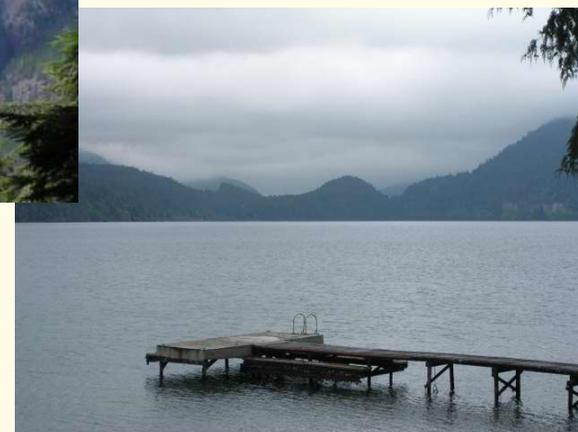
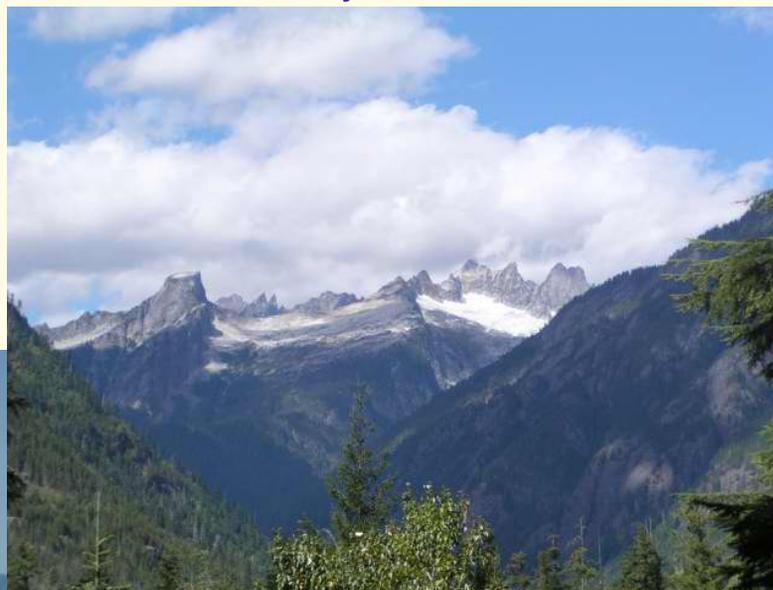


# Introduction to the IMPROVE program's new interactive web-based data validation tools

Linsey DeBell



# Interagency Monitoring of Protected Visual Environments (IMPROVE)

## **What is IMPROVE?**

IMPROVE is a cooperative measurement effort governed by a steering committee composed of representatives from Federal and regional-state organizations. The IMPROVE monitoring program was established in 1985 to aid the creation of Federal and State implementation plans for the protection of visibility in Class I areas (156 national parks and wilderness areas) as stipulated in the 1977 amendments to the Clean Air Act.

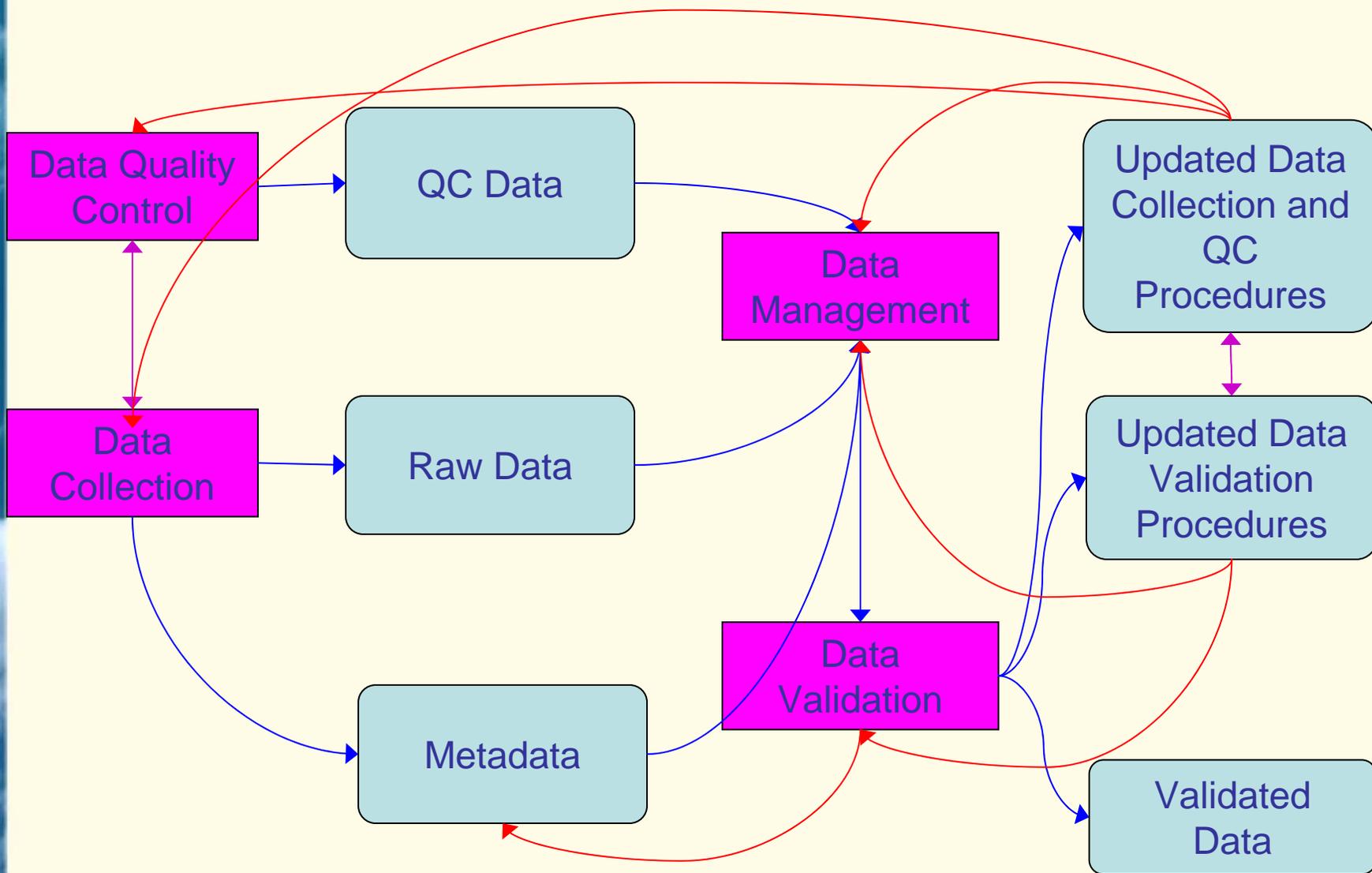
The objectives of IMPROVE are:

- (1) to establish current visibility and aerosol conditions in mandatory class I areas;
- (2) to identify chemical species and emission sources responsible for existing man-made visibility impairment;
- (3) to document long-term trends for assessing progress towards the national visibility goal;
- (4) and with the enactment of the Regional Haze Rule, to provide regional haze monitoring representing all visibility-protected federal class I areas where practical.

