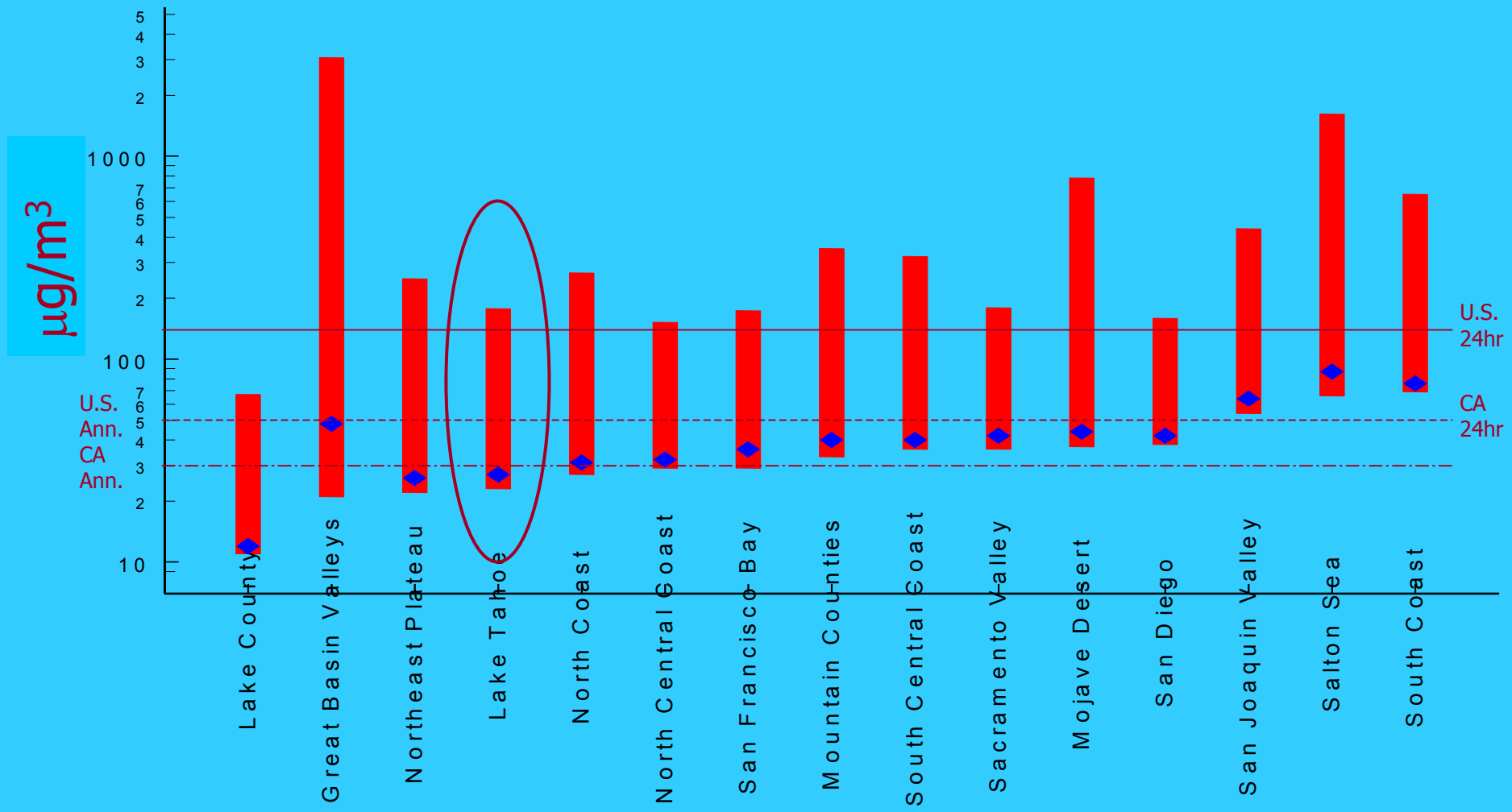
Introduction to the Lake Tahoe Atmospheric Deposition Study (LTADS) Interim Report

- LTADS Purpose
  - Atmospheric Component of Tahoe TMDL
- Today's Presentation
  - Part 1 - Background to the Present Study
    - Regional Context
    - Historical Data Review
    - Deposition Calculation Methodology
    - Field Study Program Update
  - Part 2 - Preliminary Results

California Air Basins

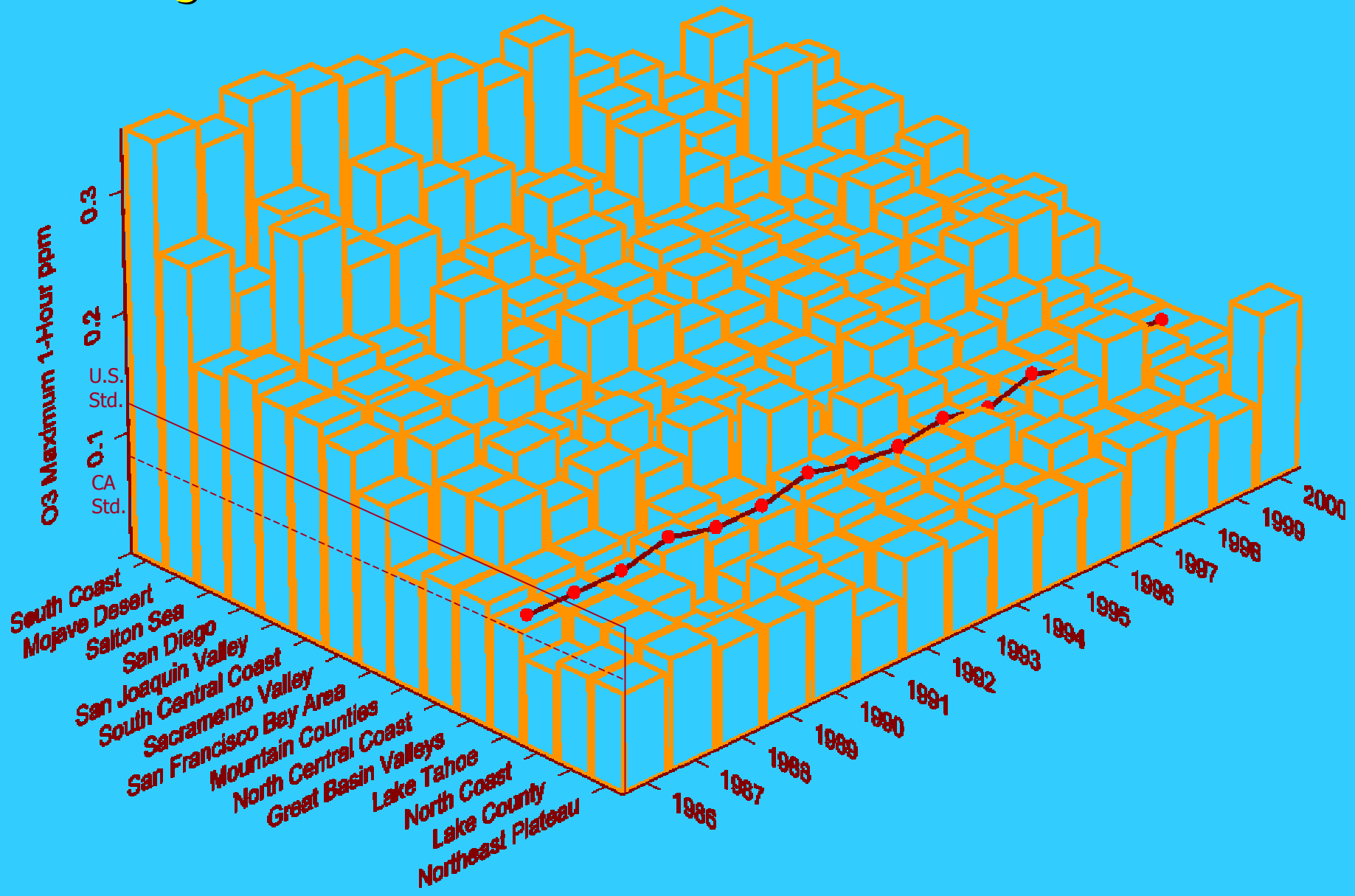
Preliminary Data - Not for Public Release

PM10 "Air Basin Days" (Daily Basin Maxima) 1986-2000



Preliminary Data - Not for Public Release

O_3 Annual Basin Maxima 1986-2000



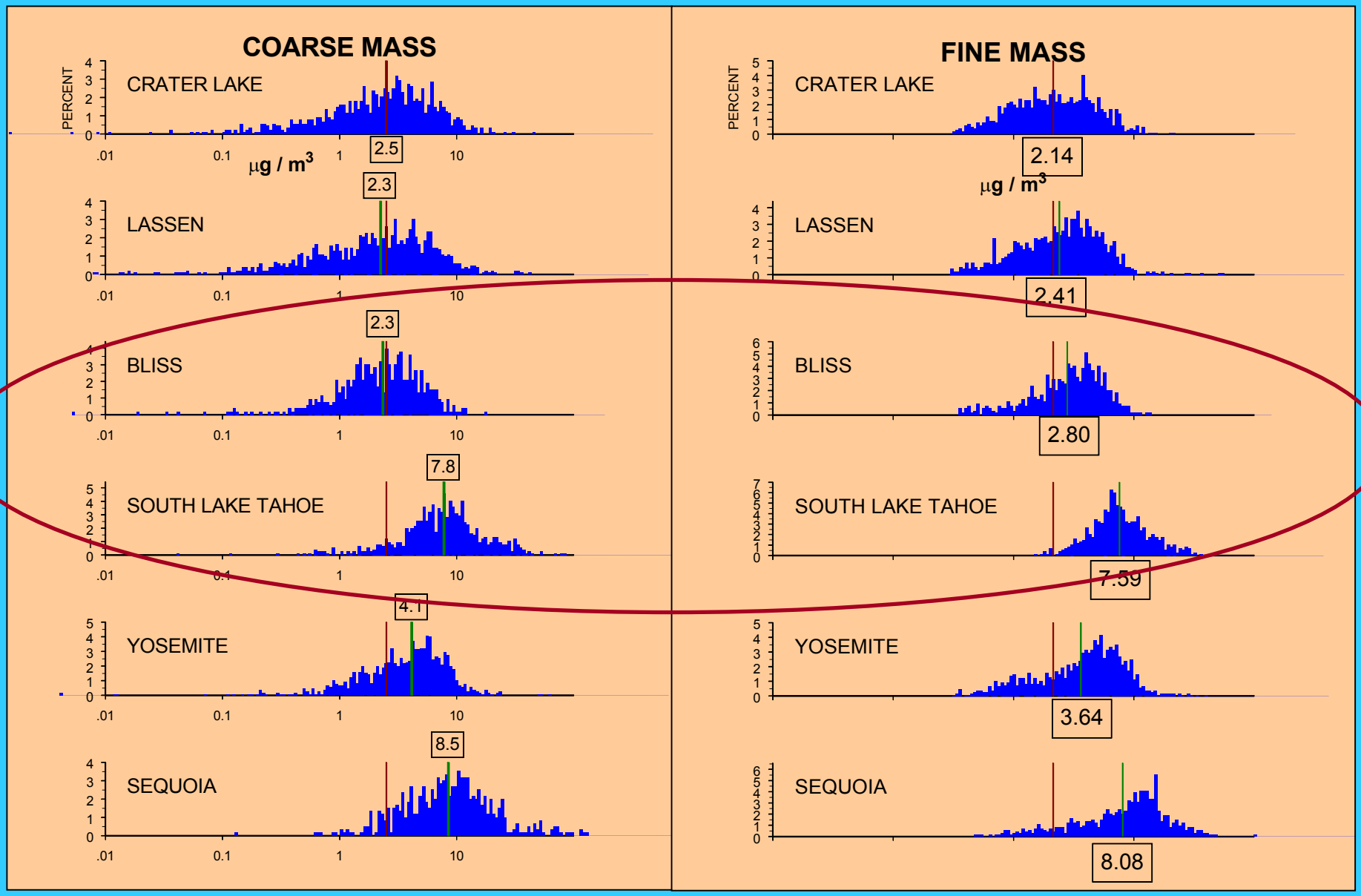
Preliminary Data - Not for Public Release

Tahoe in the Sierra-Cascade Environment

- Crater Lake National Park
  - ***Park Headquarters on Rim*** *1981m (6500')*
- Lassen Volcanic National Park
  - ***Manzanita Lake Visitor's Center*** *1790 m (5900')*
- D. L. Bliss State Park
  - ***W of U.S. 89 N of Emerald Bay*** *2042 m (6700') - 200m above LT*
- South Lake Tahoe
  - ***N Lake Tahoe Bl. at Lake Level*** *1905 m (6250')*
- Yosemite National Park
  - ***Turtleback Dome above Merced River Canyon*** *1905 m (6250')*
- Sequoia National Park
  - ***Park HQ in Kaweah Canyon*** *549m (1800')*

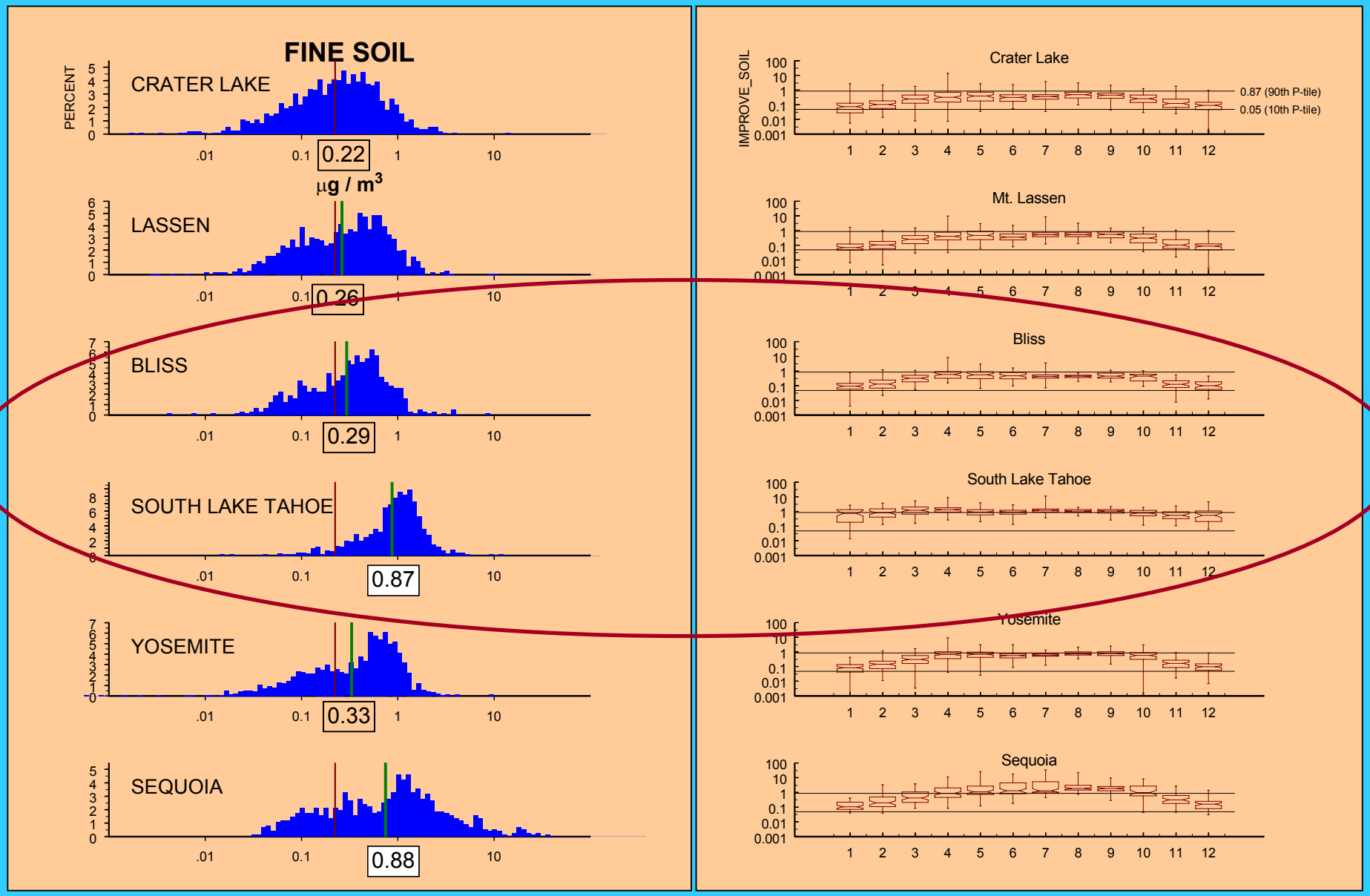
Preliminary Data - Not for Public Release

Sierra-Cascade PM10 / PM2.5



Preliminary Data - Not for Public Release

Sierra-Cascade Fine Soil



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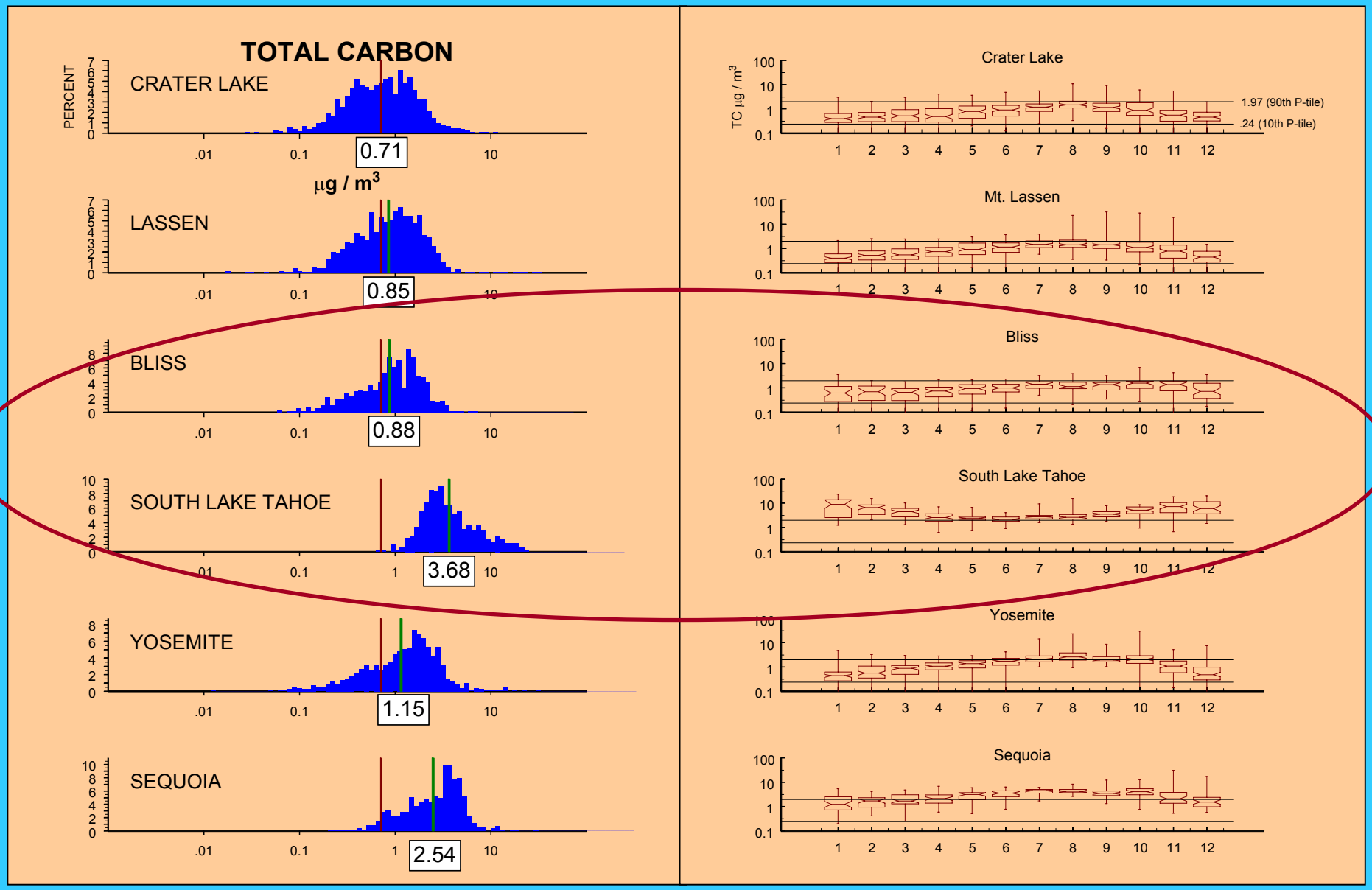
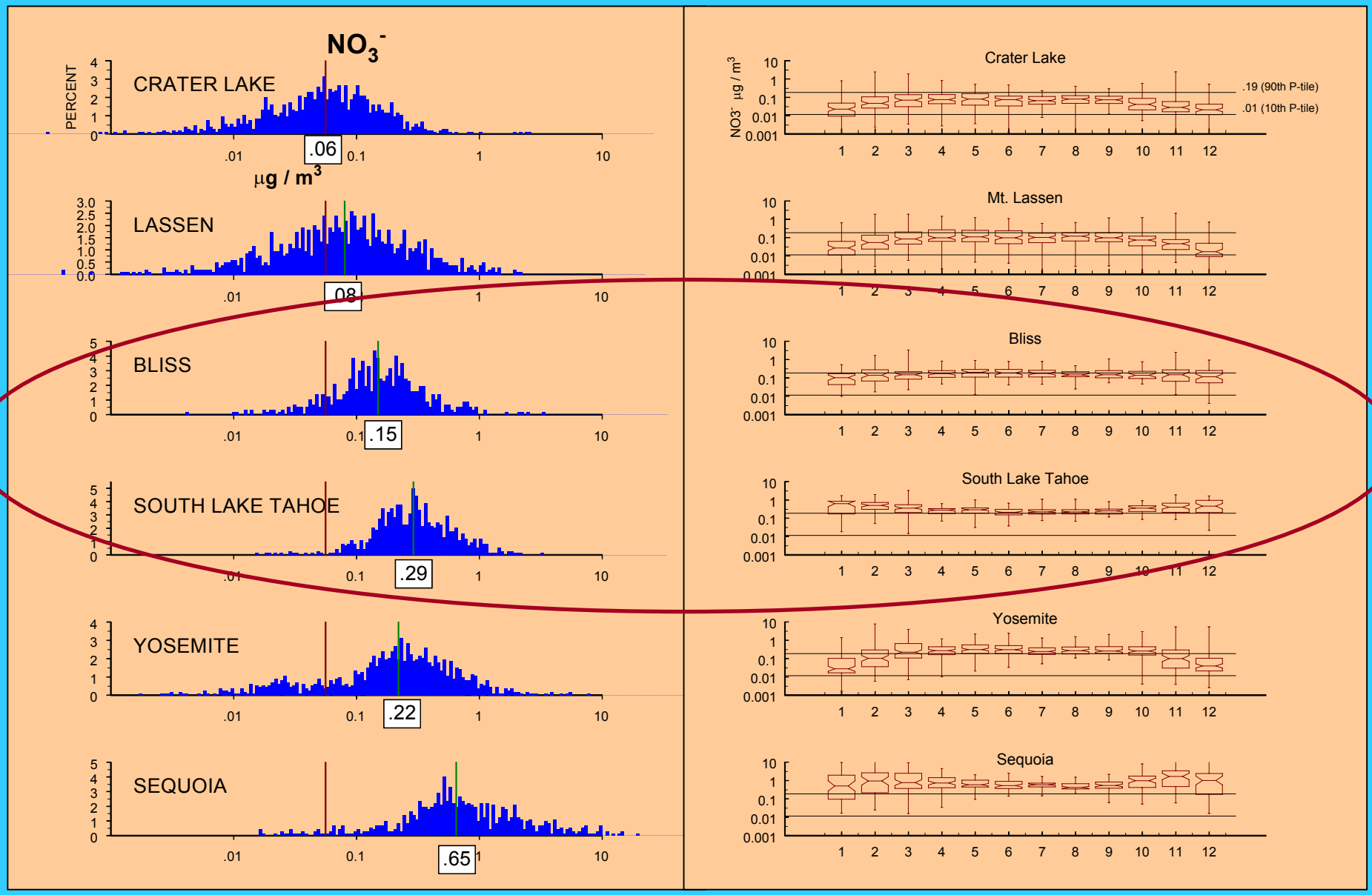
Sierra-Cascade Fine Carbon



