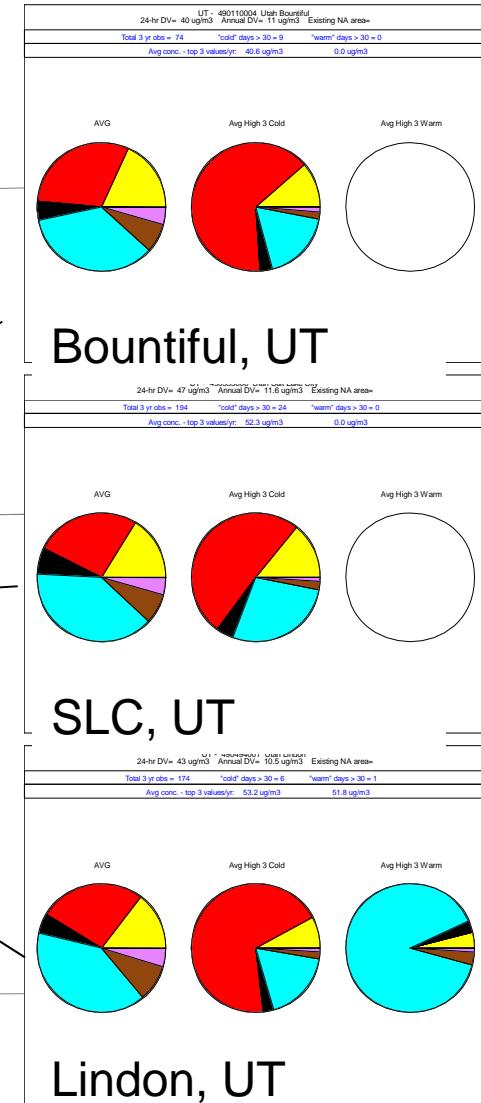
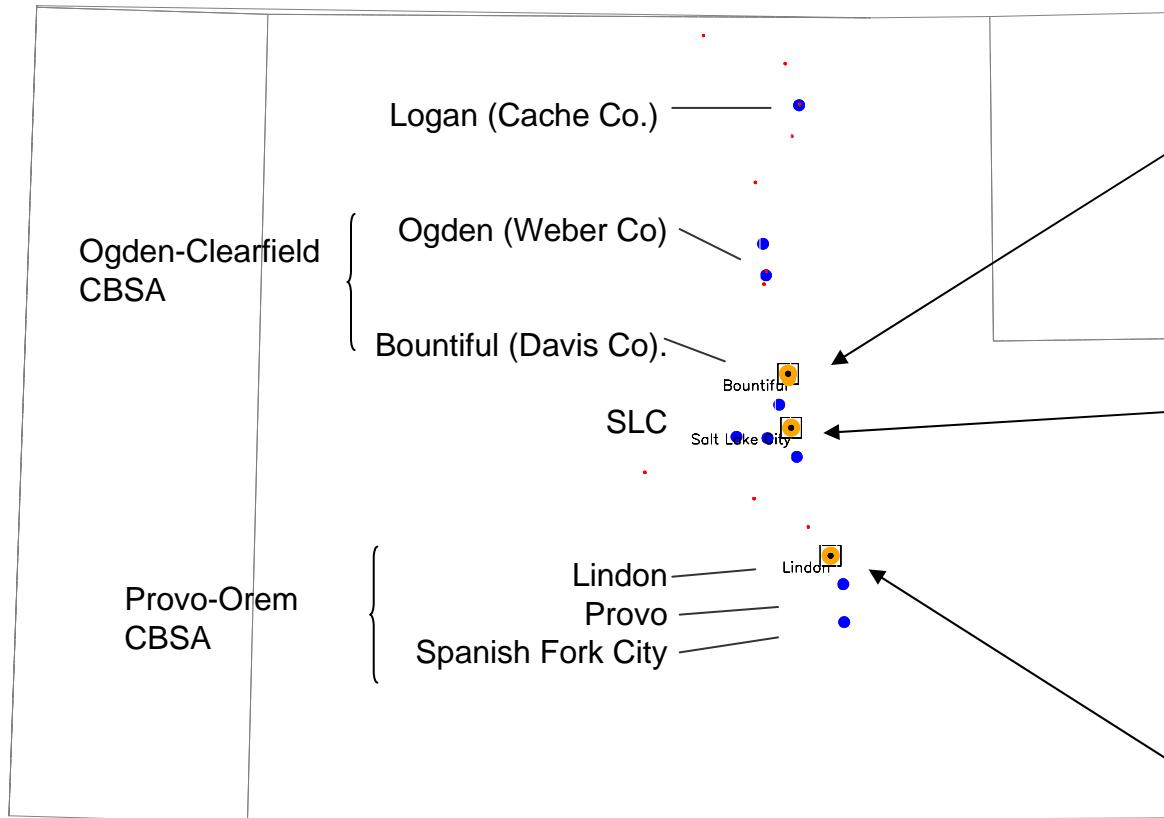


UT - 490494001 Utah Lindon 24-hr DV= 43 ug/m <sup>3</sup> Annual DV= 10.5 ug/m <sup>3</sup> Existing NA area=	Total 3 yr obs = 174 "cold" days > 30 = 6 "warm" days > 30 = 1	Avg conc. - top 3 values/yr: 53.2 ug/m <sup>3</sup> 51.8 ug/m <sup>3</sup>
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## Lindon, UT