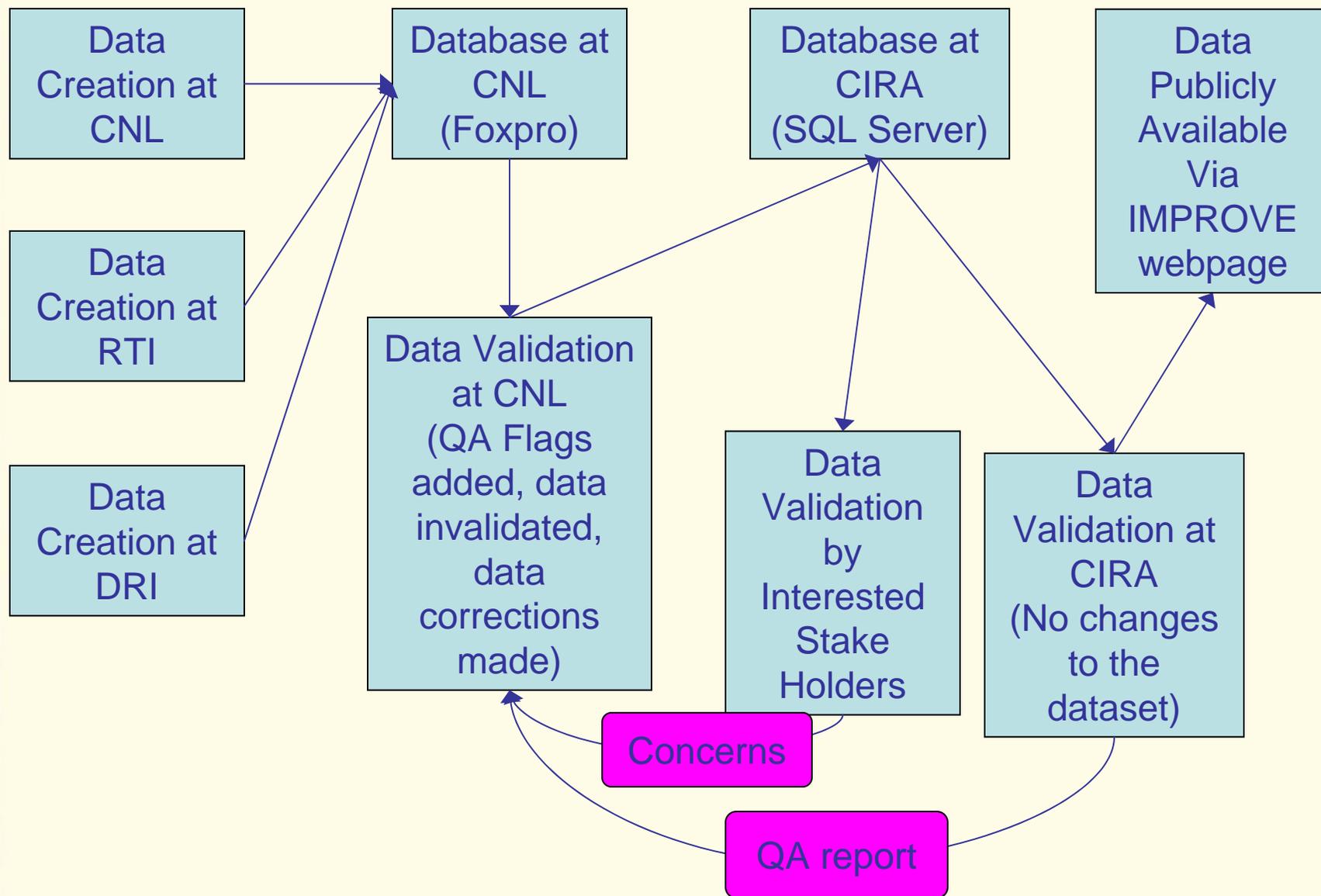
IMPROVE has also been a key participant in visibility-related research, including the advancement of monitoring instrumentation, analysis techniques, visibility modeling, policy formulation and source attribution field studies.

<http://vista.cira.colostate.edu/improve>

## Interplay between Data Collection, Quality Control, Management, and Validation



# IMPROVE Data Validation Roles and Responsibilities



## Current Data Validation Theory and Process

### ❖ Process

- Qualitative visual inspection of the data
- Scatter plots and time series charts
- Metadata review
- Simple pairwise statistics for identifying swapped samples
- Data integrity checks
- Some tests applied routinely others periodically

### ❖ Theory: **Beyond confirming that the dataset has no obvious errors in content or form, the validation process is designed to check that:**

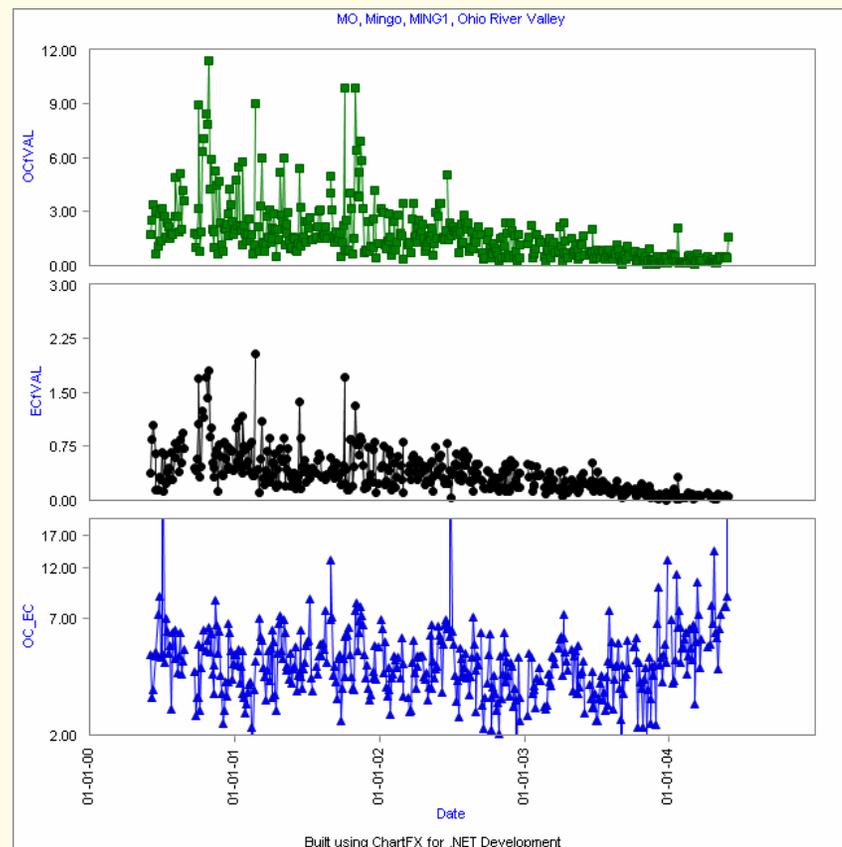
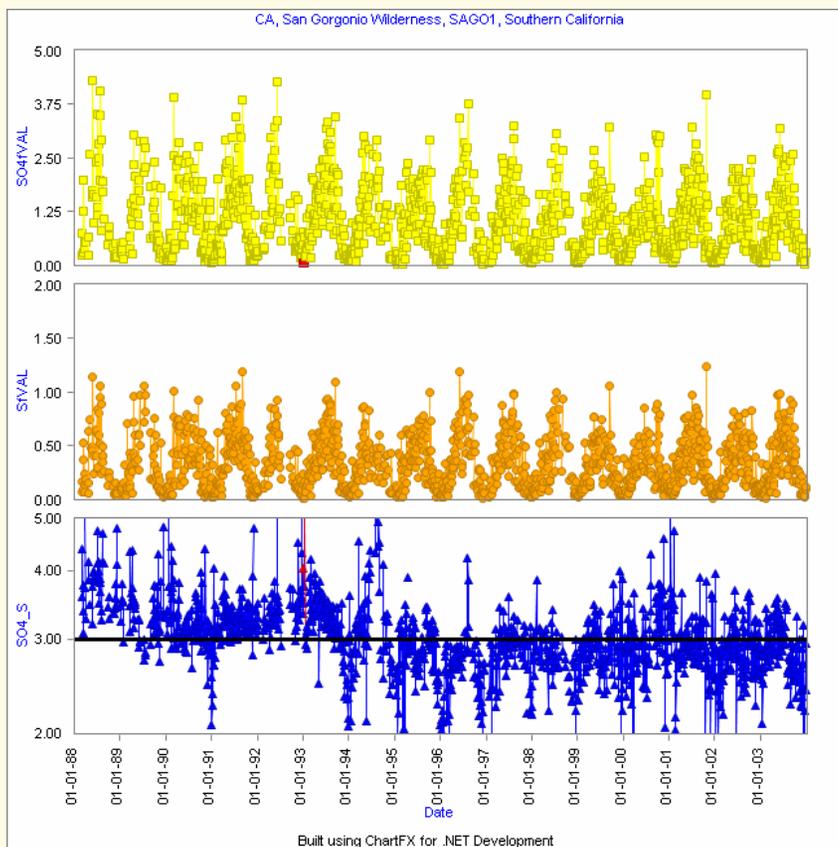
- internal consistency between redundant measurements exists
- spatial and temporal comparability are being maintained
- external consistency between the aerosol chemical and physical measurements and the optical measurements exists