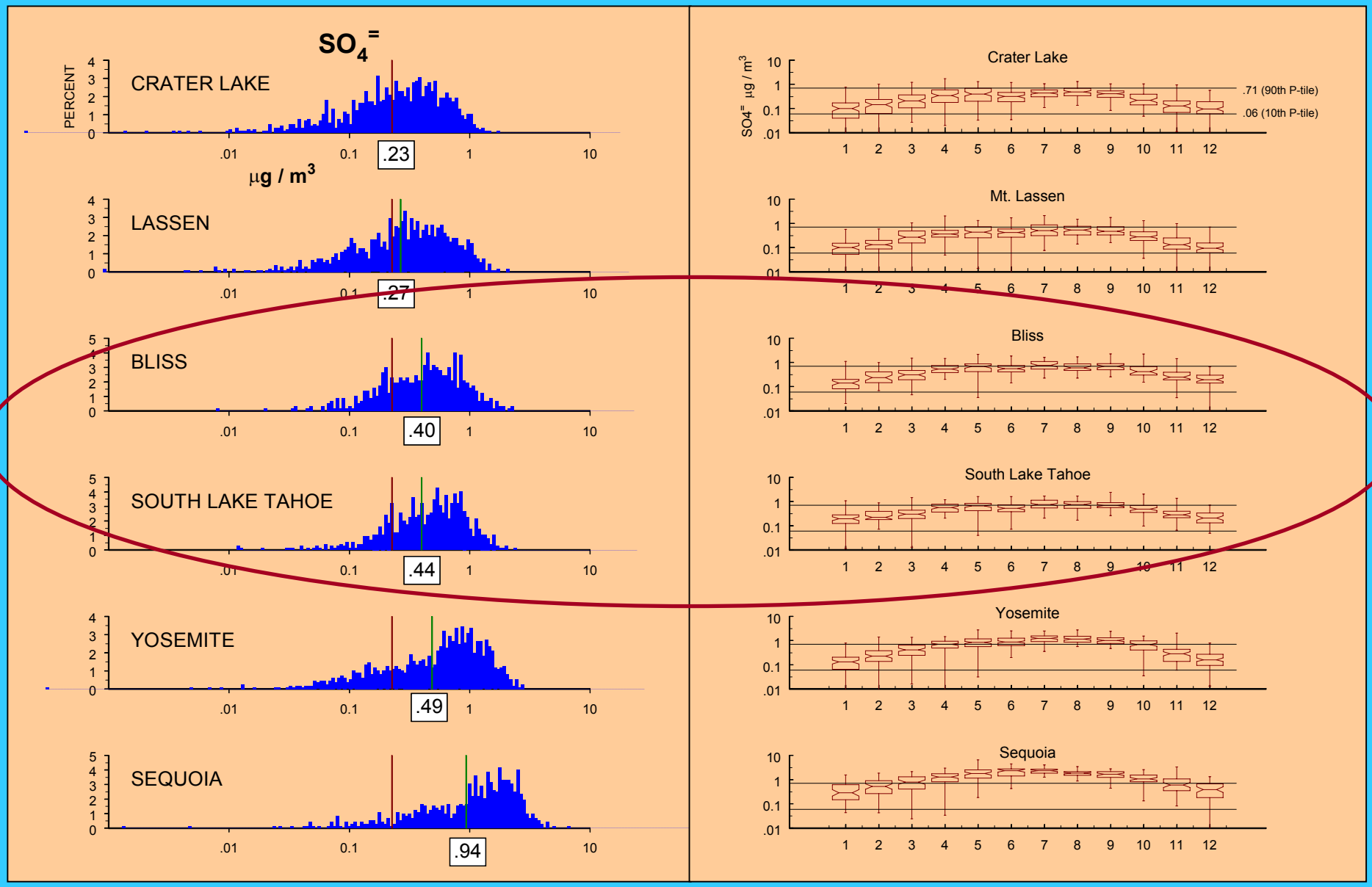
Preliminary Data - Not for Public Release

Sierra-Cascade Fine Nitrate



Preliminary Data - Not for Public Release

Sierra-Cascade Fine Sulfate



Preliminary Data - Not for Public Release

Four General Sierra-Cascade Aerosol Types

- Hemispheric aerosol
  - Northern Hemisphere “Background”
- Montane rural aerosol
  - Biogenics, dust, smoke, etc.
- Local community aerosol
  - Wood smoke, vehicle exhaust, dust, etc.
- California subregional aerosol
  - Transport from upwind urban & agricultural regions

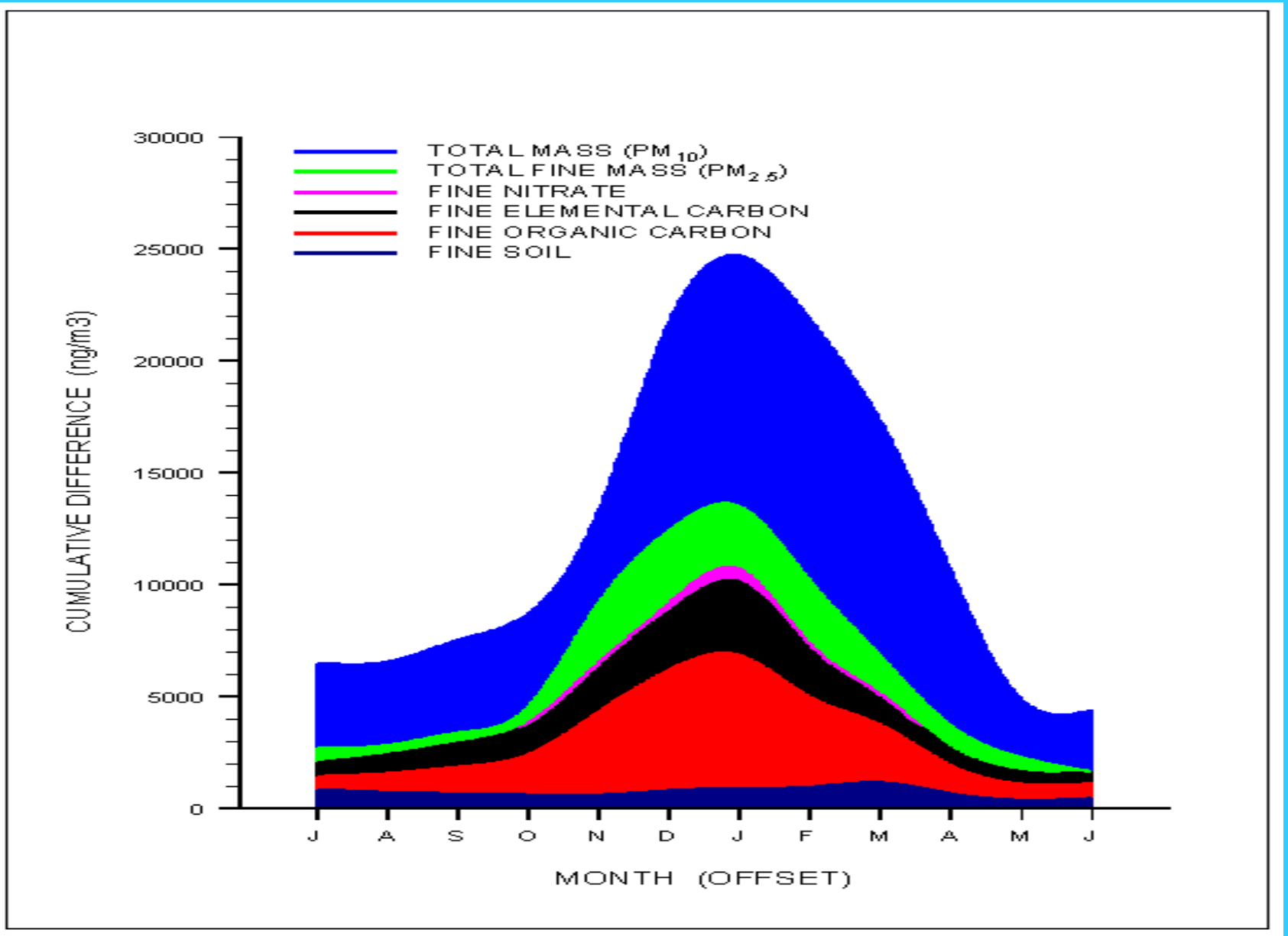
Preliminary Data - Not for Public Release

IMPROVE Data at Lake Tahoe

- SOLA appears to be the peak aerosol location in the Tahoe Basin
- BLIS represents the undeveloped, elevated portions of the Tahoe Basin

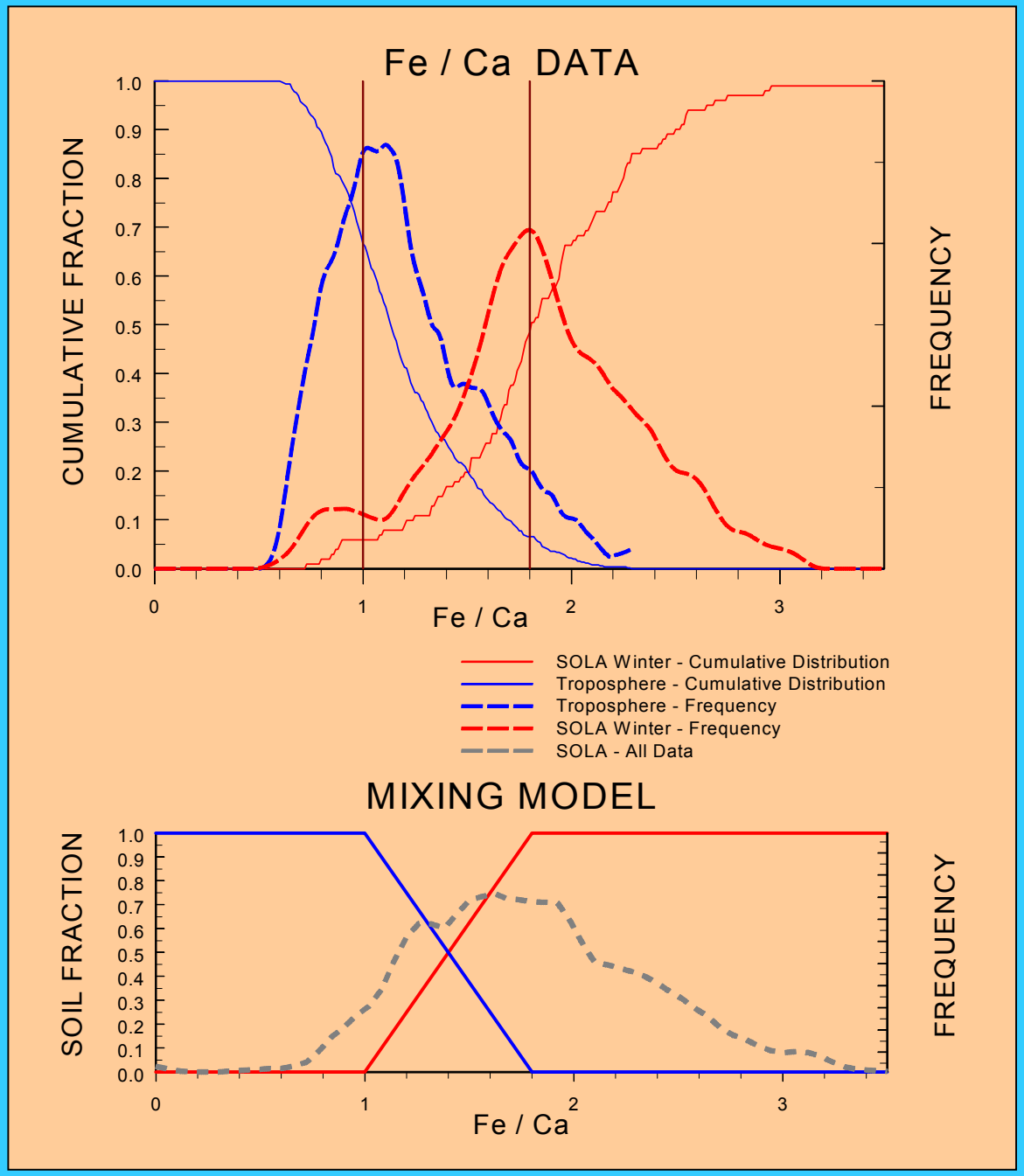
- Assuming transported pollutants reach both sites, then daily differences reflect local pollutants generated in the basin.

Seasonal Difference SOLA - BLIS



Preliminary Data - Not for Public Release

Distinguishing Local & Hemispheric Soil Dust



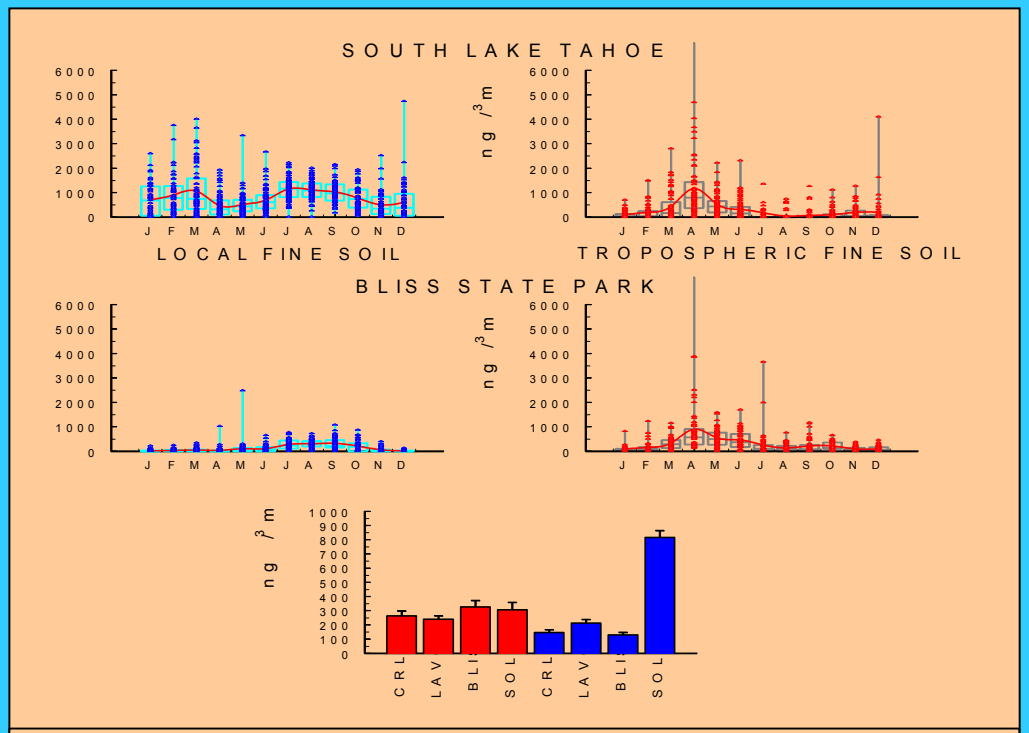
Elemental ratios vary in soil from different parent rocks:

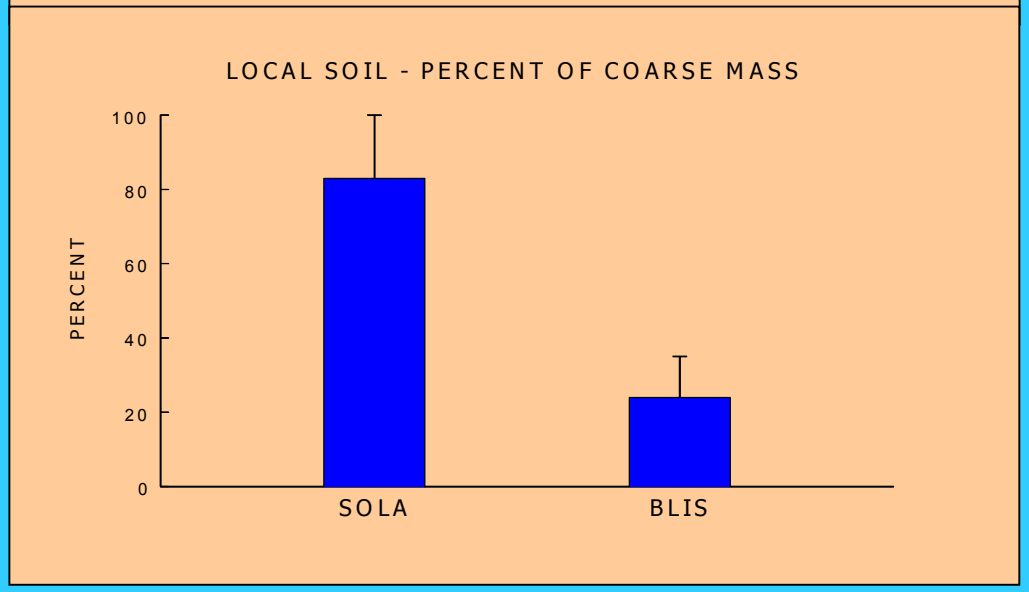
SOLA winter assumed to be local;

CRLA - LAVO Asian dust events assumed to represent hemispheric fine dust

Preliminary Data - Not for Public Release

Modeled Local & Hemispheric Soil Dust Concentrations





Fine soil mixing model:

-SOLA dominated by local dust

-BLIS dominated by hemispheric dust

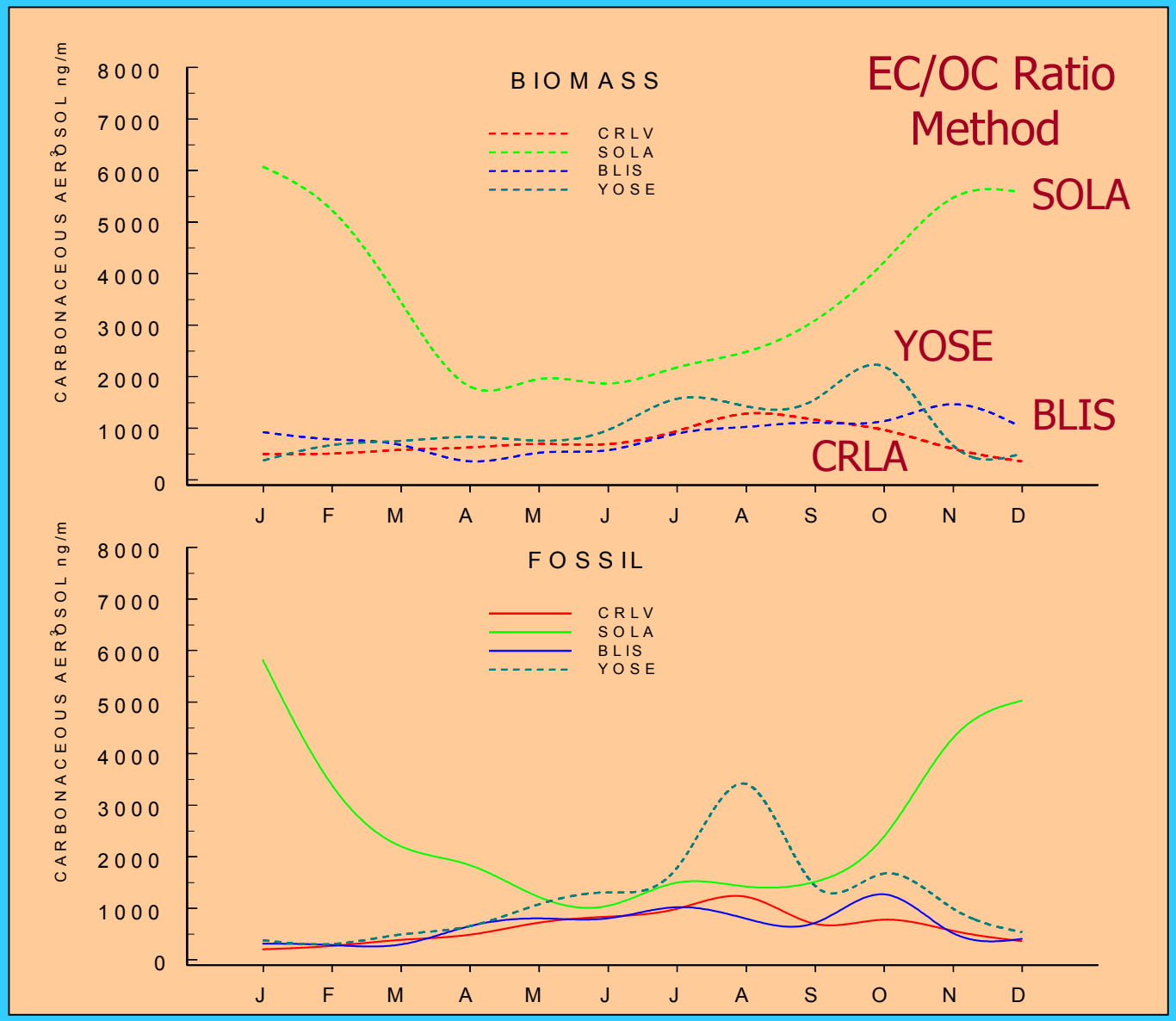
Coarse soil regression model:

