



Overview and Description of IMPROVE

Presented by Charles E. McDade
University of California, Davis

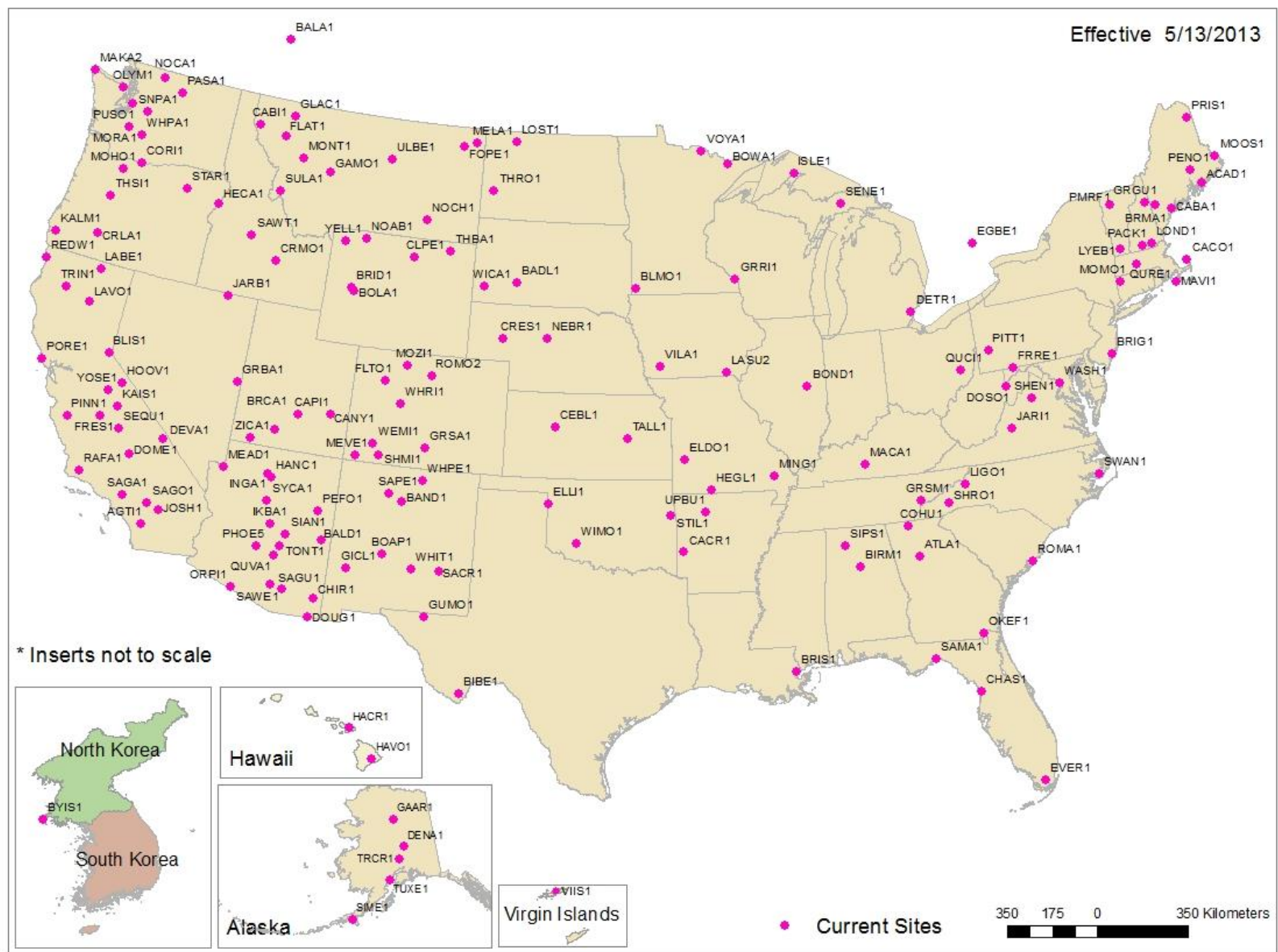
Presented at NADP 2013 Fall Meeting
Park City, Utah
October 9, 2013

IMPROVE

- Interagency **M**onitoring of **P**rotected **V**isual **E**nvironments
- Cooperative effort started in 1988 with ~30 sites
 - Expanded to ~165 sites ca. 2000

The IMPROVE network maintains ~165 sites.