## New Data Validation Tools Currently Only Address a Limited Number of Data Validation Steps

<p><b>Level 0</b> (Performed by field and lab staff)</p> <ul style="list-style-type: none"> <li>● Sample Identification</li> <li>● Operator Observations</li> <li>● Sampler Flags</li> <li>● Shipping &amp; Disassembly</li> <li>● Laboratory Checks (per SOPs)</li> <li>● Range Checking</li> <li>● Flow Rate audits</li> <li>● Exposure Duration checks</li> <li>● Elapsed time before retrieval</li> <li>● Holding times</li> </ul>	<p><b>Level 1</b> (Performed by QA personnel at CNL)</p> <ul style="list-style-type: none"> <li>● Mass balance</li> <li>● Field Operations Database Review</li> <li>● Lab Operations Database Review</li> <li>● Flow Rate Analysis</li> <li>● Flagged Samples Review</li> <li>● QC samples and analytical accuracy and precision review</li> </ul>
<p><b>Level 2</b> (Performed by QA personnel at CNL)</p> <ul style="list-style-type: none"> <li>● Internal Consistency Analysis</li> <li>● Outlier Analysis</li> <li>● Data Completeness</li> <li>● Collocated Bias and Precision</li> <li>● Data Integrity</li> </ul>	<p><b>Level 3</b> (Performed by QA personnel at CIRA)</p> <ul style="list-style-type: none"> <li>● Time Series Analysis</li> <li>● Correlations between sites</li> <li>● Mass Reconstruction Analysis</li> <li>● Species Distribution Analysis</li> <li>● Optical Reconstruction Analysis</li> <li>● Others</li> <li>● Modeling</li> </ul>

# Measurement-to-Measurement Comparisons

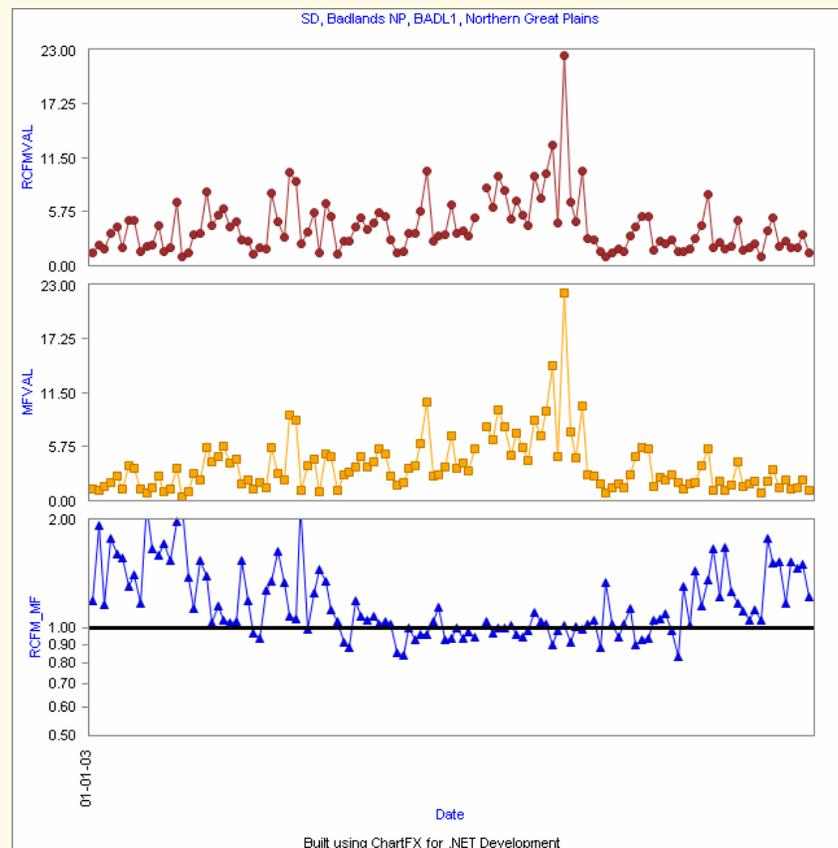
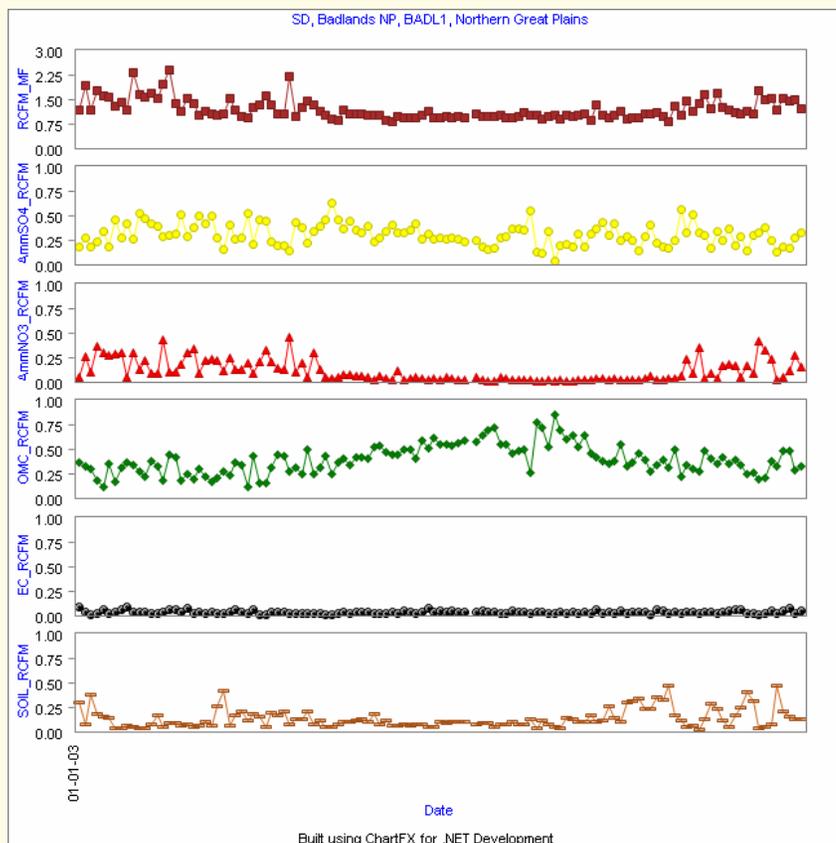
## Internal Consistency Between Redundant Measurements