-SOLA dominated by local dust

-BLIS dominated by hemispheric dust

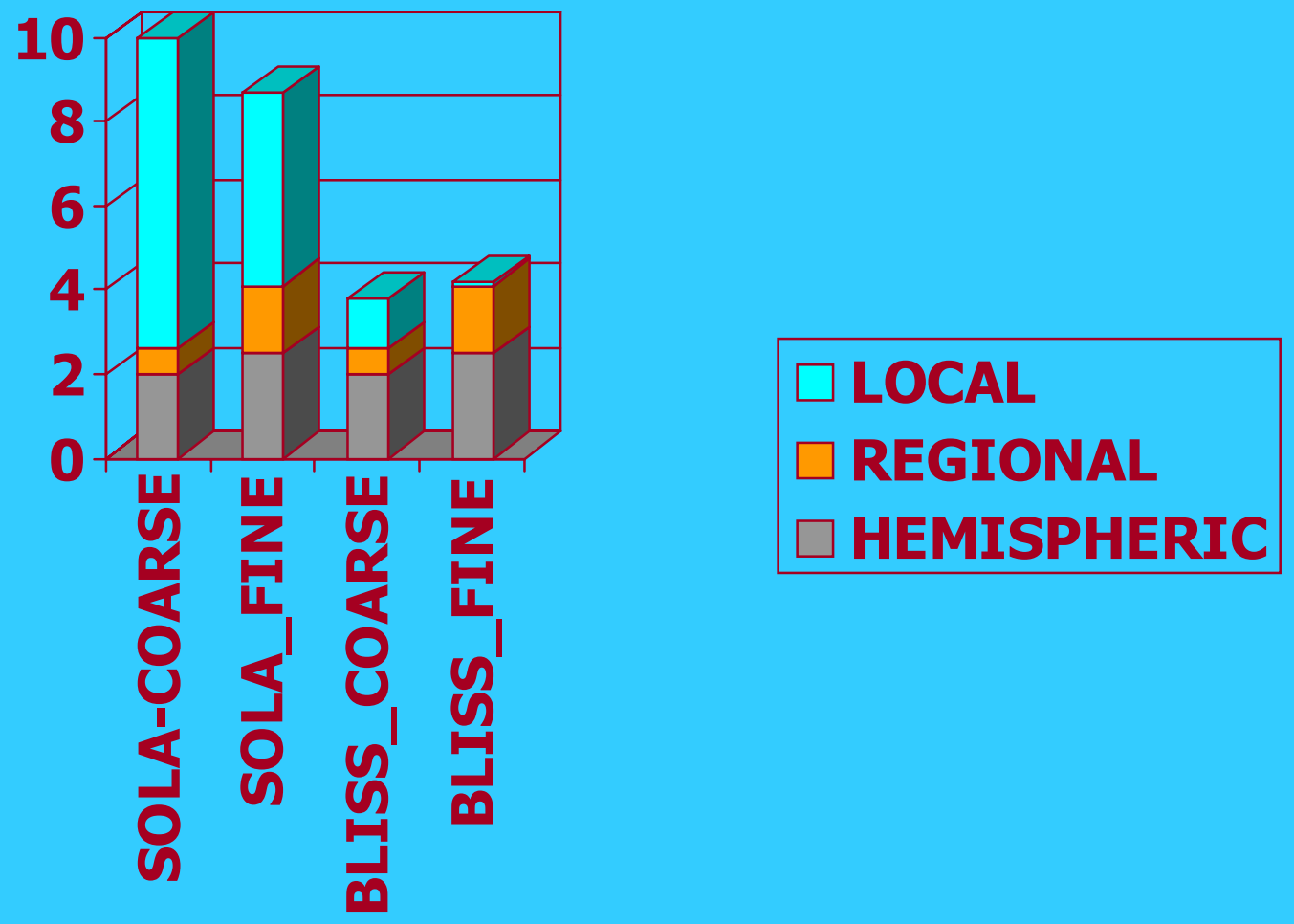
Preliminary Data - Not for Public Release

Modeled Biomass & Fossil Fuel Carbon



Preliminary Data - Not for Public Release

Estimated Local and Transported Aerosol Concentrations



Preliminary Data - Not for Public Release

Review of Existing Data

Discussion and comments

15 Minutes

Lake Tahoe
Atmospheric Deposition Study

Deposition Calculation Methodology

LTADS Deposition Calculation Methodology

- Direct Measurements Considered and Not Used
- Relevant Concentration Measurements
- Modeled Deposition Velocities
- Basic Processes Considered
- Level of Detail in Deposition Calculation
- Uncertainty Estimates

Direct Measurement Methods

- Surrogate Surfaces
- Eddy Covariance
- Eddy Accumulation
- Profile or Flux Gradient
- Dual Tracer Plume Depletion
- Mass Balance

LTADS Concentration Information

Two-Week Concentrations

- Nitric Acid, Ammonia
- PM Chemistry: PM2.5, PM10, TSP

Hourly PM mass - PM2.5, PM10, TSP

PM Size Observations

- Size Counts (in 6 "bins")
  (0.3-0.5, 0.5-1.0, 1.0-2.5, 2.5-5, 5-10, and 10-25 μm)
- Spatial & Diurnal Patterns

LTADS Meteorological Observations

- Wind, Temperature, & Humidity
- Surface & Aloft
- Uses of Meteorological Data
  - Vertical Mixing
  - Transport Trajectories
  - Deposition Velocity

What Sets Deposition Rates?

Ambient Concentrations

Largest Particles:

- **Settling velocity** (PM size, density)

Gases and Smaller Particles:

- **Multiple Rate Limiting Steps**

Deposition Velocity

- Deposition Rate/Concentration
- Normalized Rate - Not Process
- Differentiate deposition velocity from settling velocity

How Gases and Particles "Deposit"

1. Turbulence mixes pollutants toward "sink"

(larger particles reach surface by gravitational settling)

Atmospheric turbulence set by wind speed and surface roughness (decreased by thermal stratification)

Aerodynamic Resistance

2. Diffusion across very thin laminar layer

Depth of layer (wind speed, surface elements)

Rate of diffusion (particle size, molecular weight)

Quasi-laminar Resistance

3. Capture by surface

Pollutant solubility, chemical reactivity

Surface type, biophysical factors (stomatal opening)

Surface Resistance

Preliminary Data - Not for Public Release

Particle Deposition to Water

Surface Resistance ~ 0 for PM to water

Quasi-Laminar Resistance

- Wind Speed
- Particle Size

Aerodynamic Resistance

Water May Modify Processes, Resistances

- Hygroscopic particle growth
- White caps and spray

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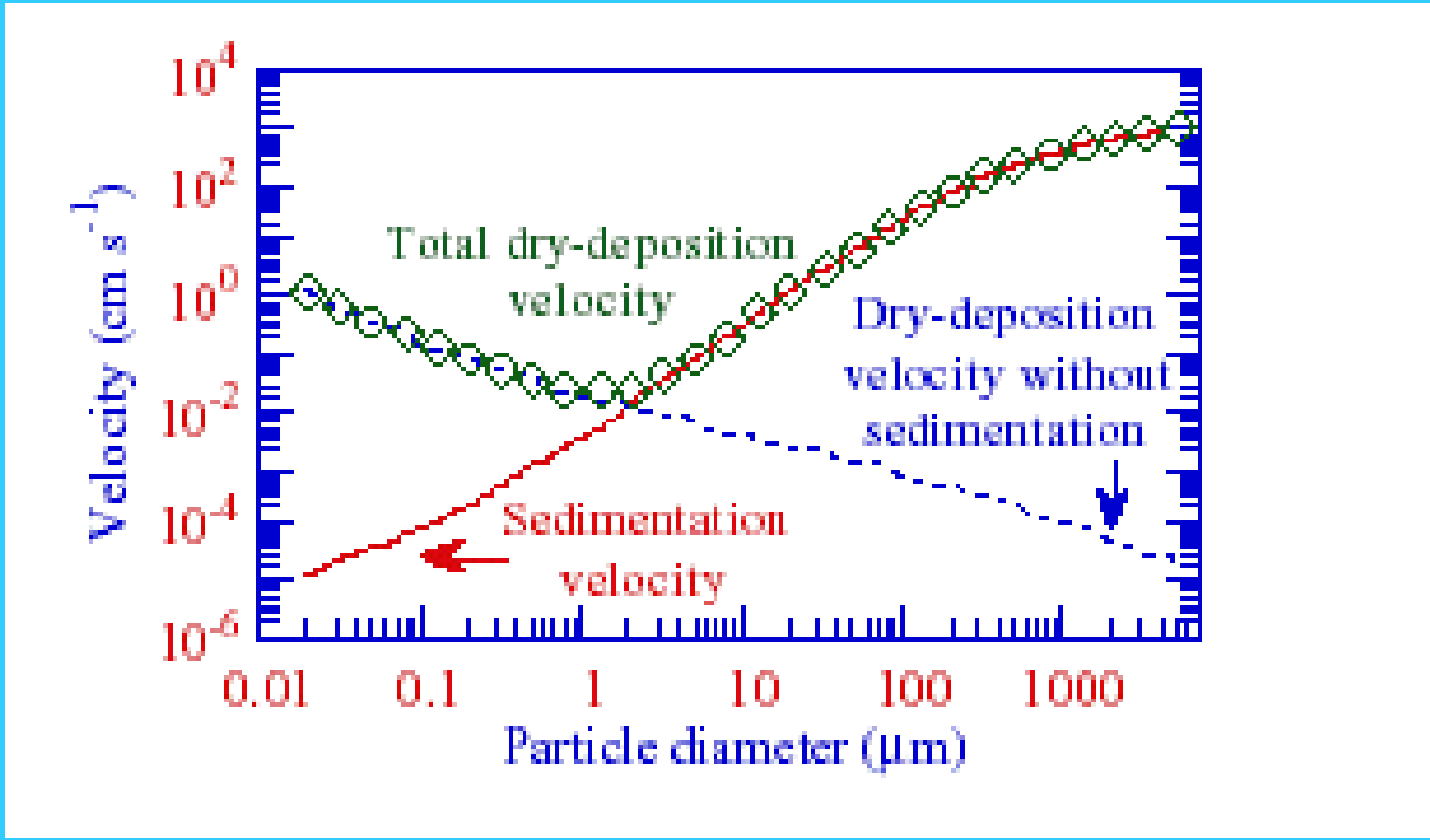
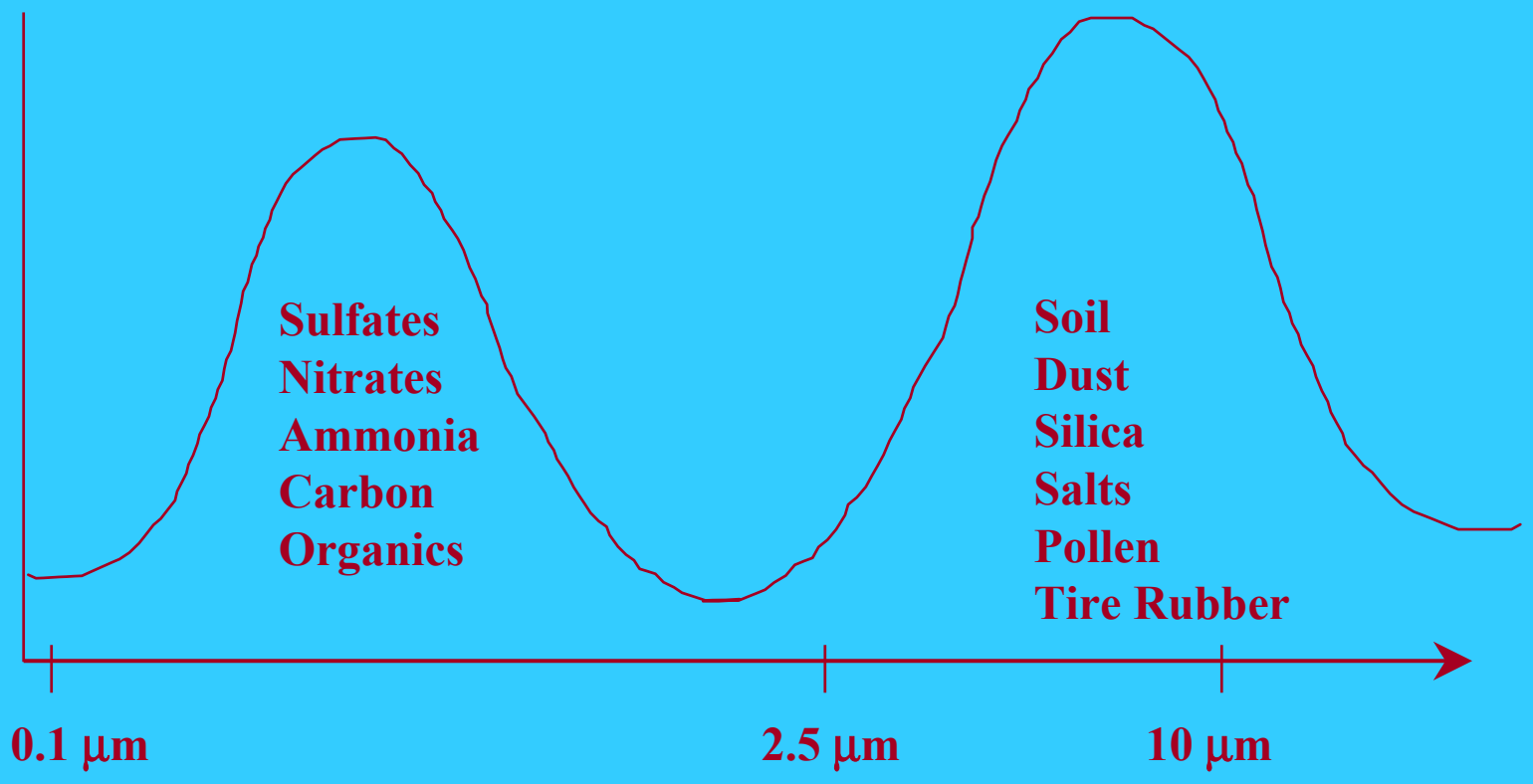
Deposition Velocity



Source: Jacobson 2002

Observed Particle Size Distribution



Preliminary Data - Not for Public Release

Calculating Deposition Rates

Use Observed Concentrations
Estimate Deposition Velocities
Consider Spatial and Temporal Variations
- **Concentration**
- **Deposition Velocity**

Calculate Deposition Rate
- (Concentration x Deposition Velocity)

Analysis of Uncertainty
Bounding Calculations

Level 1 Deposition Estimates

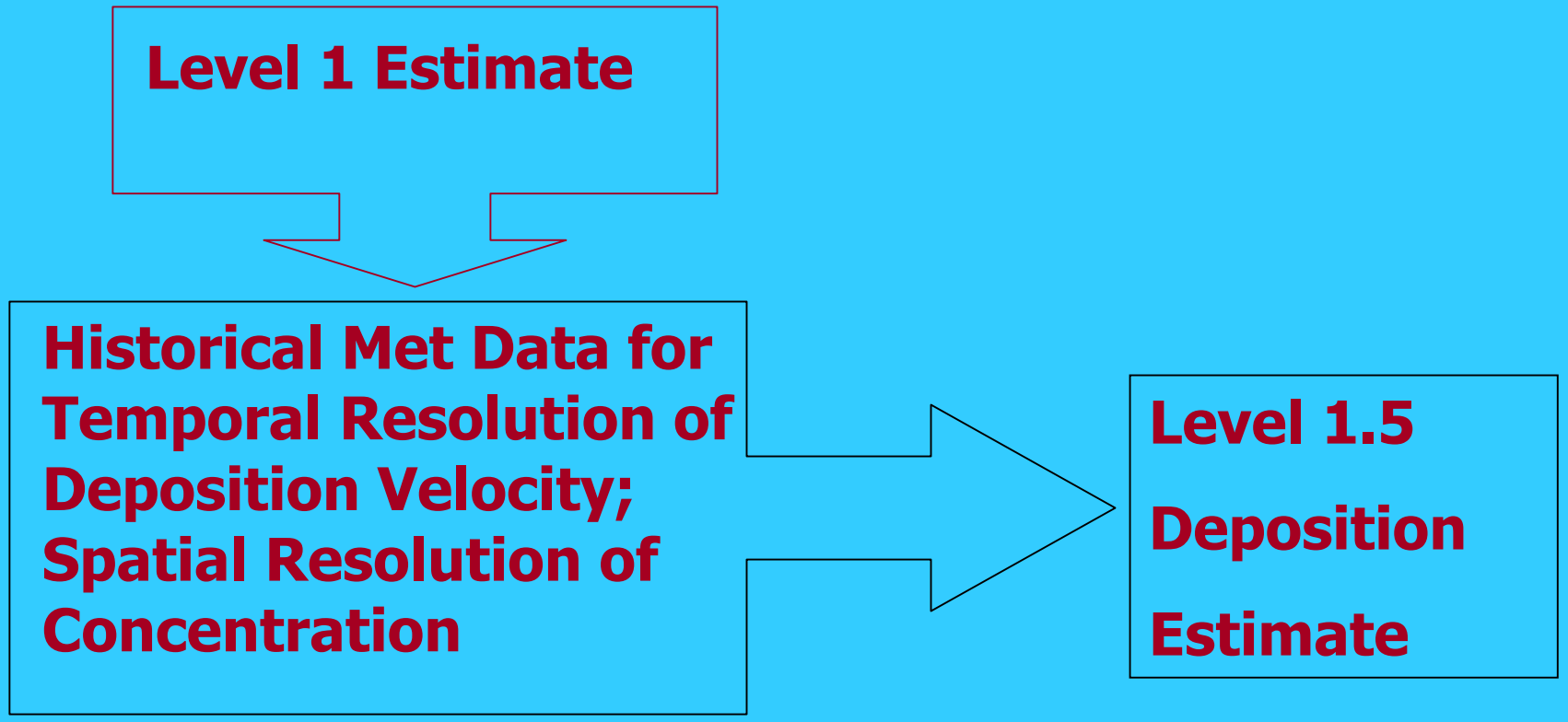
Average Observed Concentrations

Lit. Deposition Velocities

→

Level 1 Deposition Estimate

Level 1.5 Deposition Estimates



Level 2 Deposition Estimates

Level 1.5 Estimate

Improved temporal Resolution of Concentration, by use of data from BAMs, MiniVols, Particle Counters

Level 2 Deposition Estimate

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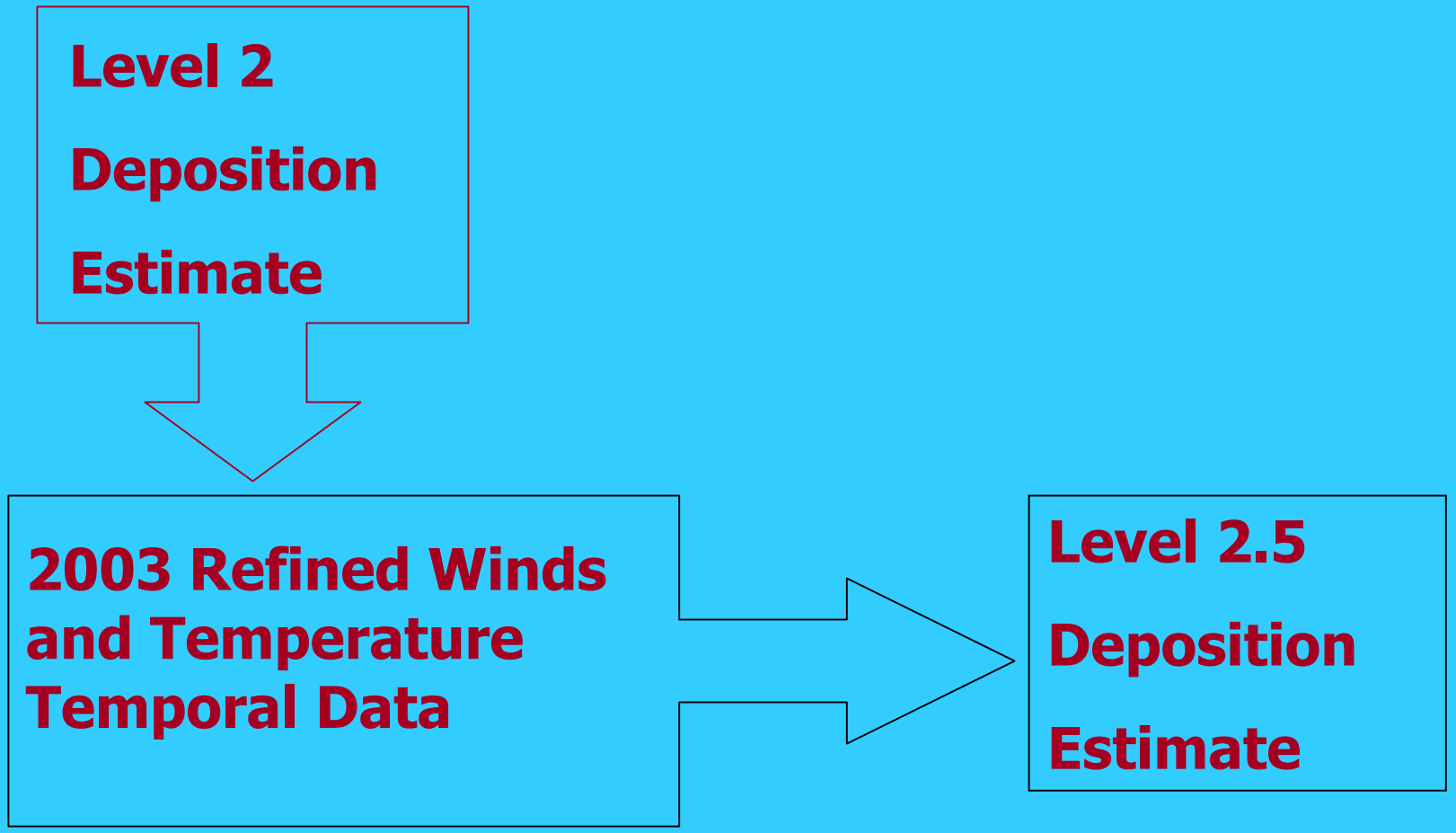
Level 2.5 Deposition Estimates