Effective 5/13/2013



Most samplers are located in National Parks & other remote areas



A few samplers are collocated with urban network samplers.



Current List of Sponsors

- U.S. National Park Service
- U.S. Forest Service
- U.S. Fish & Wildlife Service
- U.S. Environmental Protection Agency
- Various State Governments & Tribes
- Environment Canada
- South Korea Ministry of Environment

IMPROVE Measurements

Samples are collected every 3rd day,
24 hours, midnight to midnight

April

Su	M	Tu	W	Th	F	Sa
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

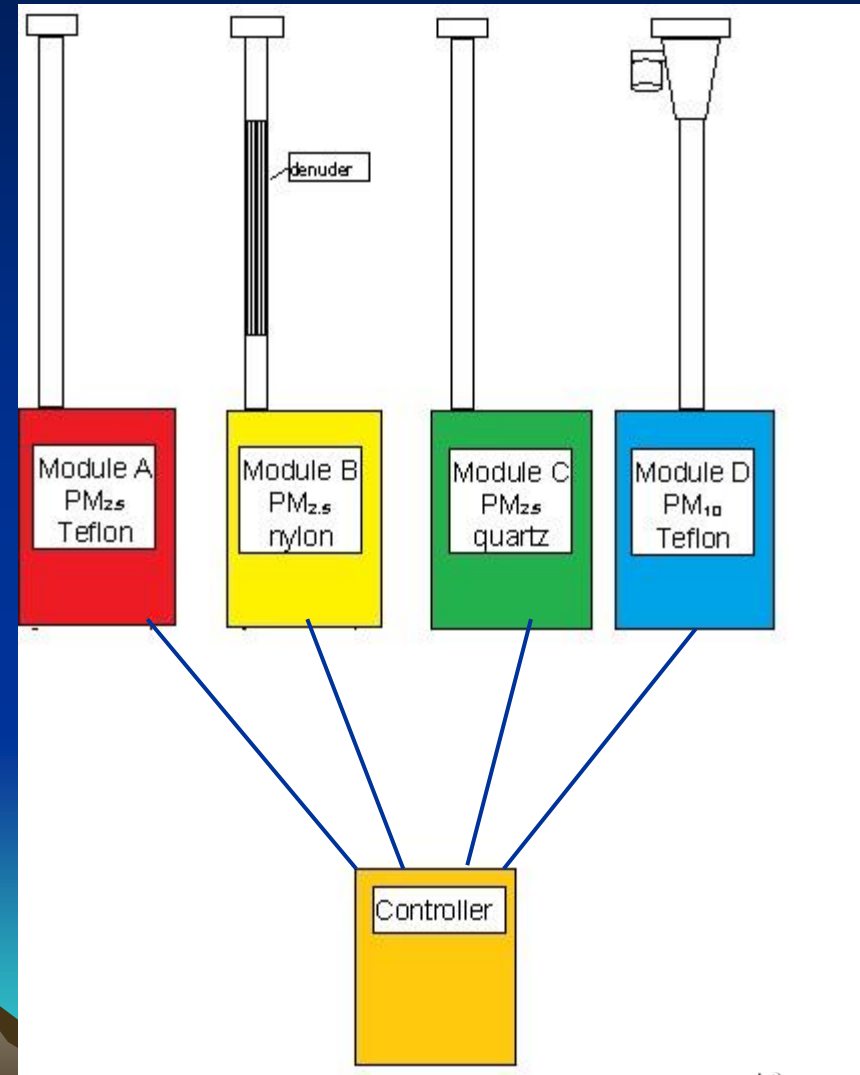
The IMPROVE sampler is designed for sampling clean air

- High flow rate – 23 liters per minute
- Small filter – 25 millimeter diameter filter concentrates the sample in a small area
- The result is better detection of small amounts of particulate matter



IMPROVE Sampler:

- 4 modules to collect different aerosol components
- Controller
 - Starts/stops pumps
 - Electronically records operating information
 - Solenoid positions
 - Flow rate readings