Consistency Through Time

# Measurement-to-Model Comparisons

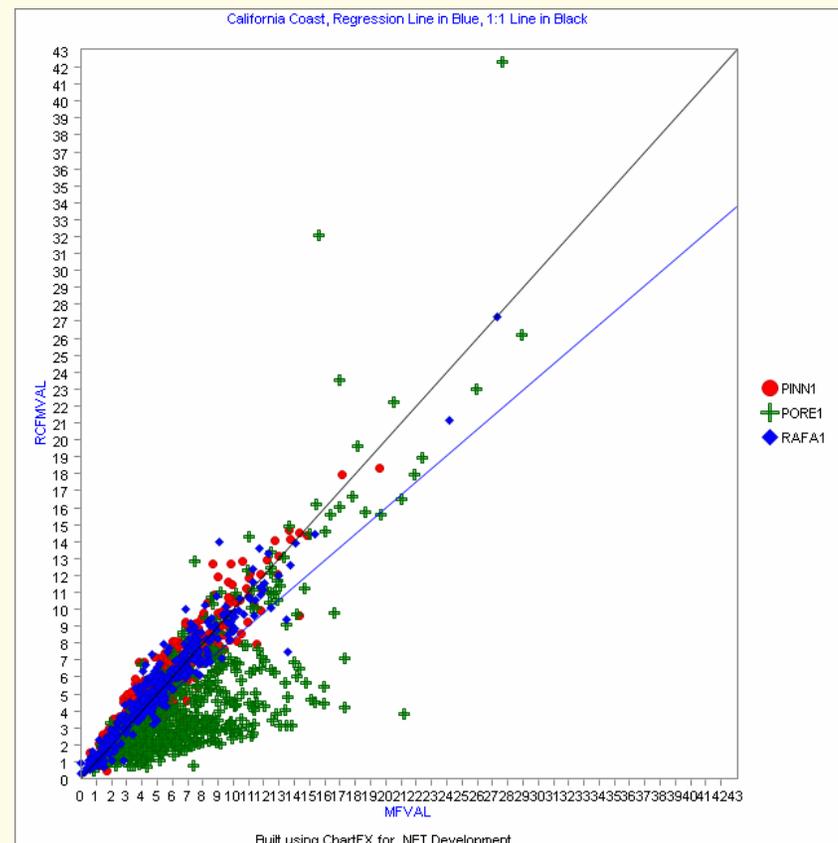
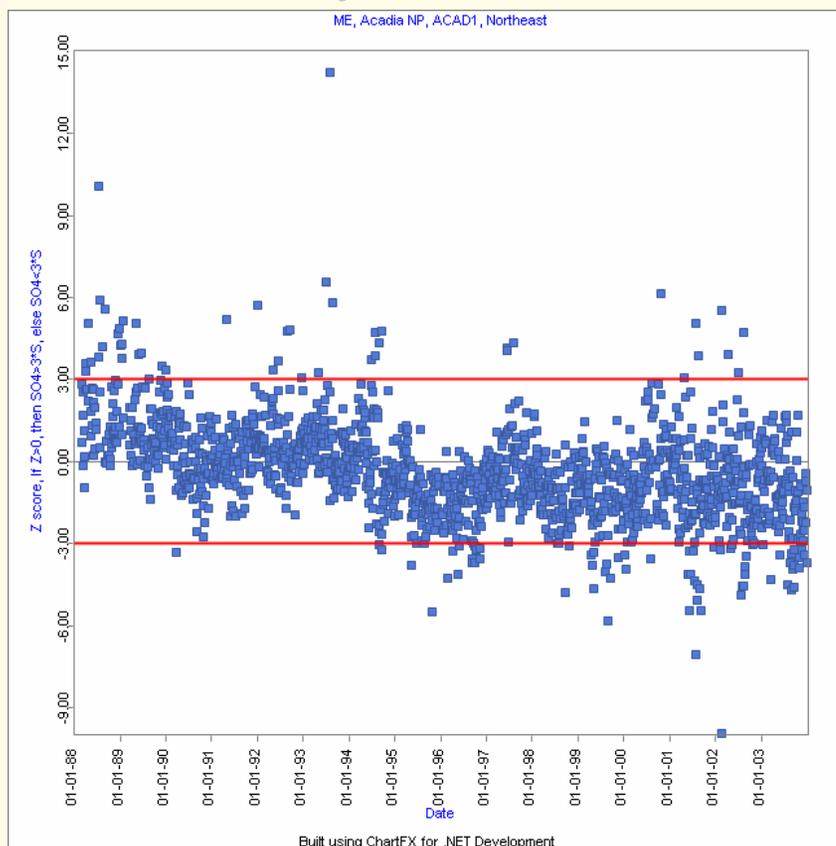
## Species Distribution as a Fraction of Reconstructed Fine Mass



## Mass Reconstruction Analysis

# Measurement-to-Model Comparisons

Internal Consistency  
Between Redundant  
Measurements Taking into  
Account Measurement  
Uncertainty



Consistency Through  
Space

## New validation tools built in context of the VIEWS data management system

- Major Components of the VIEWS System Utilized in the New Tools
  - Fully relational SQL Server Databases
  - Visual Basic ASP .NET web applications
  - Third party charting package (Chart FX)
- Data Holdings Include
  - Routine IMPROVE data
  - AQS STN and FRM
  - NADP
  - CASTNet
  - IMPROVE special studies



## VIEWS: An Approach to Air Quality Data Management



### What is VIEWS?

The Visibility Information Exchange Web System is a **database system** and set of **online tools** originally designed to support the Regional Haze Rule enacted by the EPA to **reduce regional haze** in national parks and wilderness areas.

### What are some of its other goals?

- Provide easy online access to a wide variety of air quality data.
- Provide online tools for exploring and analyzing this data.
- Maintain a catalog of relevant air quality-related resources.
- Facilitate the research and understanding of global air quality issues.

**Web Address:** <http://vista.cira.colostate.edu/views>

**Sponsor:** Five EPA Regional Planning Organizations (RPOs)

**Guiding Body:** VIEWS Steering Committee

**Location:** Cooperative Institute for Research in the Atmosphere (CIRA),  
Colorado State University, Fort Collins, CO

**Staff:** Scientists, researchers, and IT professionals

**Affiliations:** Interagency Monitoring of Protected Visual Environments (IMPROVE)

### Some facts:

- Over 600 registered users
- Over 200 organizations represented
- Almost 100 countries represented
- 300+ unique hits a day
- Linked to by over four dozen sites
- Over 40 million records of air data
- Dozens of monitoring networks
- CSU Research Initiative Award
- Uses the new Manifold GIS
- Monitoring site photographs
- Class I Area webcams
- Visibility photographs
- Visibility Grey Literature
- Periodic Newsletter
- Contour Maps
- Trends Analysis
- Air Mass Composition Analysis



## Technical Notes:



### ➔ Major Components

- Website and associated online tools
- Integrated Database and Data Ingest procedures
- Raw data files and support documents
- Code libraries