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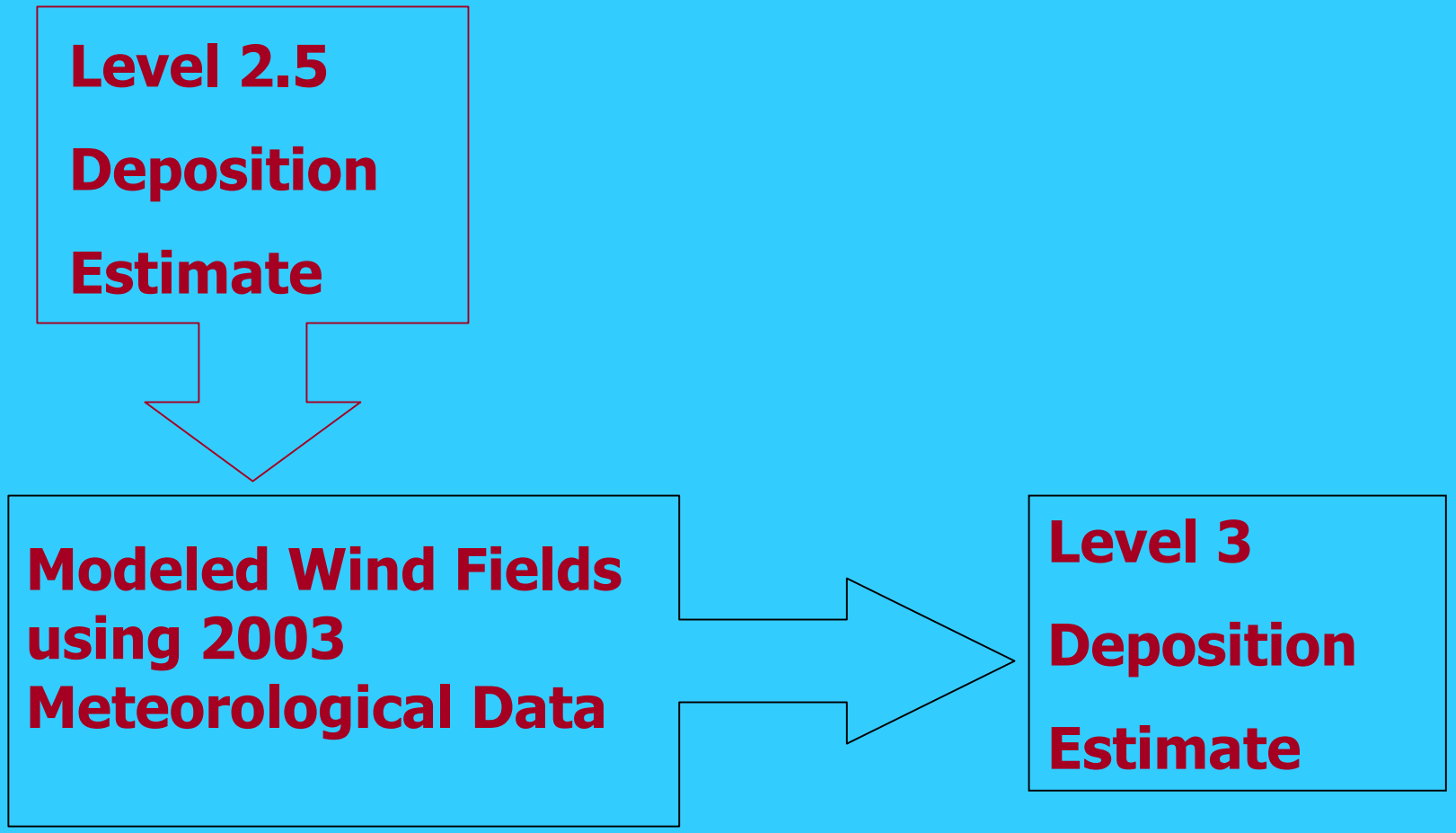
Level 3 Deposition Estimates



Preliminary Data - Not for Public Release

Example Level 1 Estimate of total Phosphorus Deposition to Lake

- Fine Fraction (<2.5 micron)
  - 13 ng-P/m3, Vd = 0.4 cm/s
- Coarse Fraction (2.5-10 micron)
  - 13 ng-P/m3, Vd = 1 cm/s
- Large Particles (>10micron)
  - 4 ng-P/m3, Vd = 2 cm/s
- With these assumptions deposition to Lake would be 25 pounds-P/day.

Lake Tahoe
Atmospheric Deposition Study

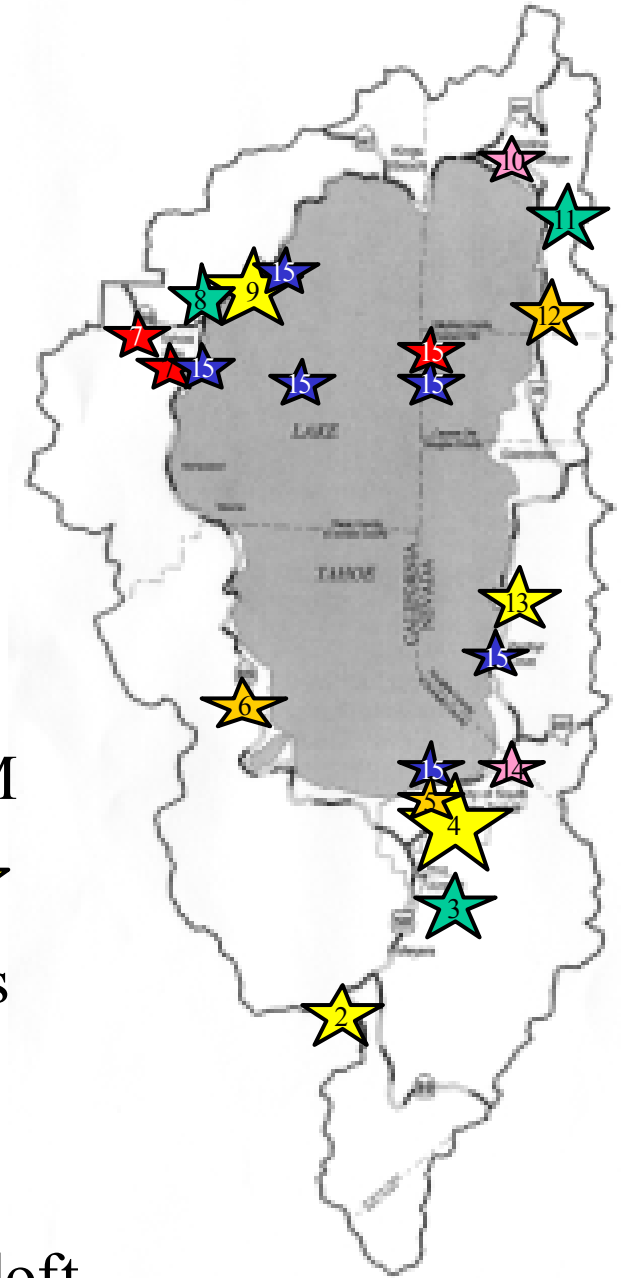
Deposition Calculation Methodology
Questions
Concerns
Comments

15 Minutes Please

LTADS Interim Report Overview
Nov. 21, 2003

Field Study Status

LTADS Monitoring Network



1. **Big Hill**
2. Echo Summit
3. Tahoe Airport
4. **SLT-Sandy Way**
5. SLT-SOLA
6. DL Bliss SP
7. Ward Creek
8. Tahoe City
9. **Lake Forest**
10. Incline Vlg - AQ
11. Incline - Met
12. **Thunderbird Ldg**
13. Cave Rock SP
14. Stateline - Harvey
15. **Buoys/Piers**
16. Grass Valley

- AQ - gas & PM
- AQ - PM
- AQ - single gas
- Deposition
- On-Lake
- Meteorology aloft

LTADS Field Study Status

What is different from the initial plan?

- Big Hill replaced Homewood as an upwind site
- No additional W/D dep measurements
- Dry dep methods comparison only in Sac
- No continuous nitrate analyzer
- Delay Tahoe-specific photochemical modeling
- Added additional mini-vol samples & sites
- Added sized particle counts
- Extended LIF data collection period
- Additional lab analyses

LTADS Field Study Status

- Air quality monitoring
- Meteorological monitoring
- Emissions support measurements
- Dry deposition methods comparison

LTADS Field Study Status
Enhanced Air Quality Monitoring

- Two Week Samplers (5 + Day/Night)
- Mini-vol samplers (~24)
- Beta Attenuation Monitors (13)
- Laser Induced Fluorescence (1)

LTADS Field Study Status
Enhanced Air Quality Sampling

- Optical Particle Counters (2 + 5)
- Aircraft program (1)
- Boat program (1)
- "Dust" experiments (~12)
- Passive ozone & HNO_3 sampling

LTADS Field Study Status
Enhanced Meteorological Monitoring

- Radar Wind Profilers w/ RASS (2)
- mini-sodars (4)
- aircraft (1)
- UCD/NASA buoys & piers (6/6)
- DRI evaporation study (4)

LTADS Field Study Status
Emissions Support Measurements

- UCR (report available)
  - vehicle mix
  - driving patterns
  - wood burning (residential & prescribed)
- DRI (in progress)
  - vehicle test stand
  - road dust
  - sanding material
  - fireplace sampling

LTADS Field Study Status
Dry Deposition Methods Comparison

- AC standard dry bucket
- TRG-modified bucket
- TRG-tube (bulk)
- Water Surface Sampler

LTADS Field Study Status
Two Week Samplers

Site	Start	Data Gaps	Notes
Big Hill	2/26/03	Prd: 1-8, 10-13,18	storm damage; power
Lake Forest	11/20/02	Prd: 4	Prds 5 & 6 combined
Thunderbird	11/20/02	Prd: 4	
SLT-SW	11/20/02		
SOLA	11/20/02	Prd: 2,14,18	field blanks
SOLA-D/N	10/22/03		denuders only

Note: data gaps are based only on sampling time; a review of flow rates could invalidate more samples

Preliminary Data - Not for Public Release

LTADS Field Study Status
Beta Attenuation Monitors

Site	Start	Data Gaps	Notes
Big Hill	5/14/03	5/30-6/18	no TSP; storms; power
Lake Forest	11/1/02	PM10 11/1-1/9; 4/9-6/30+	
Thunderbird	10/22/02	TSP thru 1/31	
SLT-SW	10/1/02	TSP thru 10/19	
SOLA	10/04/02	11/14-4/25	TSP only;low flows
Cave Rock	9/1/02		TSP only

Note: data gaps are based only on sampling time; a review of flow rates could invalidate more samples.

LTADS Field Study Status
Mini-Volume Samplers

Site	Start	Capture Rate	Notes
Buoy TB1 (e)	10/9/02	13/15	
Buoy TB4 (w)	10/9/02	13/15	
Wallis tower	3/12/03	12/15	
Wallis pier	3/12/03	14/18	
LF-CG pier	9/26/02	31/36	
Zephyr Cove	2/24/03	9/14	
Timber Cove	10/1/02	14/15	1 set in lake
SOLA	7/4/03	1/1	

Wallis sites are located near Ward Creek

LTADS Field Study Status
Miscellaneous

Program	Start	Location(s)	Notes
LIF, O_3, NOy	>2/15/03	Big Hill	power problems
NOy	3/26/03	SLT-Sandy Way	line leak initially
O_3, NOy	7/10/02	aircraft in & upwind	22 days
O_3, NOy, CO	>11/1/02	Lake Forest	power problems
dry dep method exp.	3/6/03	Sacto-MLD roof	water surface sampler repairs
dust exp.	5/22/03	on & near Lake	Optical Particle Counter
mini-sodars	>1/15/03	4 sites	except @ AP, intermittent ops

LTADS Field Study Status

Questions
Concerns
Comments

15 Minutes Please

Lake Tahoe
Atmospheric Deposition Study
Preliminary Results

Preliminary Data - Not for Public Release

LTADS "Starting Point"

Subjective Impressions:

- Seasonality is critical
- Summer
  - Potential transport
  - Lake cooler than land
  - Emphasis
    - soil dust
    - smoke (campfires, prescribed/wild, residential)
- Winter
  - Minimal transport
  - Strong inversions
  - Lake warmer than land
  - Emphasis
    - road dust
    - smoke (residential)

LTADS Research Model

Critical Information:

- Micro/meso meteorology
  - Regional flow fields
  - In-basin mixing and drainage
- Emissions
  - Road dust
  - Soil dust
  - Smoke (campfires, prescribed/wild, residential)
- Monitoring
  - Transport pathways
  - Lake shore
  - High and low density zones in basin
  - Particle sizing
  - Species:
    - Nutrients (N + P)
    - Inert particles

Lake Tahoe
Atmospheric Deposition Study

- Two Week Sampler Program (TWS)
- Beta Attenuation Monitors (BAM)
- Mini Volume Sampler Program (MVS)
- Phosphorus & Nitrogen Deposition Estimates
- Dry Deposition Method Comparison
- Size Distribution, Particle Counters, Dust Experiments
- Transport Assessment
- Airplane Measurements 2002
- Successes & Challenges

Preliminary Data - Not for Public Release

Lake Tahoe Atmospheric Deposition Study Future Data

- Aloft Program Data
  - Data Available for 2002 & through July 03
- DRI Surface Met Flux Data
  - Available
- DRI Surface Evaporation Met Data
- Buoy & Pier Surface Met Data
- Extensive US Forest Service Passive Ozone & Nitric Acid Program Summer 2002

Lake Tahoe Atmospheric Deposition Study Perspective

- Our Final Database will achieve our goals:
  - An integrated understanding of the Tahoe Basin atmosphere.
  - A refined deposition estimate based on spatially & temporally resolved inputs.

Initial LTADS Monitoring Results

Two Week Sampler Program

Initial LTADS Monitoring Results

Summer/Winter Means for TWS Data (ug/m³)

Site	**Size: # Prds**	**<2.5u (fine)**	**2.5 - 10u (coarse)**	**>10u (large)**
Big Hill	6 / 2	6 / 5	5 / 0	3 / 1
Lake Forest	10 / 8	5 / 3	8 / 13	1 / 7
T-Bird	10 / 9	5 / 3	3 / 1	0 / 1
SLT-SW	10 / 10	6 / 12	7 / 9	2 / 5
SOLA	8 / 8	5 / 8	10 / 18	0 / 4

Winter = first 10 TWS sampling periods (11/20/02-4/8/03); Summer = 2nd 10 TWS sampling periods (4/9-8/26/03)

Preliminary Data - Not for Public Release

Initial LTADS Monitoring Results

Grand Means for TWS PO_4 Data (ng/m^3)*

Site	**#>0/#>U/# Mn PM2.5±Unc**	**#>0/#>U/# Mn PM10±Unc**	**#>0/#>U/# Mn TSP±Unc**
Big Hill	1 / 1 / 8 81±9	1 / 1 / 8 73±8	0 / 0 / 8
Lake Forest	0 / 0 / 18	1 / 1 / 18 107±12	0 / 0 / 18
T-Bird	0 / 0 / 19	0 / 0 / 19	0 / 0 / 19
SLT-SW	0 / 0 / 20	0 / 0 / 20	0 / 0 / 20
SOLA	1 / 1 / 17 89±49	0 / 0 / 17	0 / 0 / 17

* Means = Mn= mean of all samples with measurable concentrations

Preliminary Data - Not for Public Release

Initial LTADS Monitoring Results

Grand Means for TWS P Data by XRF (ng/m³)*

Site	**#>0/#>U/# Mn PM2.5±Unc**	**#>0/#>U/# Mn PM10±Unc**	**#>0/#>U/# Mn TSP±Unc**
Big Hill	1 / 0 / 8	0 / 0 / 8	0 / 0 / 8
Lake Forest	1 / 0 / 18	2 / 1 / 18 16±10	3 / 1 / 18 7±7
T-Bird	1 / 0 / 19	1 / 1 / 19 27±19	0 / 0 / 19
SLT-SW	0 / 0 / 20	1 / 0 / 20	1 / 0 / 20
SOLA	0 / 0 / 17	2 / 2 / 17 118±8	3 / 0 / 17

* Means = Mn = mean of all samples with measurable P concentrations

Preliminary Data - Not for Public Release

Initial LTADS Monitoring Results

S/W Means for TWS HNO_3 and NH_3 Data (ng/m^3)

(gas phase collected by denuders)

Site	HNO_3 Summer	HNO_3 Winter	NH_3 Summer	NH_3 Winter
Big Hill	123 ± 52	205 ± 61*	668 ± 45	234 ± 28*
Lake Forest	102 ± 23	336 ± 68	675 ± 40	626 ± 41
T-Bird	146 ± 32	249 ± 66	210 ± 23	67 ± 22
SLT_SW	285 ± 27	972 ± 79	949 ± 51	841 ± 48
SOLA	279 ± 30	1134 ± 90	1266 ± 67	2376 ± 123

* only 2 winter samples collected at Big Hill so far during study

Winter = first 10 TWS sampling periods (11/20/02-4/8/03); Summer = 2nd 10 TWS sampling periods (4/9-8/26/03)