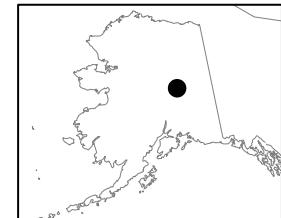
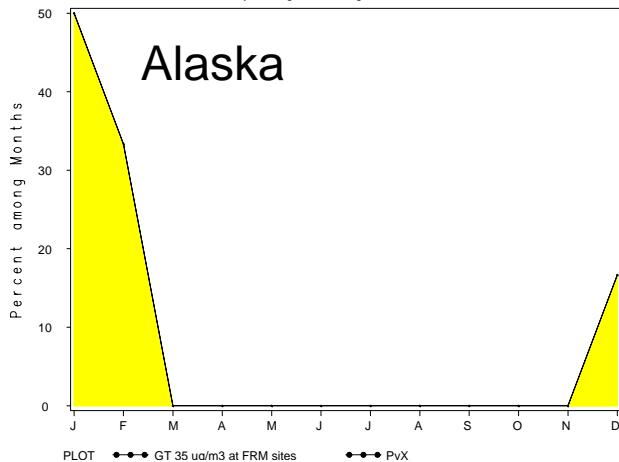


## Many Violating Locations in UT Nitrates seems to dominate peaks



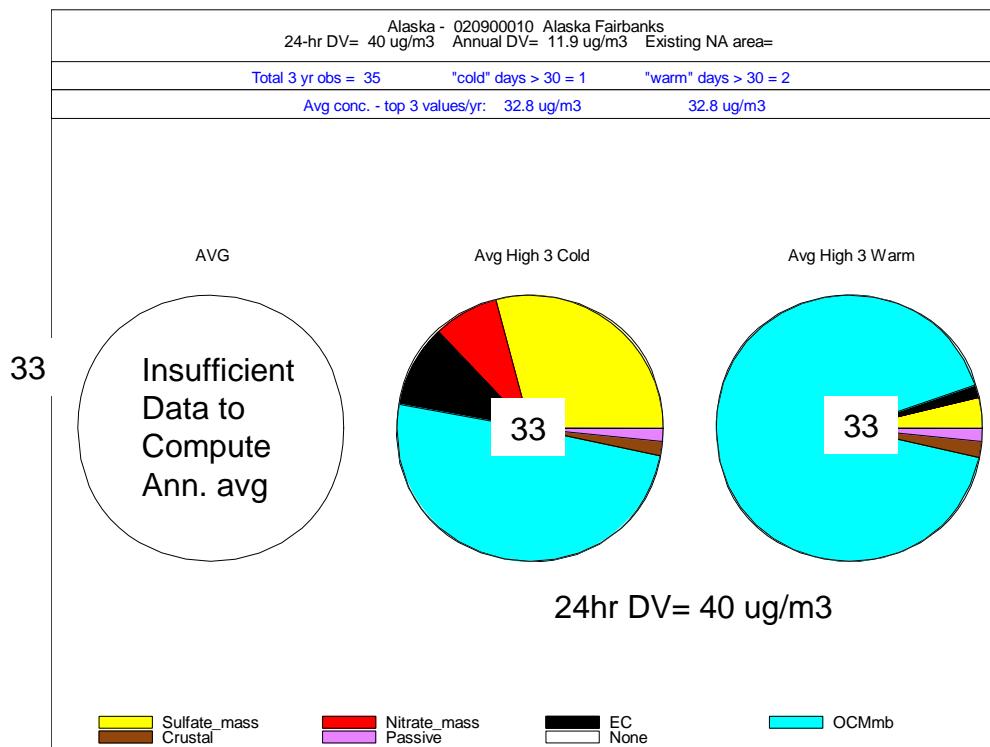
- 24hr DV >35 (& Ann DV>15) wo STN FRM wo 24hr viol
- 24hr ONLY violation (wo STN)
- 24hr ONLY STN viol
- STN
- NA area
- 24-hrDV>35ug/m<sup>3</sup> at STN (red square=only 24-hr elig.)

Percent of 2003-05 Days > 35 ug/m<sup>3</sup>, by Month, (Alaska)  
Based on all FRM Site-days throughout the Regional Domain



### High PM2.5 in Alaska (Fairbanks)

- 50% carbon on winter exceedance day
- Two summer exceedances are flagged fires (not concurred)



# Potential Source Influences by Season and Scale

Season & Affected Domains	Major PM2.5 Components	Source category	Typical Scales of Influence		
			Regional	Urban	Micro
<b>Cold</b> • IMW • Mid-Atl • S. CA • <u>UT</u> • <u>Mid CA</u> • NM • <u>AK</u>	Nitrate	EGU (NOx) Ag (NH3) Mobile (NOx+NH3)	✓ ✓ ✓	* * ✓	✓
	Sulfate	EGU (SO2)	✓	*	
	Carbon	Mobile, Area/RWC, Industry	✓	✓	✓
	Crustal	Industry, Mobile			✓
<b>Warm</b> • IMW • Mid-Atl • <u>SE</u> • S. CA	Sulfate	EGU (SO2)	✓	*	
	Carbon	Mobile, Area, Industry, Biogenics and Smoke	✓	✓	✓
	Crustal	Mobile, Area, Industry		*	✓

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Underlined text indicates dominant season for the domain

Carbon includes OC and EC

\*Sometimes occurs