### ➔ Software Environment

- Database Technology: Microsoft SQL Server, ADO .Net, ODBC
- Website Technology: Microsoft Internet Information Server (IIS), FrontPage Server Extensions
- Development Technologies:  
MS SQL Server Tools, MS .Net Framework, MS Visual Studio .Net, MS FrontPage, C#, Visual Basic, ASP .Net, HTML, DHTML, Javascript, VBScript

### ➔ Hardware Environment

- Web server and Database server
- Source Code Control server
- Backup and Build server
- Development machines
- T3 Internet Connection

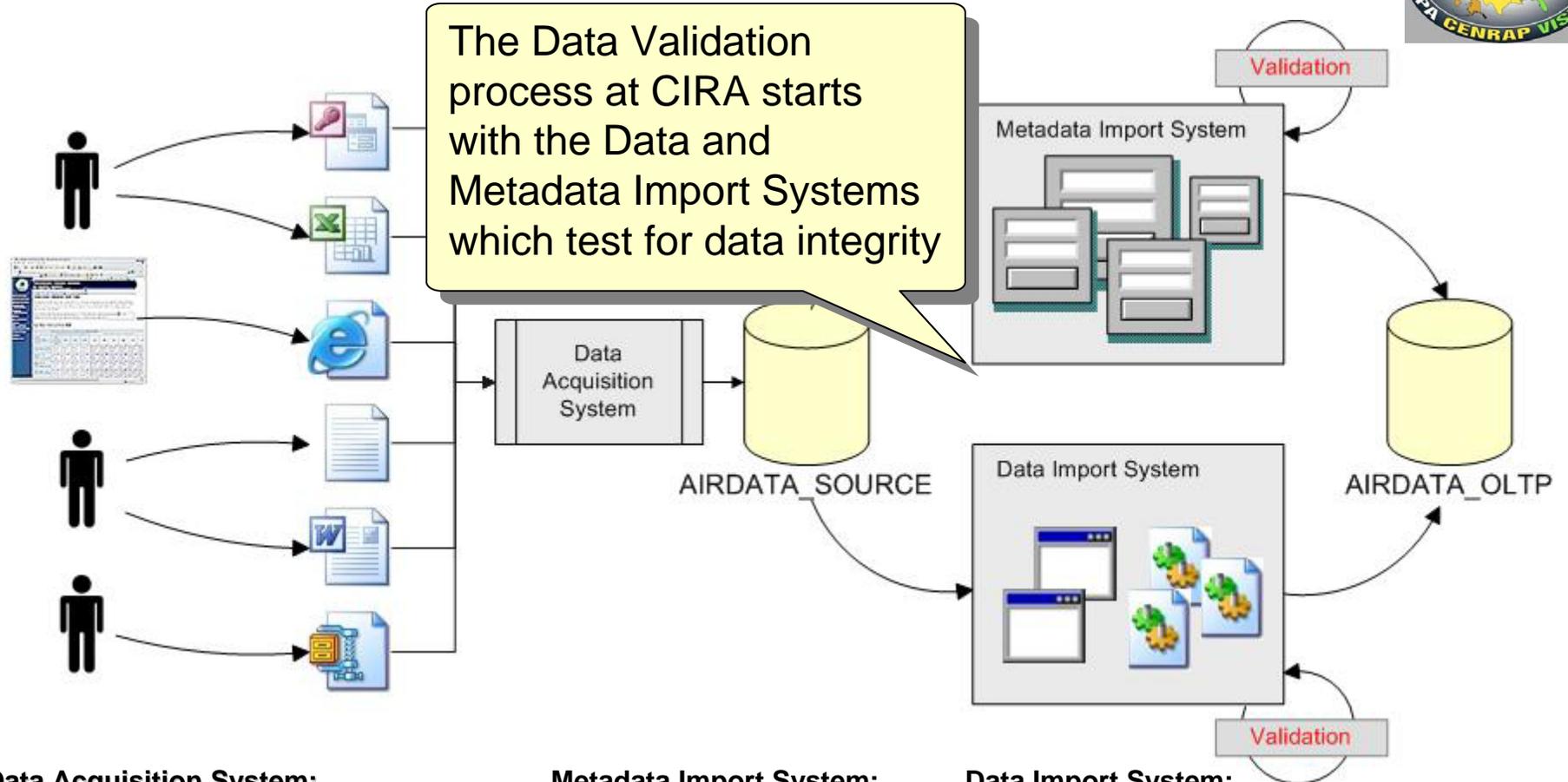
## **The new web tools currently allow the user to produce IMPROVE's data validation charts and calculated parameters through:**

- ❖ **Interactive real-time data selection from the VIEWS database**
  - Site(s)
  - Start and end dates
  - Pre-designed data validation chart types
- ❖ **On-the-fly calculation of diagnostic statistics and/or composite parameters**
- ❖ **On-line charting capabilities**
  - Download charts as jpeg images
  - Display interactive charts
    - Scalable axes
    - Color selection
    - Edit chart and axes titles
    - Zoom features enable scrollable axes
    - Mouse over or datagrid identification of chart point values
    - Series display
- ❖ **On-line data table display**

## **Advantages of Direct Database Connectivity**

- ❖ **Unification of the Data Management and Data Validation Systems in terms of design environment and shared code base increases efficiency and reduces the risks inherent in data transformation processes typically necessary for importing data into data analysis software packages**
- ❖ **Selection list boxes pull content from metadata tables based on SQL query and therefore instantly reflect database updates upon web page refresh**
- ❖ **Validation charts reflect current database content and can easily be recreated after database updates**
- ❖ **The option of direct database edits through the data validation tools exists. This option would further increase efficiency and create a system more robust to unintended or forgotten data edits.**

# IEWS Architecture Detail: Data Acquisition & Import



## Data Acquisition System:

- Accepts submission of data in a variety of schemas and formats
- Can automatically extract data from known online sources
- Uses database replication where possible
- Initially imports data and metadata “as-is” into the source database