Preliminary Data - Not for Public Release

Initial LTADS Monitoring Results
Two Week Sampler Program

Questions

Concerns

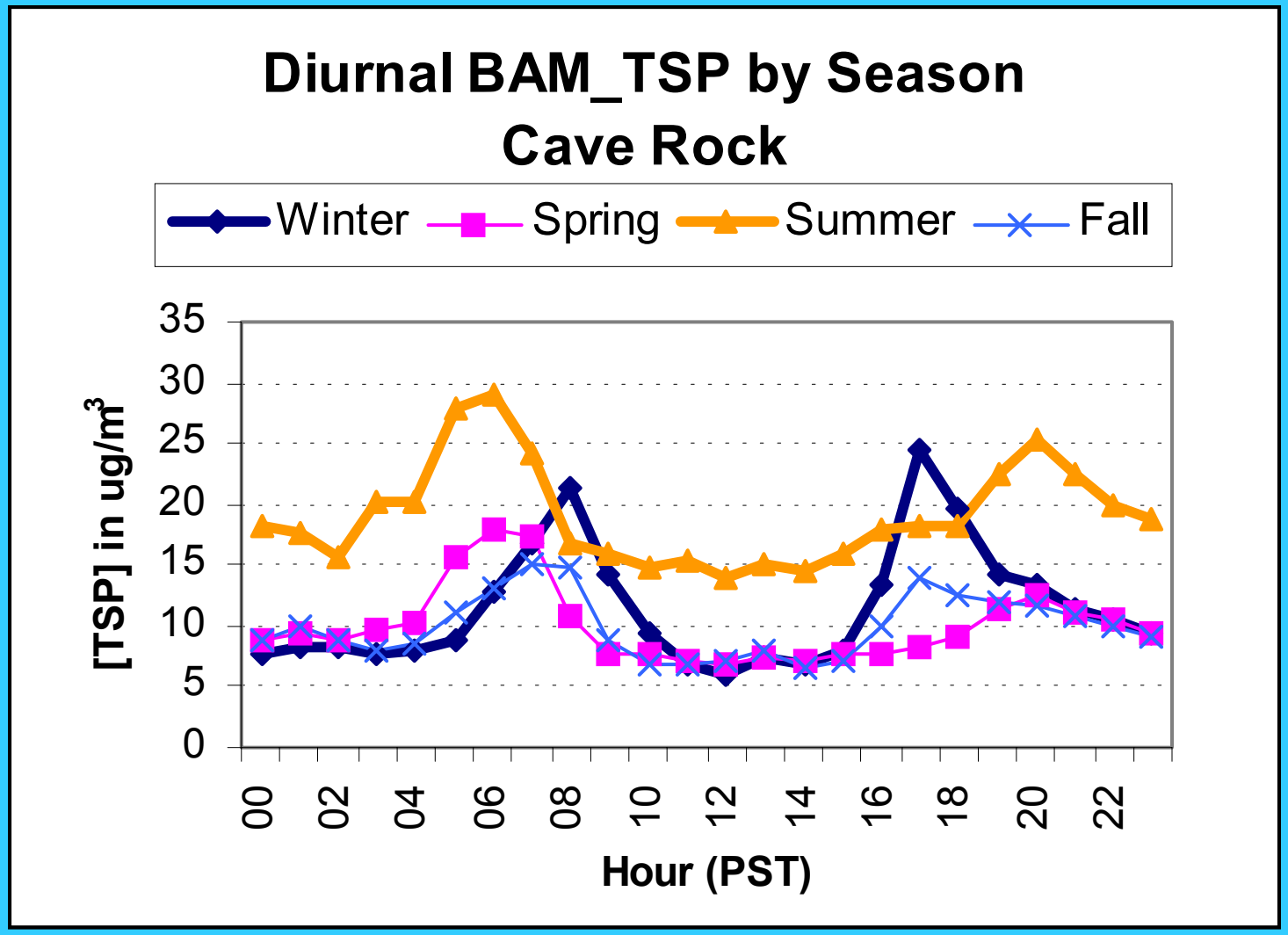
Comments

10 Minutes Please

Initial LTADS Monitoring Results

Beta Attenuation Monitoring Program

Initial LTADS Monitoring Results
Diurnal TSP Variation



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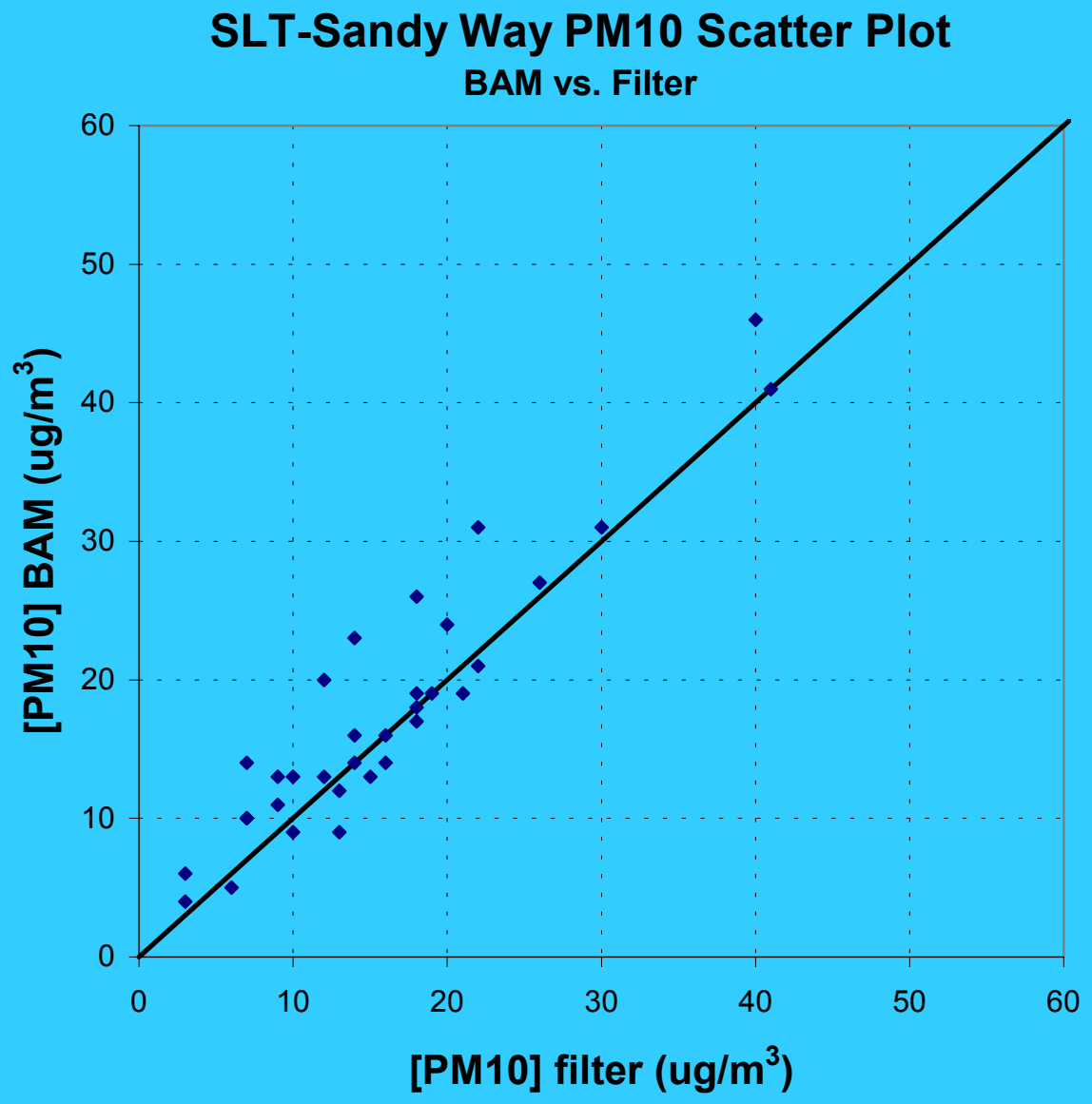
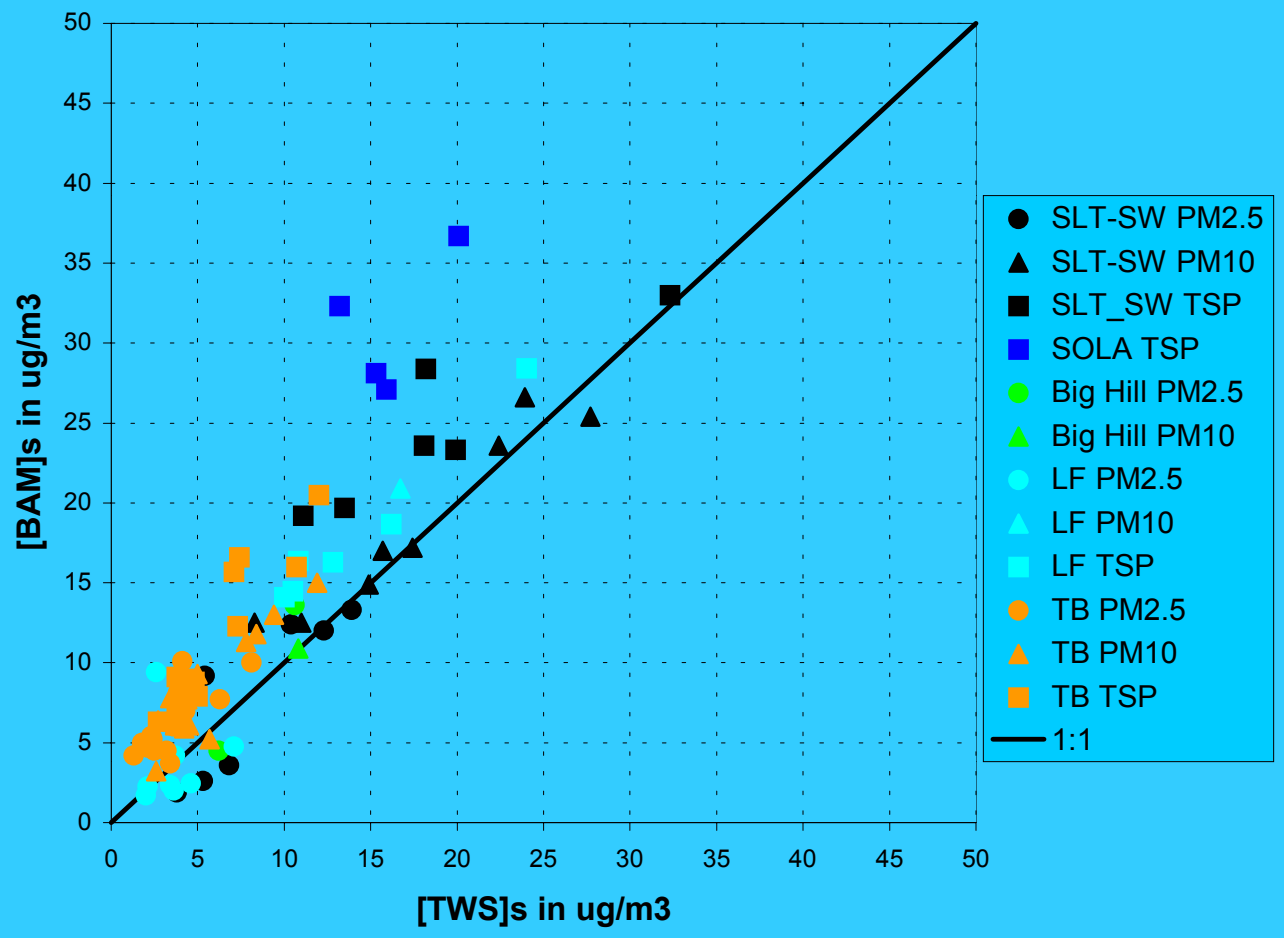
Initial LTADS Monitoring Results



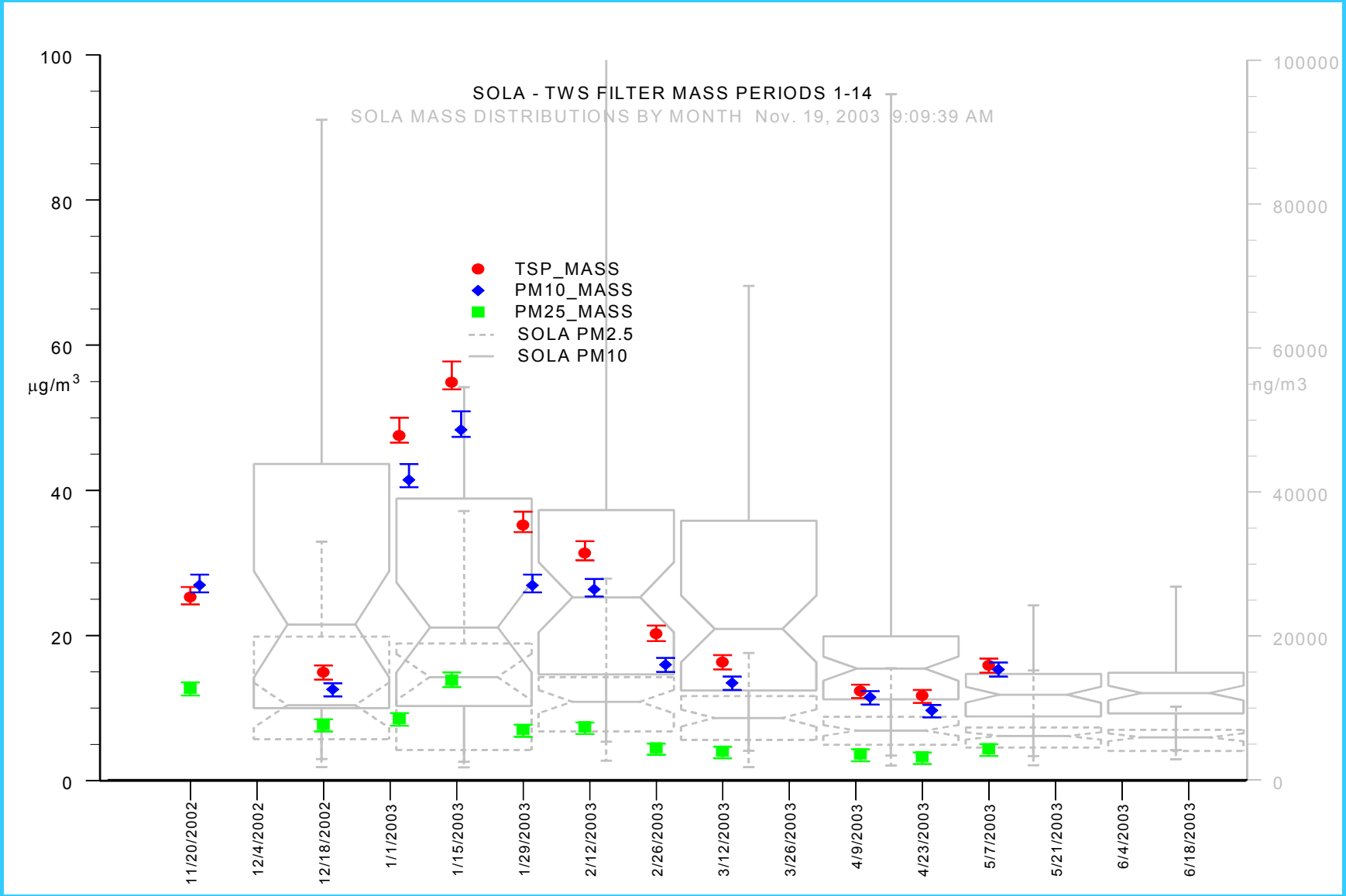
Preliminary Data - Not for Public Release

Initial LTADS Monitoring Results
Scatter Plot of Matched TWS vs. BAM Data



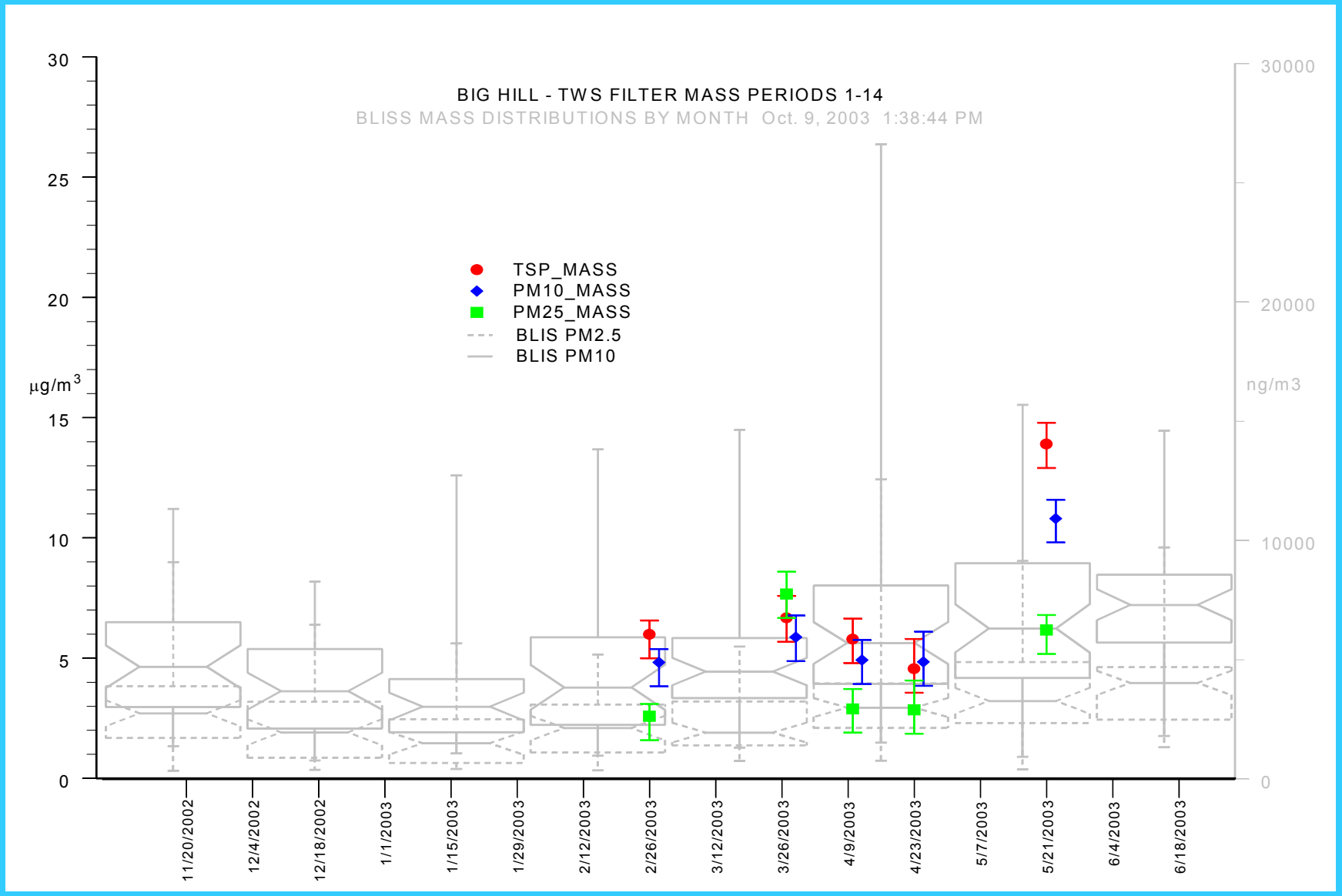
Preliminary Data - Not for Public Release

TWS SOLA vs IMPROVE Historical Record



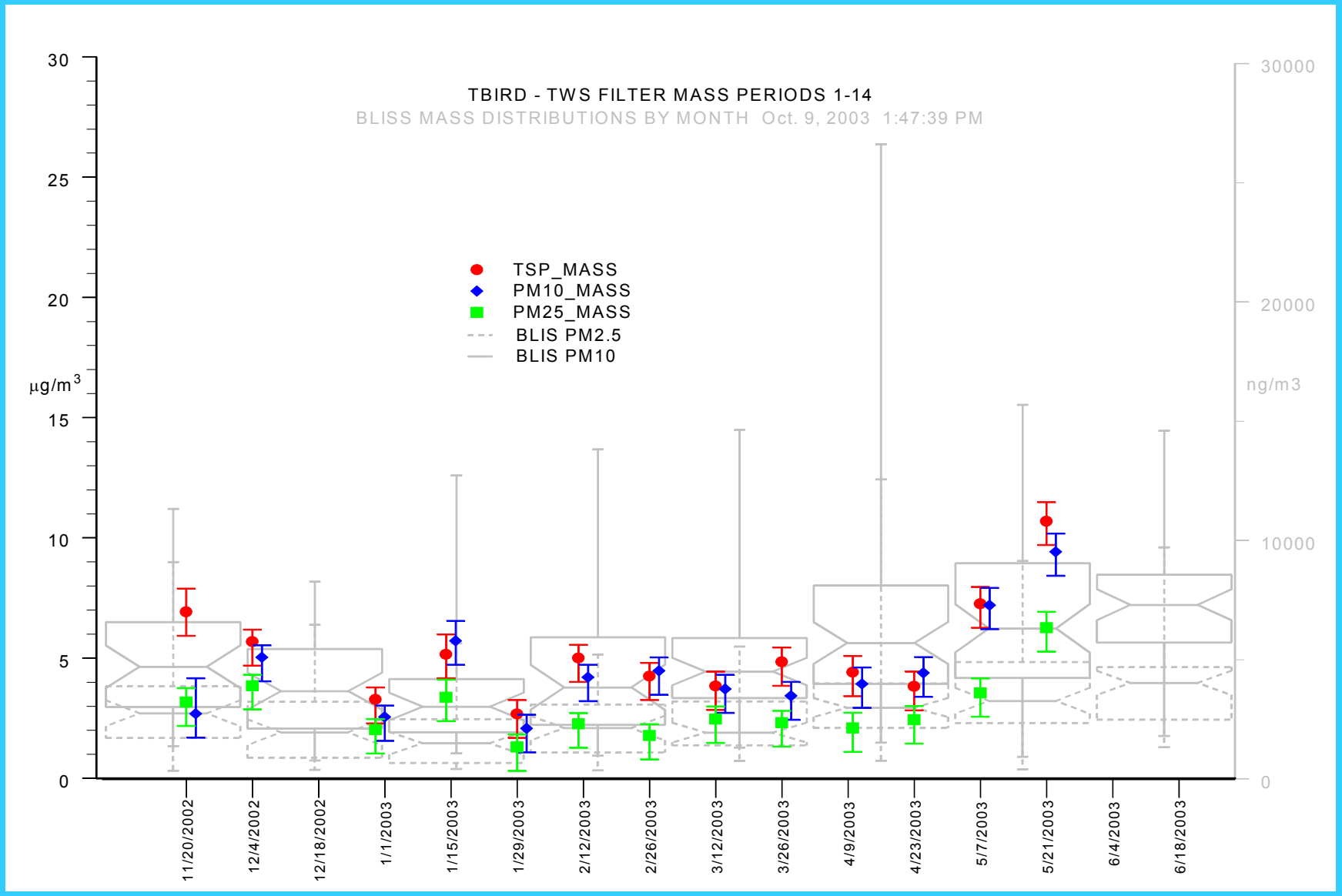
Preliminary Data - Not for Public Release

TWS Big Hill vs IMPROVE Historical Record



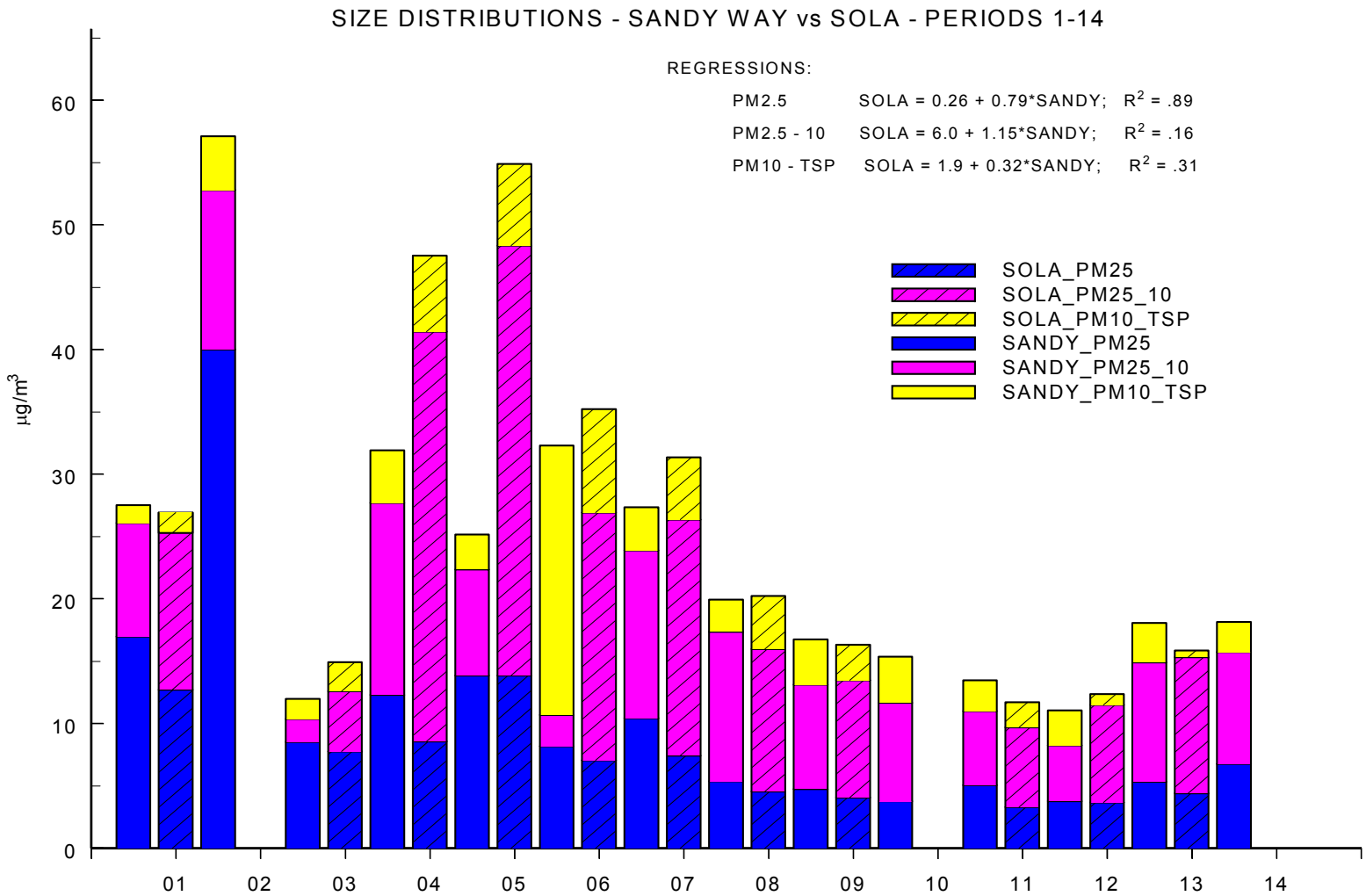
Preliminary Data - Not for Public Release

TWS T-Bird vs IMPROVE Historical Record



Preliminary Data - Not for Public Release

TWS SOLA vs TWS Sandy Way



Preliminary Data - Not for Public Release

Initial LTADS Monitoring Results

Beta Attenuation Monitoring Program

Questions

Concerns

Comments

5 Minutes Please

Lake Tahoe Atmospheric Deposition Study
Mini Volume Sampler (MVS) Program

Site	Lat	Lon	Year	Month	Monthly Avg	Avg Uncertainty	Analysis/Sample	Sample	
					Micrograms/m3	Micrograms/m3	Count	Count	
Coast Guard Pier	39.18194	-120.12	2002	September	10.9	0.6	1	1	
				November	8.0	0.4	3	3	
				December	5.9	0.3	4	4	
			2003	January	8.6	0.4	5	5	
				February	10.4	0.6	4	4	
				March	8.3	0.4	4	5	
				April	7.1	0.3	2	4	
				May	12.8	0.7	3	3	
				June	19.5	1.0	4	4	
				July	14.5	0.7	1	4	
				August			0	1	
			Winter		8.3		13	13	8.8
			Spring		9.4		8	12	
			Summer		18.5		5	8	13.6
			Fall		8.7		4	4	

Mini Volume Sampler

Particle Concentration Total Mass

Site	Lat	Lon	Year	Month	Monthly Avg	Avg Uncertainty	Analysis/Sample	Sample	
					Micrograms/m3	Micrograms/m3	Count	Count	
Mid Lake Buoy East TB1	39.153	-120.00	2002	October	6.4	0.7	1	1	
				December	2.5	0.7	1	1	
			2003	January	6.6	0.6	3	3	
				February	6.9	1.0	1	1	
				March	7.9	0.7	1	1	
				April	4.4	0.9	1	1	
				May	10.2	0.9	1	1	
				June	6.1	1.6	2	2	
				July	9.4	1.7	2	2	
				August			0	1	
				September			0	1	
			Winter		5.3		5	5	6.4
			Spring		7.5		3	3	
			Summer		7.8		4	5	7.1
			Fall		6.4		1	2	

Mini Volume Sampler

Particle Concentration Total Mass

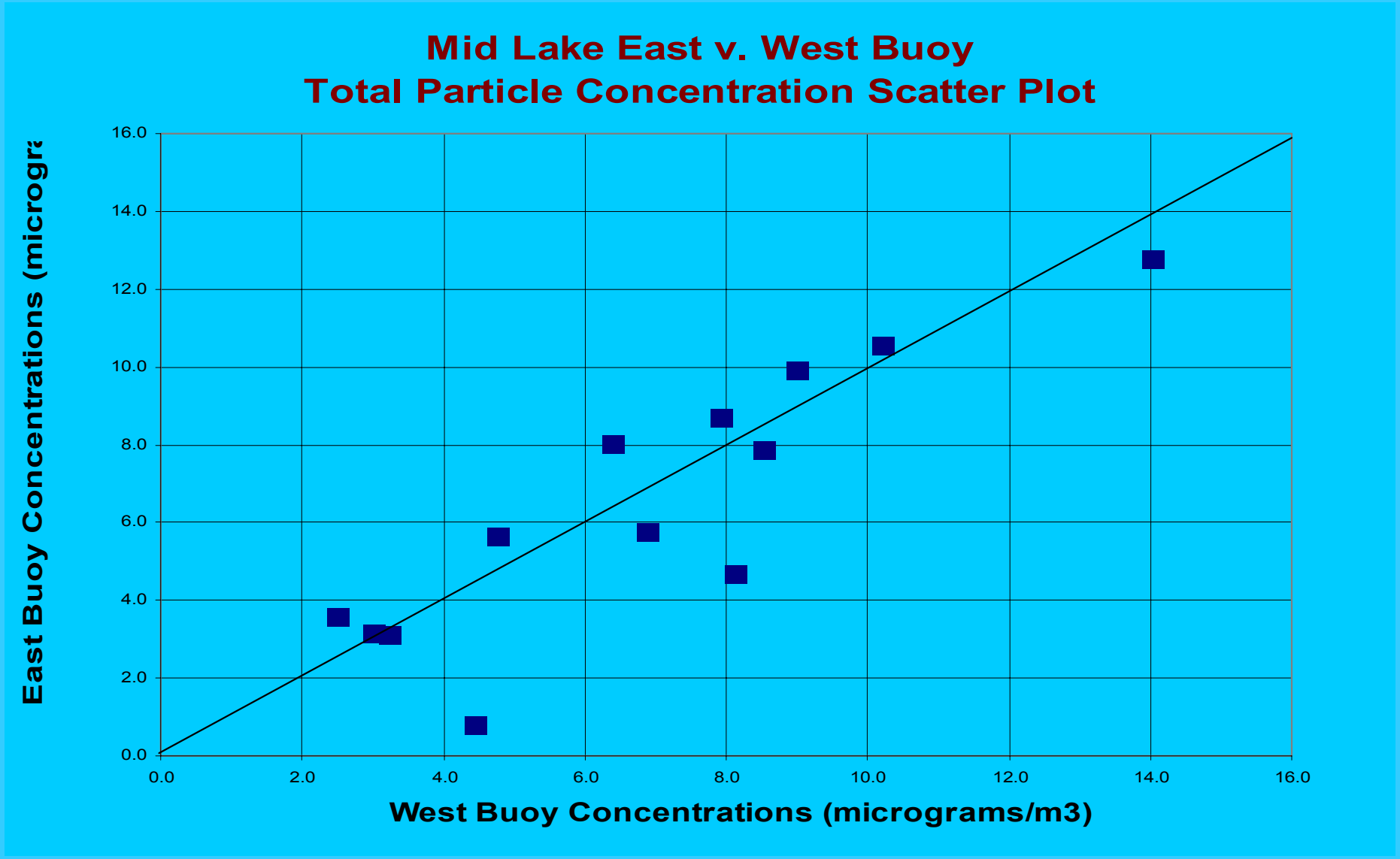
Site	Lat	Lon	Year	Month	Monthly Avg	Avg Uncertainty	Analysis/Sample	Sample	
					Micrograms/m3	Micrograms/m3	Count	Count	
Mid Lake Buoy West TB4	39.155	-120.07	2002	October	8.0	0.8	1	1	
				December	4.9	0.7	3	3	
			2003	January	4.7	0.6	1	1	
				February	5.8	1.0	1	1	
				March	8.7	0.7	1	1	
				April	0.8	0.9	1	1	
				May	10.6	0.9	1	1	
				June	6.5	1.1	2	2	
				July	9.2	0.9	2	2	
				August			0	1	
				September			0	1	
			Winter		5.1		5	5	5.9
			Spring		6.7		3	3	
			Summer		7.9		4	5	7.9
			Fall		8.0		1	2	

Mini Volume Sampler

Particle Concentration Total Mass

Mini Volume Sampler

Particle Concentration Total Mass



Preliminary Data - Not for Public Release

Mini Volume Sampler

Particle Concentration Total Mass

Site	Lat	Lon	Season	Avg Concentration	Avg Uncertainty	Analysis/Sample	Sample	
				Micrograms/m3	Micrograms/m3	Count	Count	
Zephyr Cove Pier	39.010	-119.952	Winter	14.9	1.4	1	1	12.0
			Spring	9.2	2.7	4	6	
			Summer	25.0	1.3	3	11	25.0
			Fall					
Timber Cove Pier	38.948	-119.97	Winter	9.2	0.7	10	10	6.6
			Spring	4.0	1.2	3	3	
			Summer * 4th of July	10.5	0.6	1	1	
			Fall					
SOLA	38.974	-119.982	Summer * 4th of July	32.2	1.6	1	1	
Wallis Pier	39.130	-120.158	Winter					
			Spring	5.7	0.6	8	10	
			Summer	15.5	0.8	6	9	10.6
			Fall					
Wallis Tower	39.130	-120.160	Winter					
			Spring	10.8	0.6	8	10	
			Summer	13.6	0.7	5	9	12.2
			Fall					

Preliminary Data - Not for Public Release

Mini Volume Sampler
Particle Concentration TSP Phosphate Ion Chromatography

Site	Season	Avg Concent	Sample	Analysis/Sample	Non Detect
		Nanograms/m3	Count	Count	Count
Coast Guard Pier	Winter	Non Detect	13	10	10
	Spring	Non Detect	12	8	8
	Summer	Non Detect	8	5	5
	Fall	Non Detect	4	4	4
Results from every other Lake Tahoe Site Reflect this Exact Analytical Result (220 Samples).					

Preliminary Data - Not for Public Release

Mini Volume Sampler

Particle Concentration TSP Phosphorus Standard XRF Methods

Site	Season	Avg Concentration	Avg Uncertainty	Non Zero/Sample	Sample
		Nanograms/m3	Nanograms/m3	Count	Count
Coast Guard Pier	Winter	4.0	5.1	3	12
	Spring			0	12
	Summer			0	8
	Fall			0	4
Mid Lake Buoy East TB1	Winter	10.3	16.7	4	5
	Spring	22.1	14.0	2	3
	Summer	12.7	19.2	1	5
	Fall			0	1
Mid Lake Buoy West TB4	Winter	6.7	17.4	2	5
	Spring	22.0	10.4	2	3
	Summer	2.1	24.1	1	5
	Fall			0	1
Timber Cove Pier	Winter	9.5	13.1	4	10
	Spring			0	3
	Summer * 4th of July			0	1
	Fall				
SOLA	Summer * 4th of July	12.9	17.7	1	1

Preliminary Data - Not for Public Release

Mini Volume Sampler

Particle Concentration TSP Phosphorus Standard XRF Methods

Detection Level
Nanograms/m3
XRF Protocol A
0.89
XRF Protocol D
0.22

Preliminary Data - Not for Public Release

Mini Volume Sampler

Particle Concentration TSP Phosphate

Inductively Coupled Plasma Mass Spectrometry

Site	Season	Avg Concentration Nanograms/m3	Avg Uncertainty Nanograms/m3	Non Zero/Sample Count	Sample Count
Coast Guard Pier	Winter	3.4	5.6	7	9
	Spring				
	Summer				
	Fall	13.6	6.5	3	4
Mid Lake Buoy East TB1	Winter	18.6	35.8	1	4
	Spring				
	Summer				
	Fall	48.3	41.6	1	1
Mid Lake Buoy West TB4	Winter	14.8	32.4	2	4
	Spring				
	Summer				
	Fall	45.9	36.4	1	1
Timber Cove Pier	Winter	9.8	20.2	2	6
	Spring				
	Summer				
	Fall				

Preliminary Data - Not for Public Release

IMPROVE Network

Total Particulate Phosphorus PM2.5
SOLA South & Bliss West Shore Lake Tahoe
Statistical Summary of All Days v. Detect Days

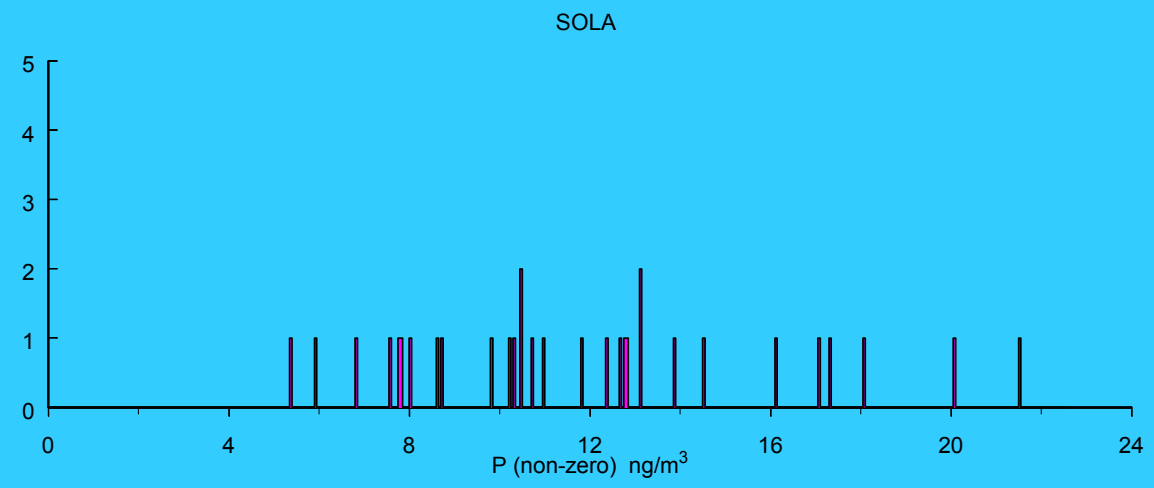
	SOLA P		BLIS P	
	ALL DAYS	NON-ZERO	ALL DAYS	NON ZERO
Min	0	5.4	0	1.0
Max	21.5	21.5	9.6	9.6
Mean	0.5	11.8	0.2	4.6
Median	0	11	0	4.7
Std. Dev.	2.5	4.1	1.1	2.1
Valid Obs.	751	31	571	30

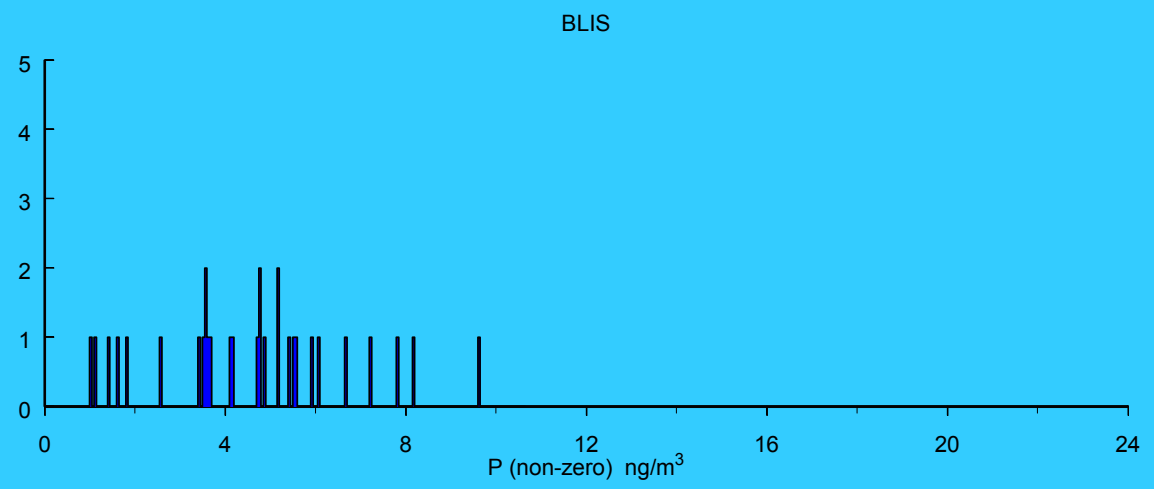
Preliminary Data - Not for Public Release

IMPROVE Network

Total Particulate Phosphorus PM2.5

Detect Days at Bliss & SOLA Frequency Distribution





Preliminary Data - Not for Public Release

Particle Concentration TSP Phosphate
Problems & Solutions

IMPROVE System Reports 31 Non-Zero Values for SOLA out of 750 Samples Taken for PM2.5 over a Decade.
Detection Limits for IMPROVE are around 0.3 ng/m3. The 31 samples offer a rough median of 11 ng/m3 for PM2.5 at SOLA.
Believe Our Standard Method Below Detection Limit Samples May Include False Non-Detects.
Assume that PM2.5 Phosphorus is 1/2 of Total Phosphorus at SOLA.
Analytical Choices:
A. Accept Limits of Detection & Construct Deposition Estimates,
B. Accept Improve's 31 Samples out of 750 & Extrapolate to Total PM & Construct Deposition Estimates
C.Investigate Alternative Methodology to Turn Non-Detects into Detectable Concentrations (Synchrotron XRF)

Example Level 1 Estimate of total Phosphorus Deposition to Lake

- Fine Fraction (<2.5 micron)
  - 13 ng-P/m3, Vd = 0.4 cm/s
- Coarse Fraction (2.5-10 micron)
  - 13 ng-P/m3, Vd = 1 cm/s
- Large Particles (>10micron)
  - 4 ng-P/m3, Vd = 2 cm/s
- With these assumptions deposition to Lake would be 25 pounds-P/day.

Mini Volume Sampler
TSP Particulate Nitrate

Site	Season	Avg Concent	Avg Uncertainty	Analysis/Sample	Sample	
		Nanograms/m3	Nanograms/m3	Count	Count	
Coast Guard Pier	Winter	215	15	13	13	
	Spring	215	17	9	12	
	Summer	113	13	5	8	
	Fall	262	16	4	4	
Mid Lake Buoy East TB 1	Winter	467	91	5	5	
	Spring	739	72	3	3	314
	Summer	236	58	4	5	
	Fall	427	79	1	2	
Mid Lake Buoy West TB 4	Winter	369	65	5	5	
	Spring	683	69	3	3	362
	Summer	197	57	4	5	
	Fall	438	73	1	2	
Zephyr Cove Pier	Winter	925	88	1	1	
	Spring	286	41	4	6	
	Summer	194	29	3	11	
	Fall					

Preliminary Data - Not for Public Release

Mini Volume Sampler
TSP Particulate Nitrate

Site	Season	Avg Concent	Avg Uncertainty	Analysis/Sample	Sample
		Nanograms/m3	Nanograms/m3	Count	Count
SOLA	Summer * 4th of July	338	34	1	1
Timber Cove Pier	Winter	404	41	1	1
	Spring	329	77	4	6
	Summer * 4th of July	275	37	1	1
	Fall				
Wallis Tower	Winter				
	Spring	215	16	6	10
	Summer	126	17	5	9
	Fall				
Wallis Pier	Winter				
	Spring	232	17	8	10
	Summer	104	12	6	9
	Fall				

Preliminary Data - Not for Public Release

Mini Volume Sampler
TSP Particulate Ammonia

Site	Season	Avg Concent	Avg Uncertainty	Analysis/Sample	Sample	
		Nanograms/m3	Nanograms/m3	Count	Count	
Coast Guard Pier	Winter	93	11	13	13	
	Spring	186	16	9	12	
	Summer	273	19	5	8	
	Fall	189	14	4	4	
Mid Lake Buoy East TB 1	Winter	318	88	5	5	
	Spring	404	57	3	3	388
	Summer	349	59	4	5	
	Fall	421	79	1	2	
Mid Lake Buoy West TB 4	Winter	263	63	5	5	
	Spring	393	57	3	3	353
	Summer	313	58	4	5	
	Fall	364	72	1	2	
Zephyr Cove Pier	Winter	585	82	1	1	
	Spring	257	42	4	6	
	Summer	435	35	3	11	
	Fall					

Preliminary Data - Not for Public Release

Mini Volume Sampler
TSP Particulate Ammonia

Site	Season	Avg Concent	Avg Uncertainty	Analysis/Sample	Sample
		Nanograms/m3	Nanograms/m3	Count	Count
SOLA	Summer * 4th of July	245	30	1	1
Timber Cove Pier	Winter	271	37	1	1
	Spring	387	79	4	6
	Summer * 4th of July	192	34	1	1
	Fall				
Wallis Tower	Winter				
	Spring	163	16	5	10
	Summer	277	22	5	9
	Fall				
Wallis Pier	Winter				
	Spring	180	17	8	10
	Summer	253	17	6	9
	Fall				