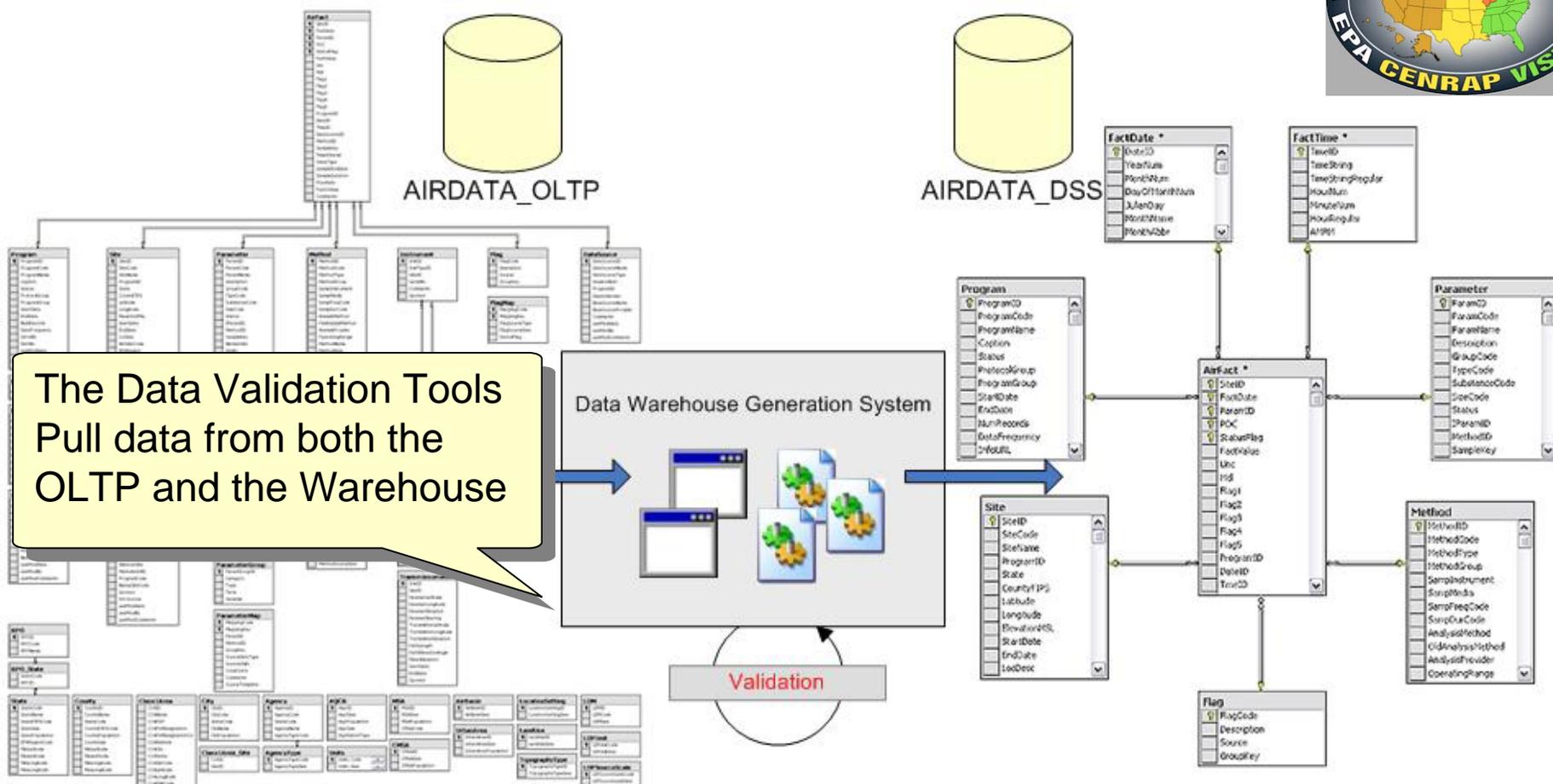
## Metadata Import System:

- Facilitates the entry of new metadata
- Validates new metadata entries
- Detects overlap with existing metadata

## Data Import System:

- Extracts data from the source database
- Scrubs data and performs conversions
- Maps source metadata to integrated metadata
- Transforms the data into an integrated schema
- Verifies and validates imported data
- Loads data into the back-end OLTP system

# VIEWS Architecture Detail (cont'd): Data Management



## OLTP:

- Functions as the “back-end” database
- Fully relational and in 3<sup>rd</sup> normal form
- Used for data import, validation, and management
- Technologies: Microsoft SQL Server

## Data Warehouse Generation System:

- Extracts data from the OLTP
- De-normalizes and transforms data
- Loads data into the Data Warehouse
- Builds table indexes
- Archives “snapshots” of the database
- Technologies: VB, stored procedures

## Data Warehouse:

- Functions as the “front-end” database
- Uses a de-normalized “star schema”
- Used for querying and archiving data
- Automatically generated from the OLTP
- Technologies: Microsoft SQL Server

Default - Microsoft Internet Explorer  
Address: http://localhost/ImproveQA/Default.aspx

### IMPROVE Aerosol QA Utility

Select Location By:  
 IMPROVE Sites  
 IMPROVE Regions

Output Type:  
 Chart(s)  
 Spreadsheet

Sites:  
ACAD1  
ADP11  
AGT11  
AMBL1  
ARCH1  
AREN1  
ATLA1  
BALD1  
BALD1  
BALT1  
BAND1  
BIBEL

Years:  
2004  
2003  
2002  
2001  
2000  
1999  
1998  
1997  
1996  
1995  
1994  
1993

Months:  
January  
February  
March  
April  
May  
June  
July  
August  
September  
October  
November  
December

Chart Type:  
Sulfate Time  
Reconstructed Mass Time  
Nitrate Time  
OC EC Time  
OMH OMC Time  
Total Mass  
Relative Mass  
Four Ratios  
Sulfate Scatter  
Sulfate Scatter Multi-Site  
OMH OMC Scatter  
OMH OMC Scatter Multi-Site

Users select data based on site(s) or regions, dates and pre-designed chart type

X and Y axes are scalable



Mouse over displays chart point X and Y values

The Chart Fx Data Editor offers additional display options

Users select data based on site(s) or regions, dates and pre-designed chart type

File Edit View Favorites Tools Help

Back Forward Stop Home Search Favorites Media

Address http://localhost/ImproveQA/Default.aspx

### IMPROVE Aerosol QA Utility

Select Location By:

IMPROVE Sites

IMPROVE Regions

Regions:

- Alaska
- Appalachia
- Boundary Waters
- California Coast
- Central Great Plains
- Central Rockies
- Colorado Plateau
- Columbia River Gorge
- Death Valley
- East Coast
- Great Basin
- Hawaii

Years:

- 2004
- 2003
- 2002
- 2001
- 2000
- 1999
- 1998
- 1997
- 1996
- 1995
- 1994
- 1993

Months:

- January
- February
- March
- April
- May
- June
- July
- August
- September
- October
- November
- December

Chart Type:

- Sulfate Time
- Reconstructed Mass Time
- Nitrate Time
- OC EC Time
- OMH OMC Time
- Total Mass
- Relative Mass
- Four Ratios
- Sulfate Scatter
- Sulfate Scatter Multi-Site
- OMH OMC Scatter
- OMH OMC Scatter Multi-Site

Output Type:

Chart(s)

Spreadsheet

GO!

View Chart

Download chart without viewing

Data can be displayed in a read only or editable VB .Net Data Grid

Site	Region	State	County	City	Lat	Long	ActDate	S04fVAL	S04fUNC	S04fMDL	SfVAL	SfUNC	SfMDL
							03/03/2003	0.4969	0.0191	0.0128	0.16746	0.00859	0.00062
							06/06/2003	1.6282	0.0592	0.0137	0.52567	0.02654	0.00072
							09/09/2003	0.7692	0.0286	0.0133	0.3003	0.01523	0.00068
							12/12/2003	0.8331	0.0308	0.013	0.33817	0.01717	0.00066
							15/15/2003	0.6193	0.0234	0.0134	0.21856	0.0112	0.00065
							18/18/2003	0.7497	0.0279	0.0131	0.28287	0.01439	0.00075
							21/21/2003	0.7505	0.0279	0.0132	0.27925	0.01423	0.00071
							24/24/2003	0.7634	0.0284	0.0132	0.26594	0.01355	0.00069
							27/27/2003	1.8171	0.066	0.0138	0.64943	0.03273	0.00079
Northeast	ACAD1	Acadia	NP	ME			01/30/2003	4.4204	0.1596	0.0133	1.40452	0.07049	0.00099
Northeast	ACAD1	Acadia	NP	ME			02/02/2003	0.3254	0.0155	0.0202	0.10299	0.00544	0.00051
Northeast	ACAD1	Acadia	NP	ME			02/05/2003	0.7751	0.0296	0.019	0.248	0.01268	0.00066
Northeast	ACAD1	Acadia	NP	ME			02/08/2003	1.4043	0.0516	0.0195	0.45001	0.02279	0.00068
Northeast	ACAD1	Acadia	NP	ME			02/11/2003	2.0614	0.0751	0.02	0.70177	0.03538	0.00082
Northeast	ACAD1	Acadia	NP	ME			02/14/2003	1.1608	0.043	0.0193	0.44755	0.02267	0.00092
Northeast	ACAD1	Acadia	NP	ME			02/17/2003	1.0694	0.0398	0.0189	0.32493	0.01653	0.0007
Northeast	ACAD1	Acadia	NP	ME			02/20/2003	4.9059	0.1772	0.0192	1.67412	0.08401	0.00104
Northeast	ACAD1	Acadia	NP	ME			02/23/2003	0.6195	0.0247	0.0205	0.21673	0.01111	0.00057
Northeast	ACAD1	Acadia	NP	ME			02/26/2003	1.6379	0.0599	0.019	0.63123	0.03184	0.00082
Northeast	ACAD1	Acadia	NP	ME			03/01/2003	4.06	0.1467	0.0163	1.52296	0.07659	0.00103
Northeast	ACAD1	Acadia	NP	ME			03/04/2003	1.5241	0.0556	0.0166	0.53065	0.02696	0.00078
Northeast	ACAD1	Acadia	NP	ME			03/07/2003	1.4379	0.0526	0.0168	0.55067	0.02799	0.00077
Northeast	ACAD1	Acadia	NP	ME			03/10/2003	1.5418	0.0563	0.0166	0.58325	0.02961	0.00082