Preliminary Data - Not for Public Release

Lake Tahoe
Atmospheric Deposition Study
Mini Volume Sampler

Questions,
Comments,
Concerns

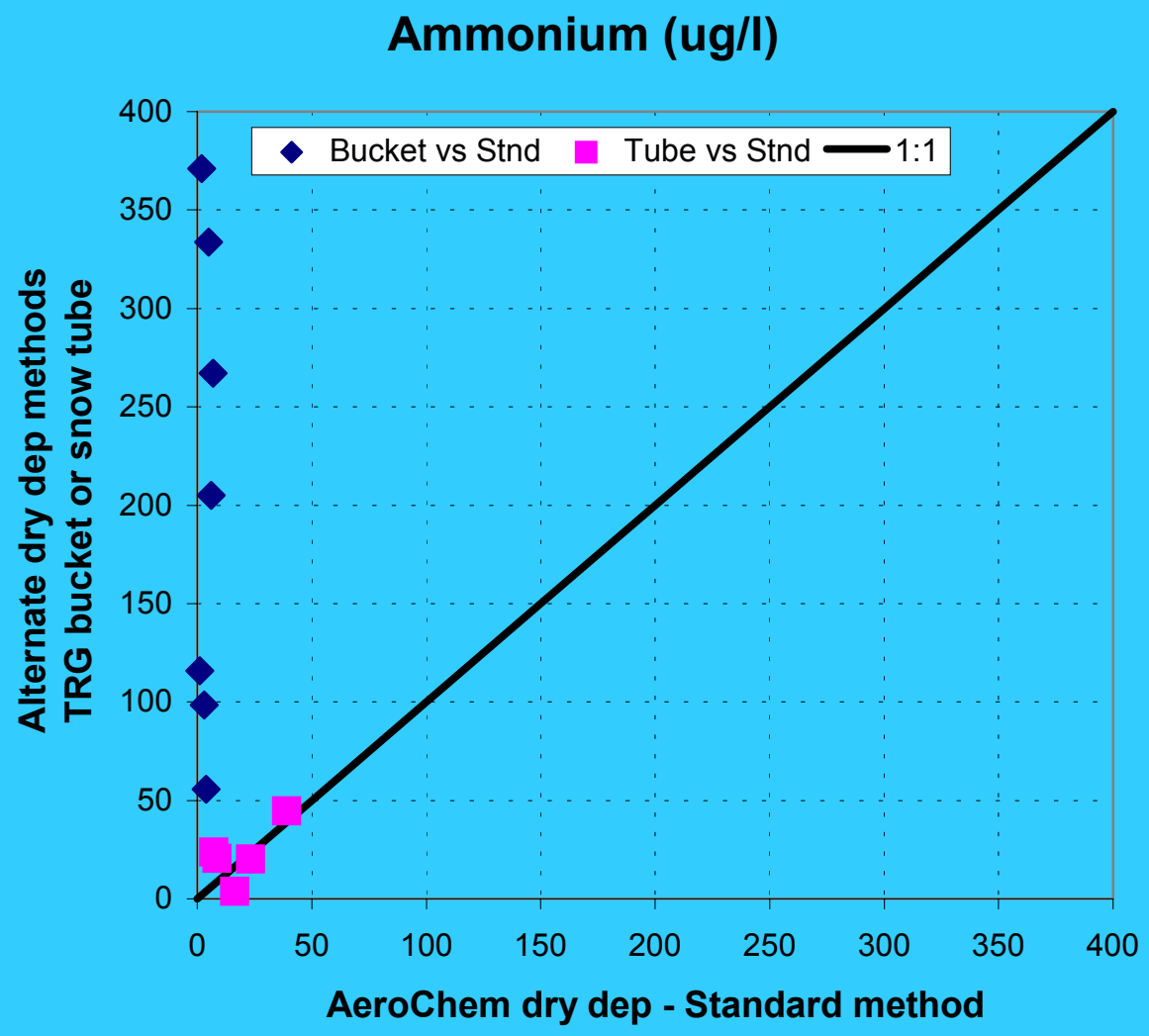
15 Minutes Please

Initial LTADS Monitoring Results

Dry Deposition Methods Comparison Program

Initial LTADS Monitoring Results

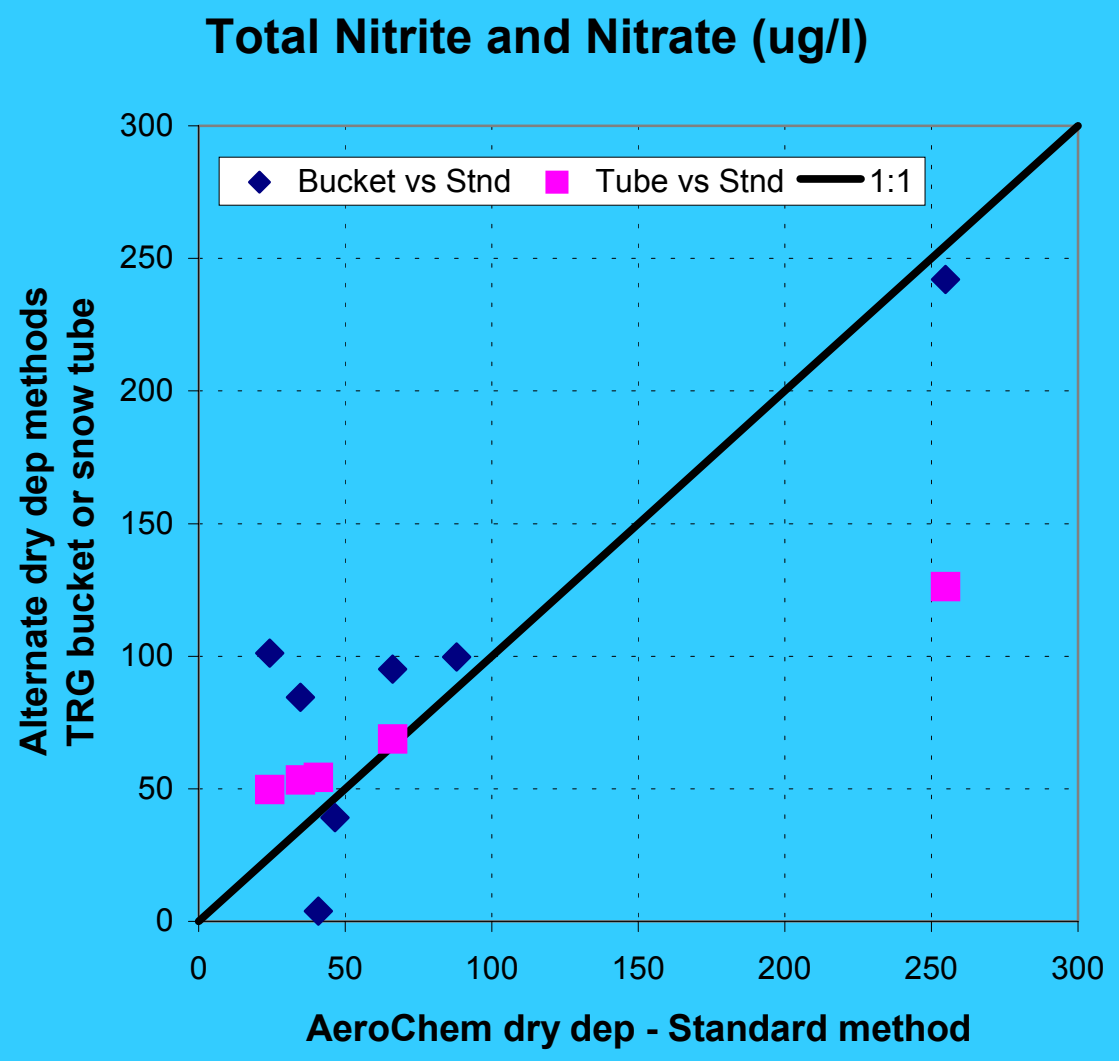
Dry Deposition Methods Comparison



Preliminary Data - Not for Public Release

Initial LTADS Monitoring Results

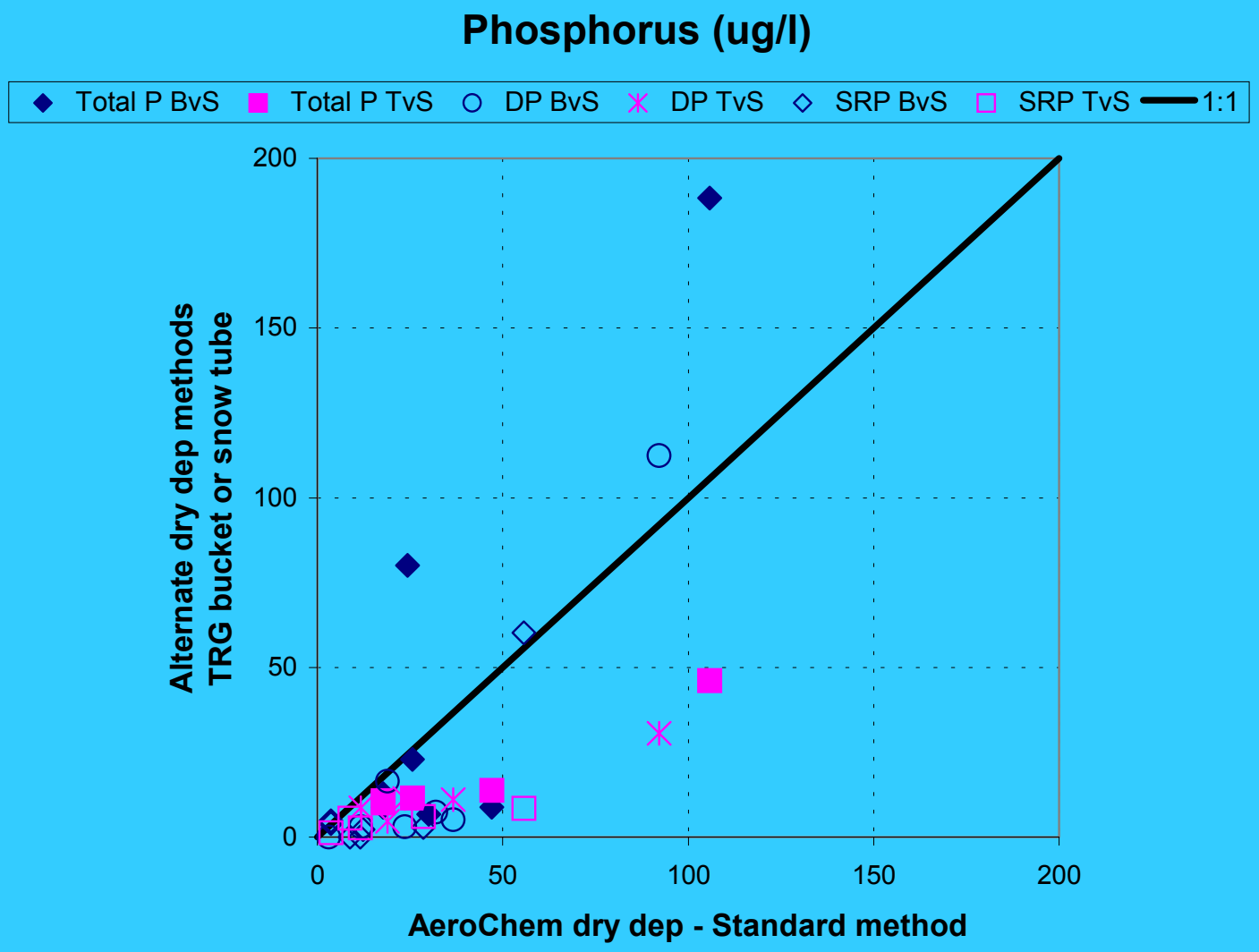
Dry Deposition Methods Comparison



Preliminary Data - Not for Public Release

Initial LTADS Monitoring Results

Dry Dep Methods Comparison



Preliminary Data - Not for Public Release

Initial LTADS Monitoring Results

Dry Deposition Methods Comparison Program

Questions

Concerns

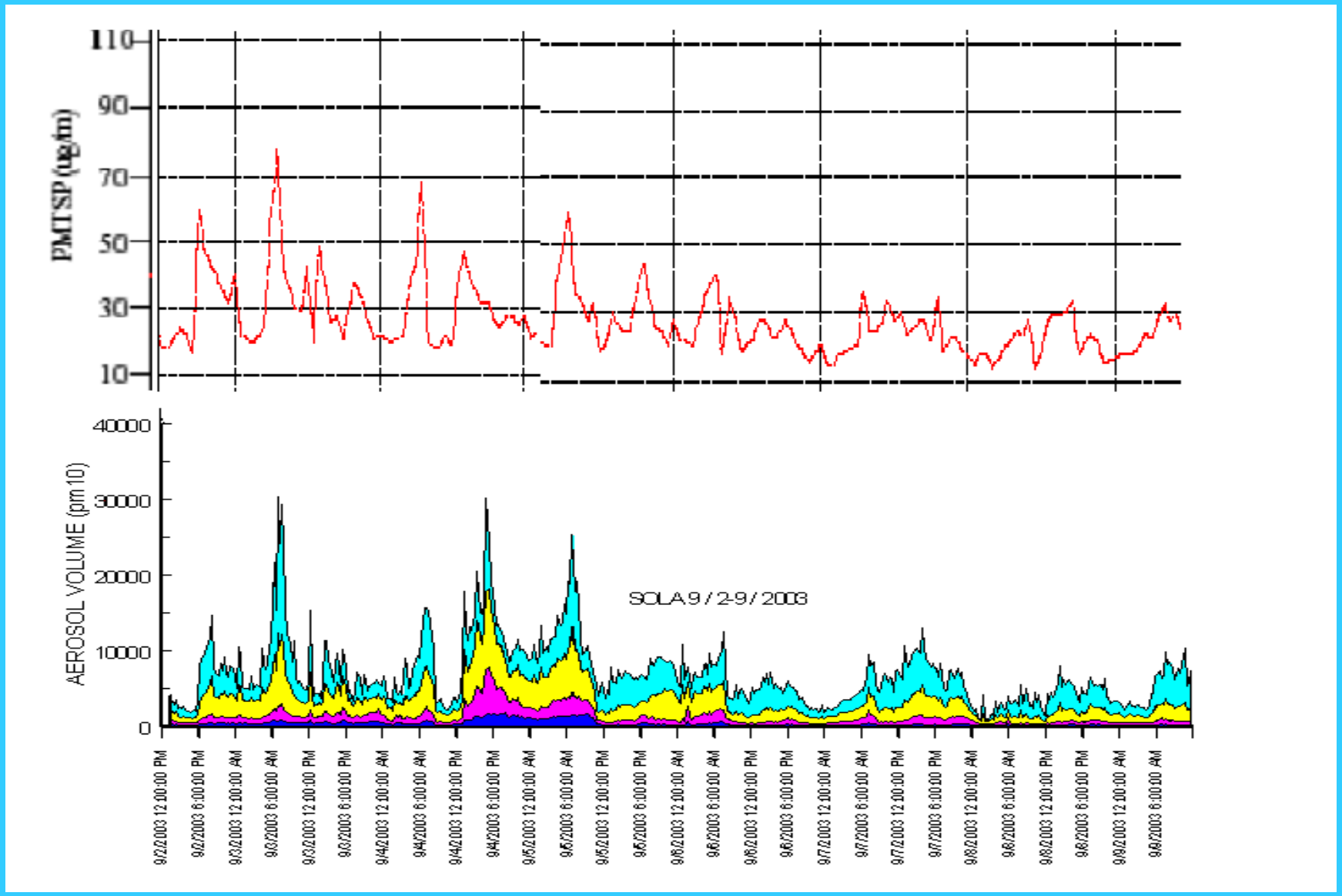
Comments

5 Minutes Please

Lake Tahoe Atmospheric Deposition Study

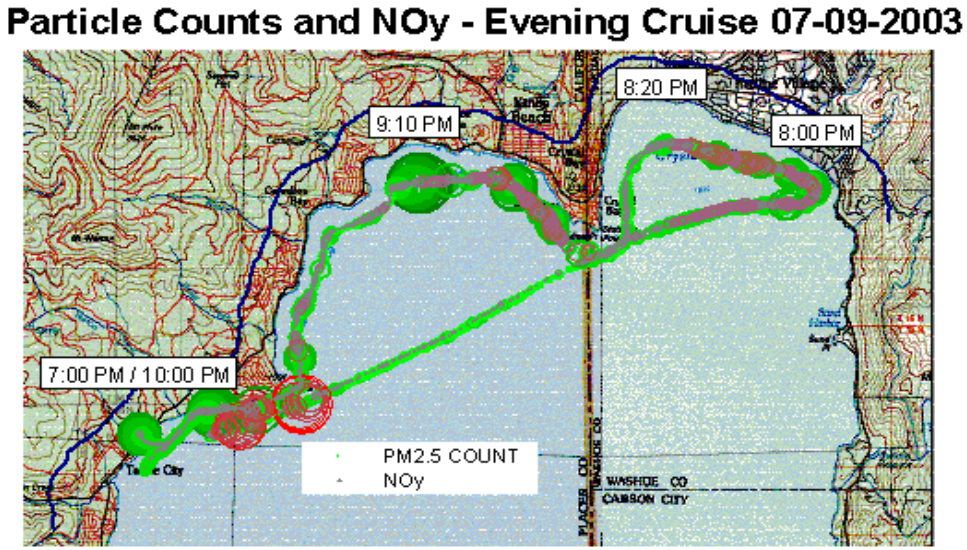
Particle Counters
& Dust Experiment

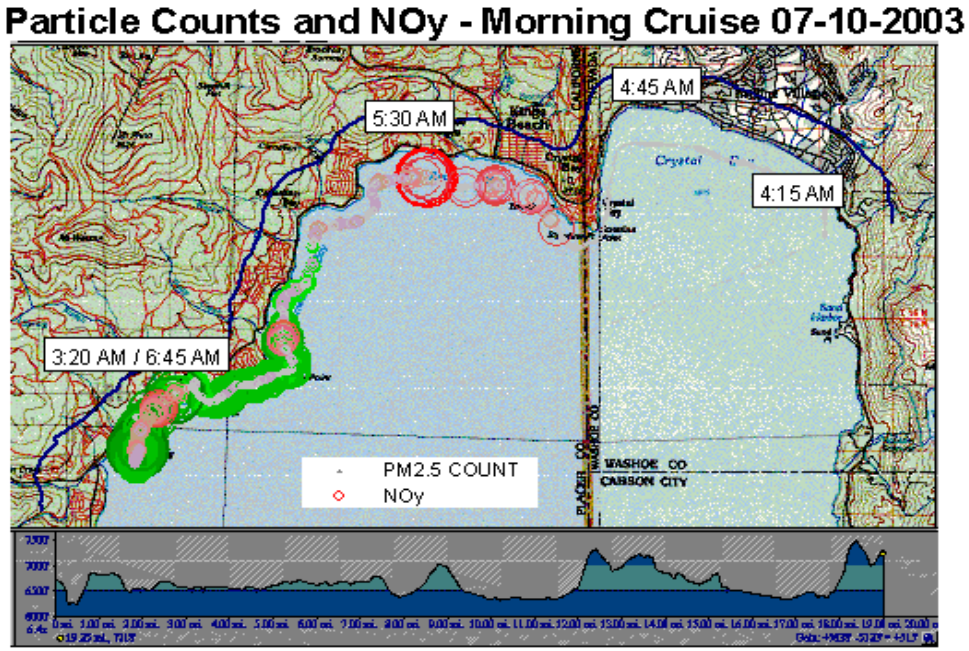
TSP BAM vs CLIMET Particle Counter



Preliminary Data - Not for Public Release

On-Lake Experiment July 9-10 2003





- Vehicle exhaust and wood smoke near population centers in evening
- Drainage flushes shore zone overnight
- Vehicle exhaust precedes smoke in morning
- Effect confined to near-shore

Preliminary Data - Not for Public Release

Lake Tahoe Atmospheric Deposition Study

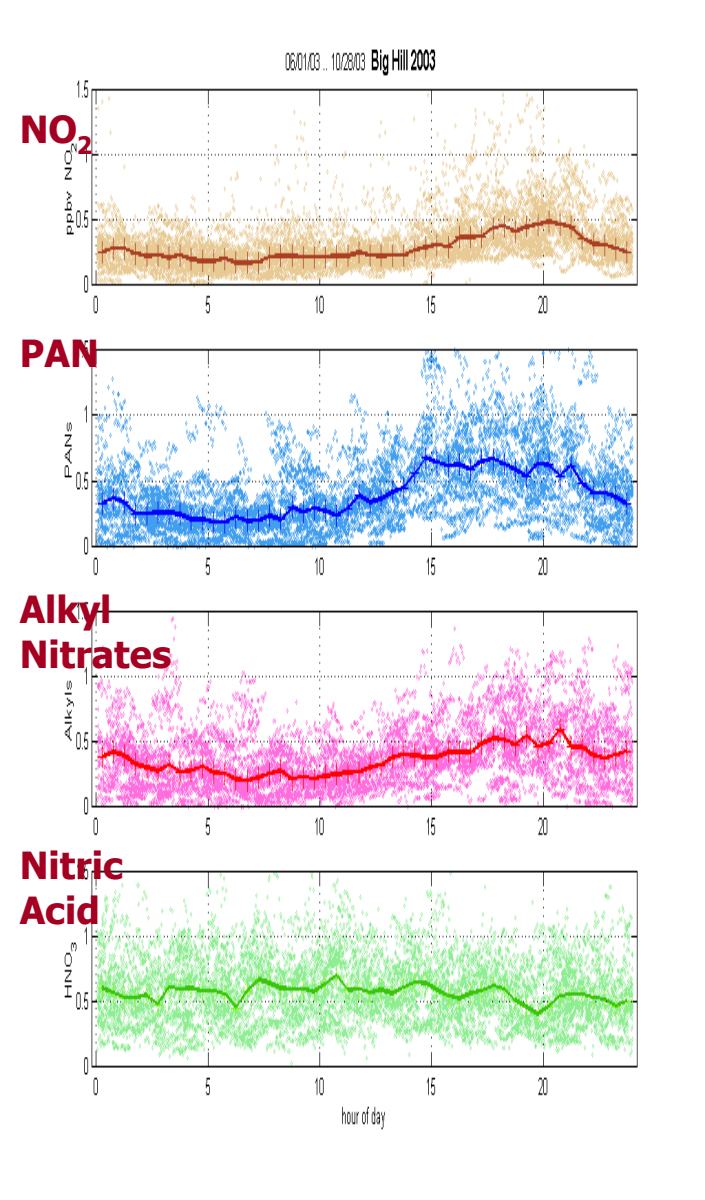
Particle Counters
& Dust Experiment

Questions, Comments, Concerns
5 Minutes Please

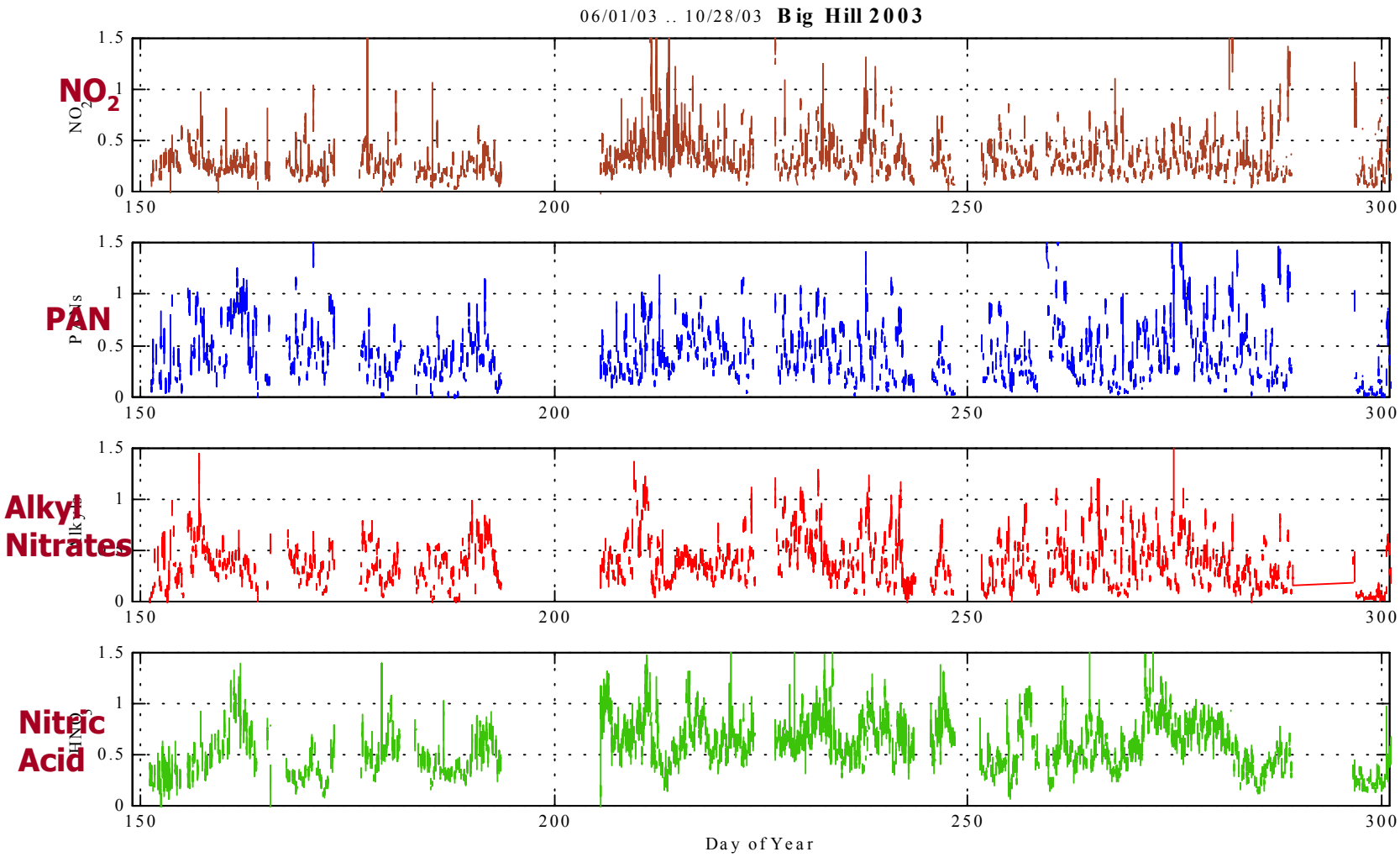
Lake Tahoe
Atmospheric Deposition Study
Transport Assessments &
Air Plane Measurements

Preliminary Data - Not for Public Release

Lake Tahoe Atmospheric Deposition Study
Transport Assessments UC Berkeley Big Hill Diurnal Profiles



Lake Tahoe Atmospheric Deposition Study
Transport Assessments UC Berkeley Big Hill 5 Months of Hourly Data



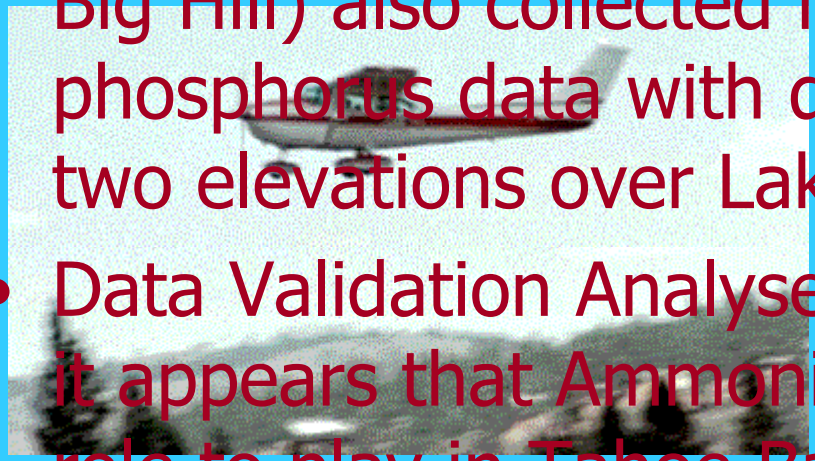
Lake Tahoe
Atmospheric Deposition Study
Transport Assessments
UC Berkeley

Questions,
Comments,
Concerns

5 minutes please

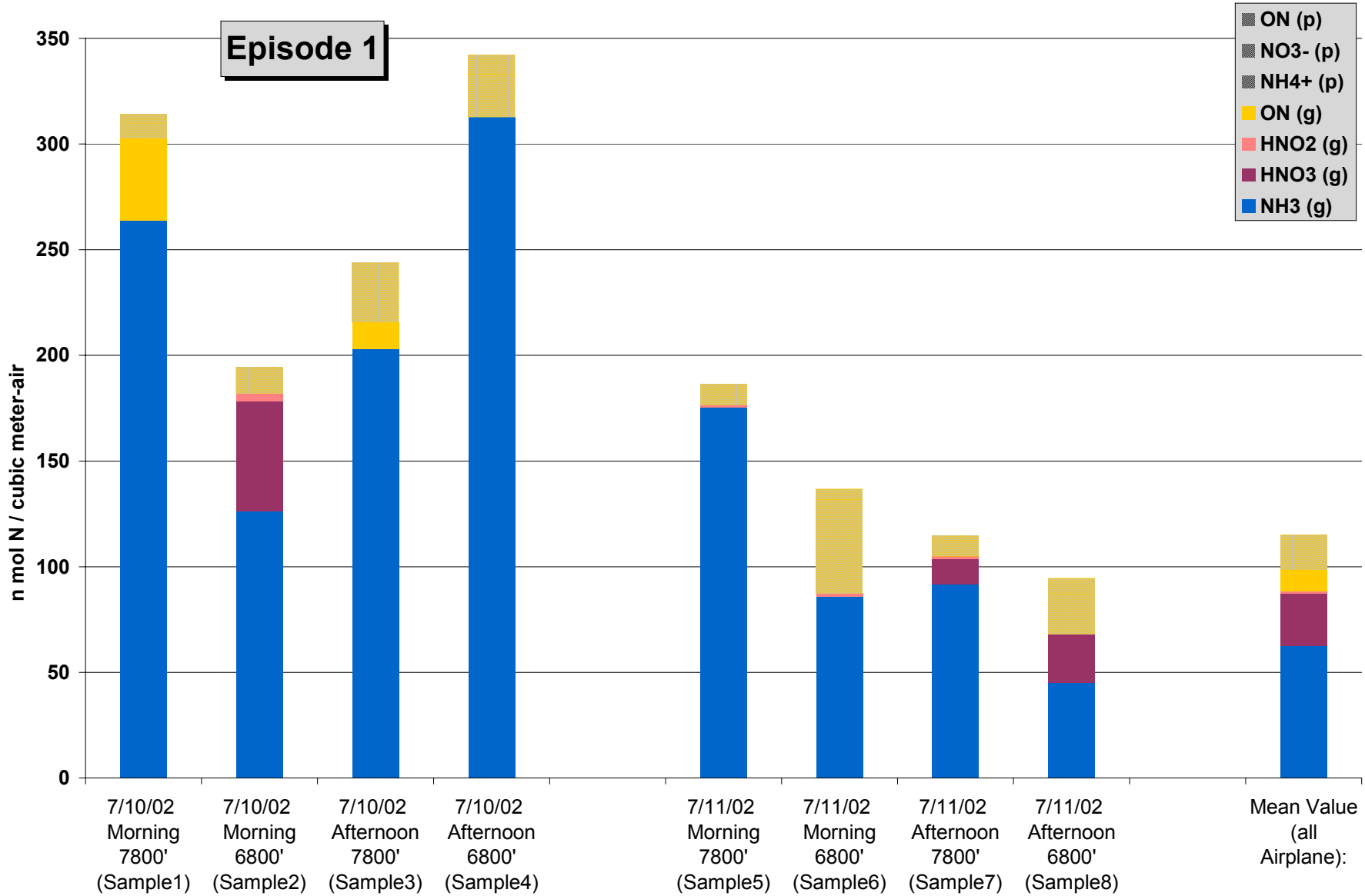
Lake Tahoe Atmospheric Deposition Study
Airplane Measurements 2002 UC Davis

- The airplane flew into the basin on 11 two-day sampling periods collecting ozone, NOY, and met.
- Spirals flown inside the basin (Mid-Lake), outside the basin (Spider Lake - Loon Lake - Big Hill) also collected nitrogen and phosphorus data with denuders orbiting at two elevations over Lake Tahoe.

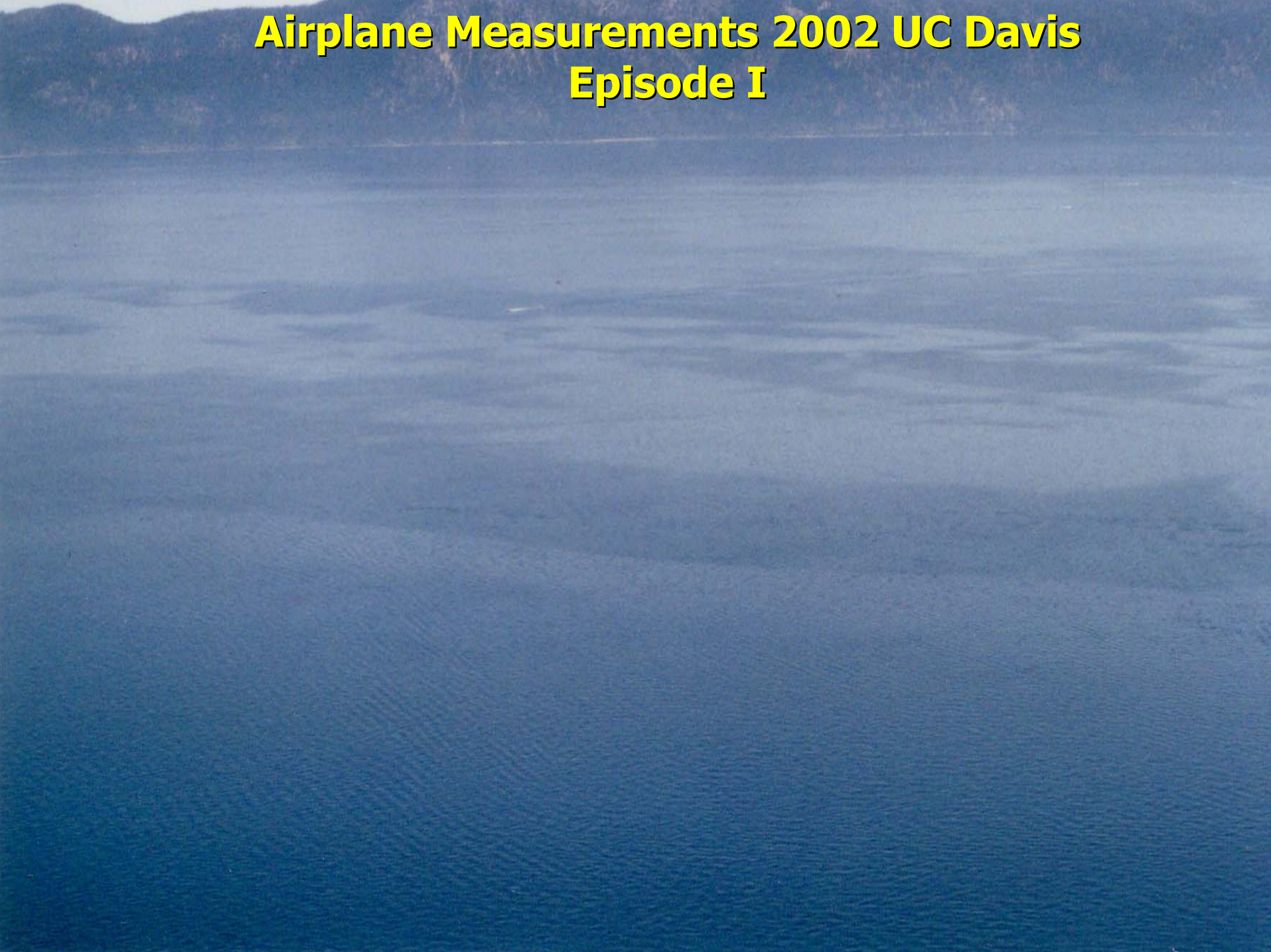


- Data Validation Analyses are still ongoing but it appears that Ammonia may have a larger role to play in Tahoe Basin nitrogen chemistry than previously thought.

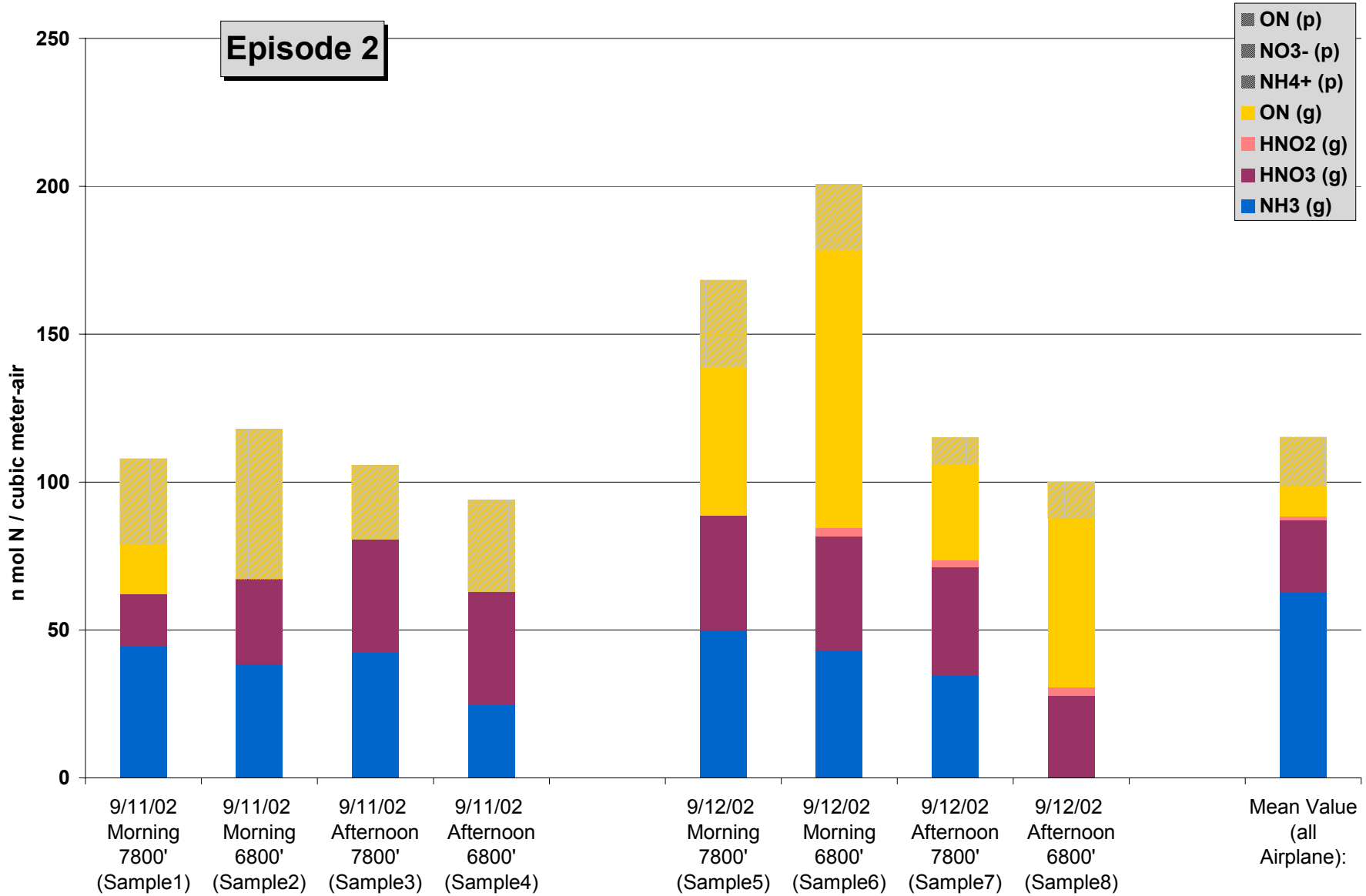
Airplane Measurements 2002 UC Davis



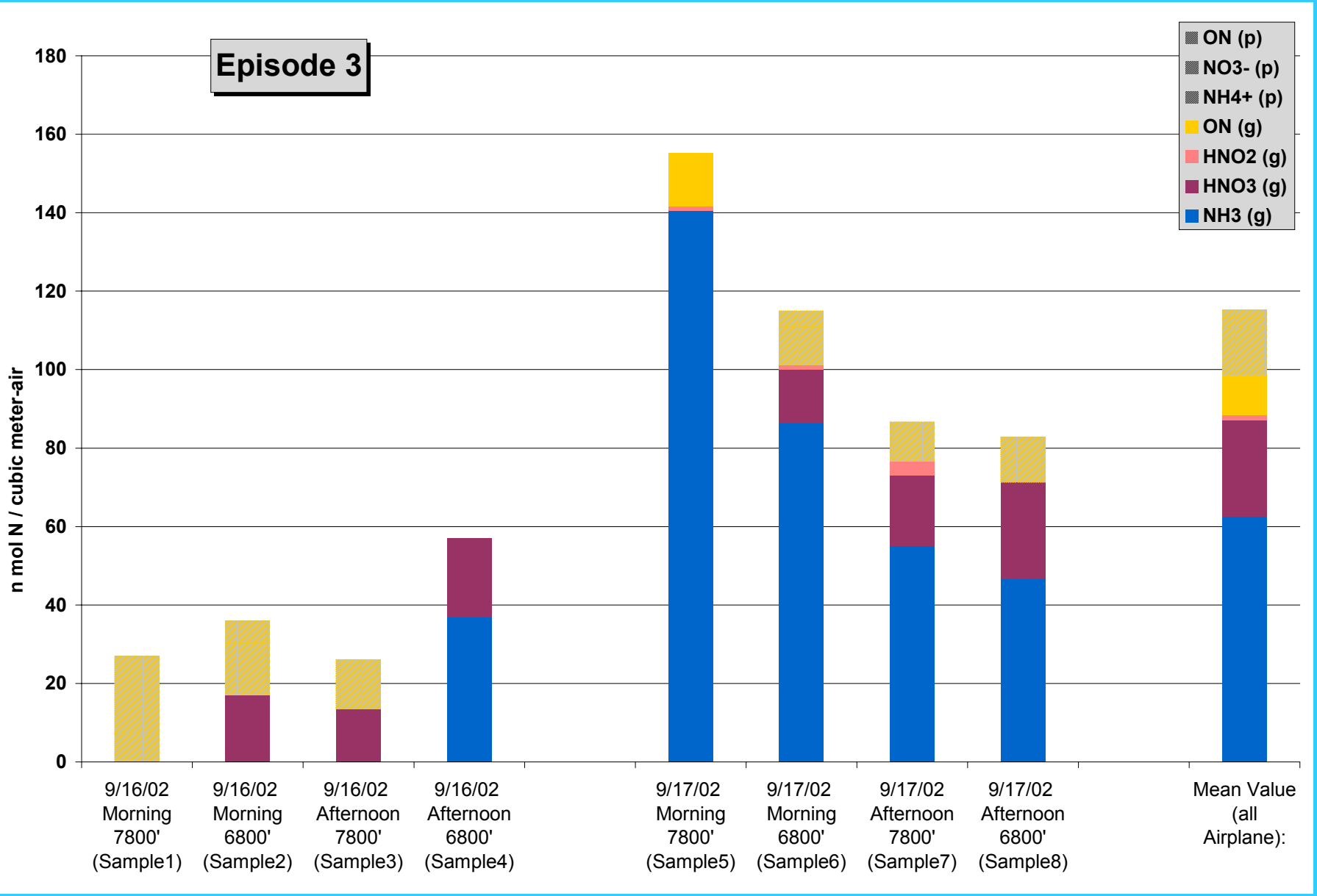
Airplane Measurements 2002 UC Davis
Episode I



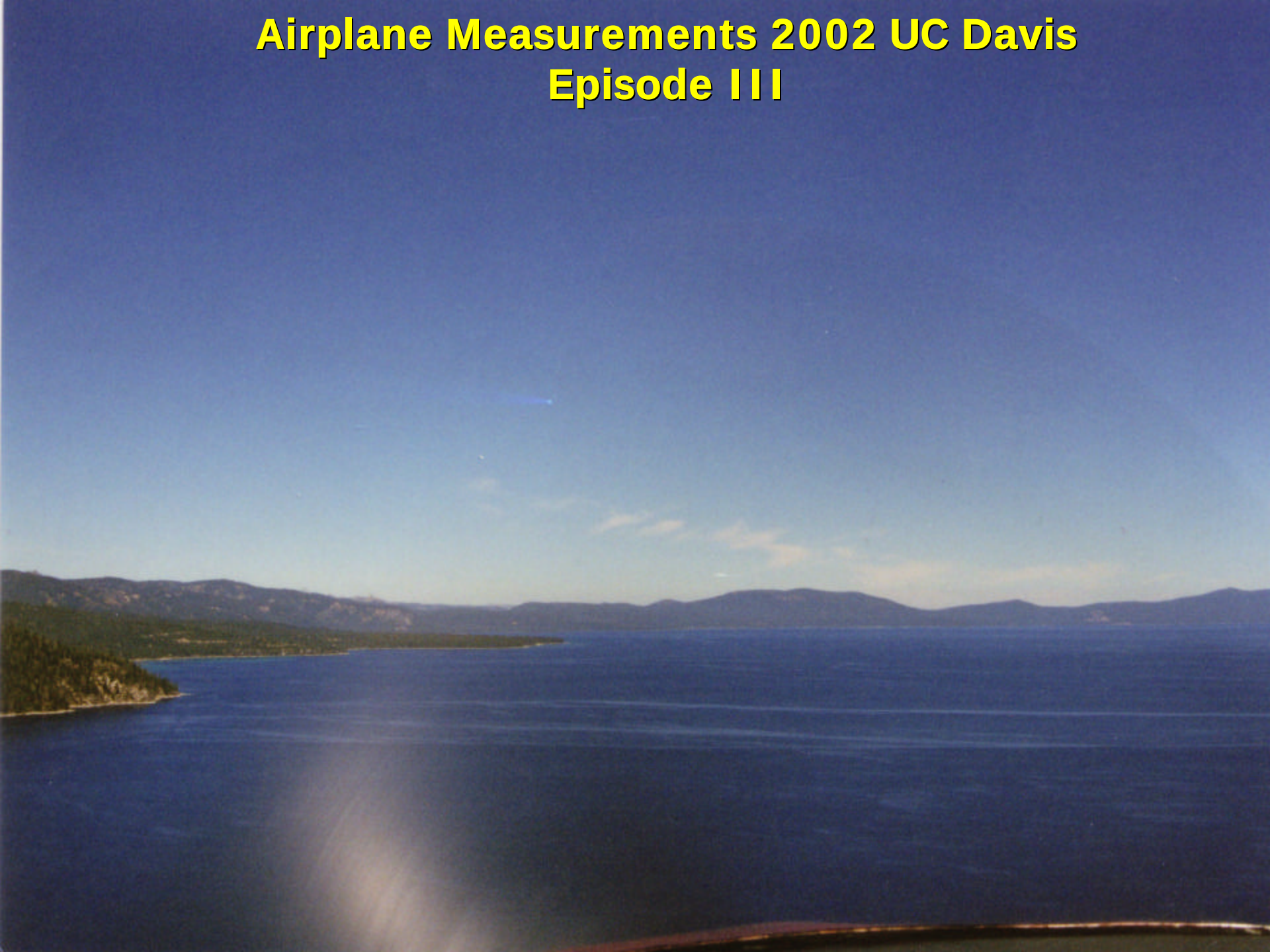
Airplane Measurements 2002 UC Davis



Airplane Measurements 2002 UC Davis



Airplane Measurements 2002 UC Davis
Episode III



Lake Tahoe Atmospheric Deposition Study Airplane Measurements 2002 UC Davis

Questions, Comments, Concerns

5 Minutes Please

Lake Tahoe
Atmospheric Deposition Study
Challenges

- Siting Equipment in Tahoe Basin's Unique Environment has proved difficult.
- Operating in Mountain Environments and in Winter has proved difficult - Power, Telemetry, Access, etc.
- Staffing has required skill transmission and volunteer assistance that makes continuity of performance and quality assurance difficult to assess.

FISHERIES RESEARCH
RANTZ

Lake Tahoe Atmospheric Deposition Study Successes

- Cooperative study participants & local - Students, Volunteers & In-Kind Supporters providing critical help.
- No loss of life with many miles on the road, boat trips, and aircraft flights. MLD, RD, TRPA, TRG, Lahontan
- Database to Characterize Seasonal & Annual Air Quality
- Thank You MLD, PTSD, RD, TRG, TRPA, Lahontan, Placer & Washoe Counties, Nevada EPA & Trans, Cal/EPA & Trans, USFS, SMUD