# VIEWS Database Query Wizard – Query Construction Interface

**SELECT MONITORING LOCATIONS**

Select Networks:

Select Sites:

ARS	IMPROVE AK: Denali National Park
CASTNet	IMPROVE AK: Simeonof
EPAFRM	IMPROVE AK: Trapper Creek
EPASPEC	IMPROVE AK: Tuxedni
IMPROVE	IMPROVE AL: Sipsy Wilderness
MOHAVE	IMPROVE AR: Caney Creek
NESCAUM	IMPROVE AR: Upper Buffalo Wilderness
PREVENT	IMPROVE AZ: Chiricahua National Monument
REVEAL	IMPROVE AZ: Hance Camp at Grand Canyon NP
SEAVS	IMPROVE AZ: Hillside
SFU	IMPROVE AZ: Hopi Point #1
	IMPROVE AZ: Hopi Point #2 (High Sensitivity)
	IMPROVE AZ: Ike's Backbone
	IMPROVE AZ: Indian Gardens
	IMPROVE AZ: Indian Gardens 2 (High Sensitivity)

Select by RPD:

WRAP  
 CENRAP  
 Midwest-RPD  
 MANE-VU  
 VISTAS

**SELECT ANY ADDITIONAL OUTPUT FIELDS**

<b>Basic Fields:</b>	<b>Data Flags:</b>	<b>Location Fields:</b>	<b>Parameter Fields:</b>
<input checked="" type="checkbox"/> Network Code	<input type="checkbox"/> Observation Uncertainty (UNC)	<input type="checkbox"/> Site Name	<input type="checkbox"/> Parameter Code
<input checked="" type="checkbox"/> Site Code	<input type="checkbox"/> Minimum Detection Limit (MDL)	<input type="checkbox"/> Elevation	<input type="checkbox"/> Parameter Description
<input checked="" type="checkbox"/> Observation Date/Time	<input type="checkbox"/> Status Flag (Flag)	<input type="checkbox"/> Latitude	
<input checked="" type="checkbox"/> Observation Value	<input type="checkbox"/> Quality Control (QC) Level	<input type="checkbox"/> Longitude	

**SPECIFY DESIRED OUTPUT OPTIONS**

Report Format:  Smart Grid  HTML Text  Text File

Row Format:  Wide  Skinny

Column Format:  Fixed Width  Delimited

Date Format:

Additional Data:  Show Metadata  Show Headers

Substitutions: Missing Values:  Inapplicable Values:

Text File Name:

**SELECT DATES FOR WHICH TO RETRIEVE DATA**

By Years and Months:

1988	January
1989	February
1990	March
1991	April
1992	May
1993	June
1994	July
1995	August
1996	September
1997	October
1998	November
1999	December

By Date Ranges:

Start Date:

End Date:

**VERIFY YOUR SELECTIONS**

Network: IMPROVE  
 Site: IMPROVE AK: Denali National Park  
 Parameter: Aerosol extinction (Calculated)  
 Range: January 1, 1988 - December 31, 1988  
 Field: Network Code  
 Field: Site Code  
 Field: Observation Date/Time  
 Field: Observation Value  
 Option: Table Format = Smart Grid  
 Option: Row Format = Wide  
 Option: Column Format = Fixed Width  
 Option: Delimiter = ,  
 Option: Display Metadata = true  
 Option: Column Headers = true  
 Output Option: Missing Values = -999

**SPECIFY THE PARAMETERS YOU WISH TO VIEW**

Aerosol extinction	(Calculated)
Air Temperature	(Meteorological)
Aluminum: Fine	(Particle)
Ammonium ion: Fine	(Particle)
Ammonium nitrate extinction: Fine	(Calculated)
Ammonium Nitrate: Fine	(Calculated)
Ammonium sulfate extinction: Fine	(Calculated)
Ammonium sulfate: Fine	(Calculated)
Arsenic: Fine	(Particle)
Bromine: Fine	(Particle)

The VIEWS Query Wizard Tool enables easy access to additional data fields



# IEWS Annual Summary - Spatial and Seasonal Patterns



## Data Views:

### Map View

This view displays contours of the selected parameter for a selected year and aggregation. Data aggregation options include the average of the annual, quarter, and best or worst 20% of sampled days. The best and worst 20% days in a year can be chosen by using chemical extinction (aerosol\_bext) or the selected parameter as a sort variable. Selecting a site icon from the map populates the **timeline view** with data for that site.

### Timeline View

This view shows daily values for the selected site and parameter. Sampling days in the chosen data aggregation are highlighted. Either chemical extinction or the selected parameter can be used as a sort variable for the best or worst 20% days. Grayed-out selections are not currently available.

### Tabular Data Summary

This view shows method information or data statistics for the selected monitoring site. When viewing data statistics, 'N samples' is the number of samples in the data aggregation and 'N substitutions' is the number of values substituted using guidelines outlined in the [RHR tracking progress](#) document.

Map View
Selected Site: Acadia NP, ME (ACAD1)

Year: 2001

Parameter: aerosol\_bext

Data Aggregation:  Annual

**Timeline View**

ACAD1 2001

**Tabular Data Summary**

Aggregate Statistics     Method Information

Site Code	Year	Parameter	Average Value	Units	N Samples	N Substitutions	Aggregation
ACAD1	2001	Aerosol extinction	40.2	Mm-1	122	1	Annual

The VIEWS Annual Summary analysis enables easy access to additional data analysis for contextualizing data validation results

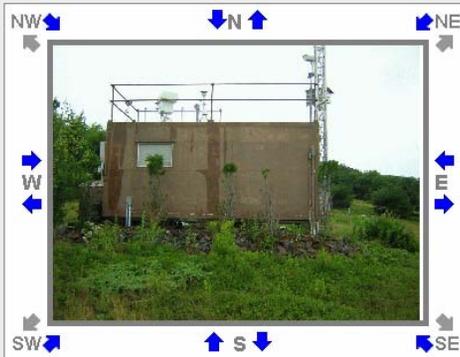
# VIEWS Site Browser Tool – Site Specific Metadata Display

SiteBrowser - Microsoft Internet Explorer

Address: http://vista.cira.colostate.edu/views/Web/SiteBrowser/SiteBrowser.aspx

**Acadia NP** [Topographic Map](#)

SiteCode: **ACAD1**  
SiteName: **Acadia NP**  
State: **ME**  
CountyFIPS: **009**  
CountyName: **Hancock County**  
EPASiteCode:  
Latitude: **44.3771**  
Longitude: **-68.2612**  
ElevationMSL: **150**  
EPARegion:  
ImproveRegion: **NEAST**  
AgencyName: **U.S. National Park Service (NPS)**  
AcqrDesc:  
MSADesc:  
CMSADesc:  
AirBasinDesc:  
ZipCode:  
LocationSettingDesc:  
LandUseDesc:  
TopographyTypeDesc: **Coastal**  
UrbanAreaDesc:  
StreetAddress:  
LocDesc: **Park Headquarters**  
Comment:  
StartDate: **3/2/1988**  
EndDate:  
Sponsor:



Looking North towards the site. (ACAD1\_2004\_N\_IN.jpg)

**Method History**

- 6/1/1996 Added glycerine to Module B denuder
- 4/26/1995 Sample area changed from 2.2 sq. cm to 3.5 sq. cm for ACAD1
- 6/28/1994 Changed nylon filter size from 47mm diameter to 25mm (17.4 to 4.9 sq cm)

**Change History**

- 5/23/2000 Version 2 IMPROVE sampler installed
- 10/29/1998 ACAD1 built new shelter on original site
- 8/18/1994 Moved ACAD1 from outdoors to indoors 150 yards

**Program History**

- 12/1/2001 Analysis of elements with atomic weights from Na to Mn was changed from PIXE to XRF by Cu anode.
- 4/5/2001 Ion samples extracted using DI water at all sites
- 10/11/2000 Ion samples extracted using anion eluent at all sites except GRSM1, SHEN1, and DOSO1 where extraction is with DI water.
- 1/28/1999 Ion samples extracted using DI water at all sites
- 6/1/1997 Ion samples extracted using DI water at GRSM1, SHEN1, DOSO1. All other sites extracted with anion eluent.

**Annual Summary**

- Spatial Patterns
- Composition
- Trends
- Back Trajectories
- Visibility Grid
- Summary Data
- Archived Graphics

**Resources**

- Air Quality Catalog
- Weather Catalog
- Emissions Catalog
- RHR Planning Docs
- CAPITA Tools

**Imagery**

- Visibility Photos
- Class I Webcams
- Forest Service

**Development**

- Data Browser
- Query Wizard II

Guest List

For best results, please use:  
Internet Explorer 5 (or higher)  
Netscape 6 (or higher)  
more info...

The VIEWS Site Browser Tool enables easy access to site specific metadata including site location, site history of sampling changes or events and network history of analytical changes

## **Future Directions: Validation Theory**

### **❖ Deeper into IMPROVE data**

- Incorporate auto-validation checks
  - Integrity checks (currently done through SQL queries)
  - Range checks for every parameter (currently not done)
  - Flow rate analysis based on continuous flow data (currently not done)

### **❖ Broader into External Validation**

- Incorporate inter-comparison of collocated sites from other networks (currently not done routinely)

## **Future Directions: Validation Tool Functionality**

### **❖ Access to additional data**

- Incorporate QC data into the data management system
- Develop algorithms for cross-network comparisons

### **❖ Design, develop and incorporate auto-validation checks**

- Develop and test algorithms
- Translate existing validation code base to be compatible with the VIEWS design environment
- Develop and test output display options

# IEWS Simple Comparison Between IMPROVE Aerosol and NADP NTN Data:

The VIEWS Data Browser Tool (still in development) will enable easy access to additional data networks and provide a code basis for broadening the data validation process

**Programs:**

- AIRMON: AIRMoN
- AFRD: AQS Fine Mass FRM - Daily
- AFRH: AQS Fine Mass FRM - Hourly
- ASPD: AQS Fine Speciation - Daily
- A10D: AQS PM 10 - Daily
- A10H: AQS PM 10 - Hourly
- CDC: CASTNet Dry Chemistry
- CVC: CASTNet Visibility Chemistry
- GAVIM: GAVIM
- INA: IMPROVE Aerosol**
- INN: IMPROVE Nephelometer
- MOH: MOHAVE Special Study

**Sites:**

- ME: INA: ACAD1
- ME: INA: BRMA1
- ME: INA: CABA1
- ME: NADP\_NTN: ME00
- ME: NADP\_NTN: ME02
- ME: NADP\_NTN: ME04
- ME: NADP\_NTN: ME08
- ME: NADP\_NTN: ME09
- ME: NADP\_NTN: ME95
- ME: NADP\_NTN: ME96
- ME: NADP\_NTN: ME97
- ME: NADP\_NTN: ME98

**Parameters:**

- SEf
- Sf
- SIF
- SO2
- SO4**
- SO4f
- SOILf
- SOILf\_bext
- SRf
- SubPpt
- Svol
- TIf

**Display As:**  Chart(s)  Spreadsheet

**Group Charts By:**  Site  Parameter  Site & Parameter

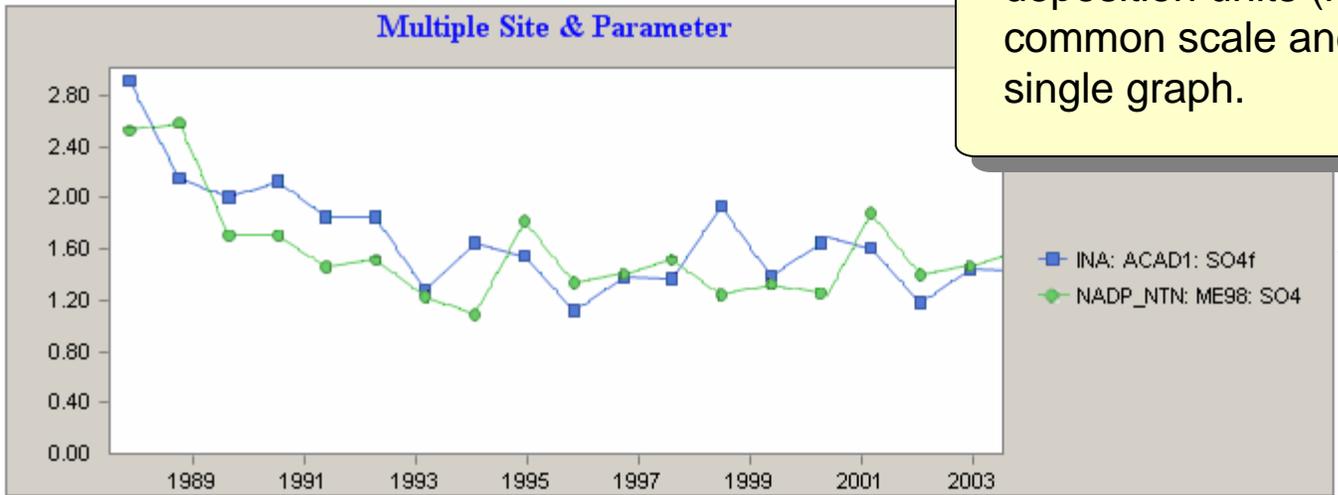
**Averaging:**  None  Daily  Monthly  Annual  All

**Chart Type:**  Timeline  Bar Chart

**Chart Options:**  Line  Step

GO!

This simple comparison was performed by “normalizing” the aerosol units (ug/m3) and the deposition units (mg/L) to a common scale and plotting on a single graph.



## **People Involved**

### **IMPROVE**

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**Bill Malm**

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