Sampling Module Design

Inlet Stack

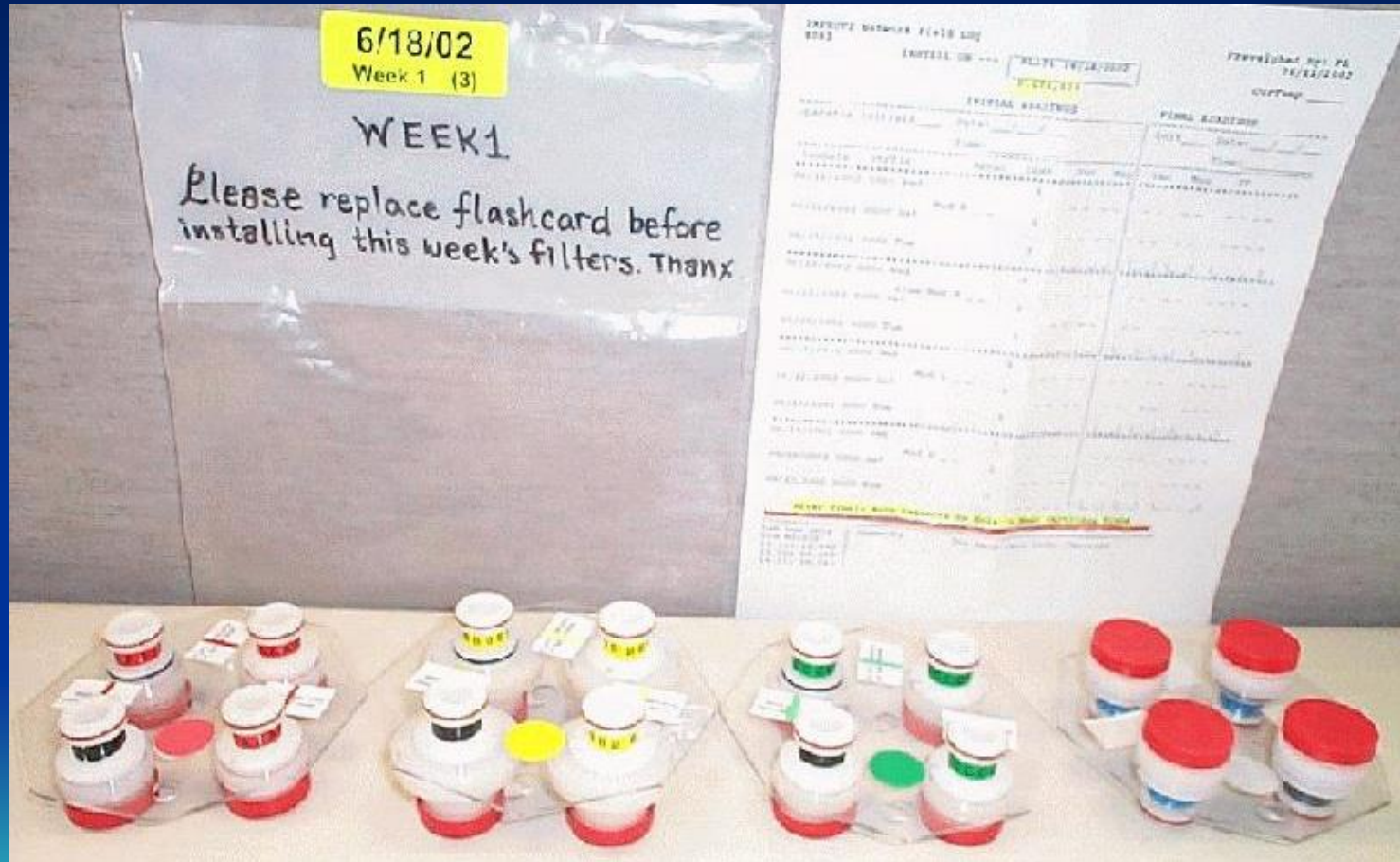
Solenoid Valves

Filter Cassettes

Cyclone



Filters are shipped in cassettes



A local operator visits each site every Tuesday



UC Davis staff visit each site every
1 to 2 years for maintenance



Collocated sampling measures precision



Data Validation at UC Davis

- UC-Davis validates data from entire network, providing consistent data quality assessment across the network
- Expected relationships are evaluated, for example sulfur compared to sulfate
- Research and advanced data analysis complement routine validation

IMPROVE data are available from AQS and at <http://views.cira.colostate.edu/fed/>

Federal Land Manager Database (FED)
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Metadata and Reference

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Federal Land Manager Environmental Database (FED)

This website provides access to an extensive database of environmental data and an integrated suite of online tools and resources to help Federal Land Managers assess and analyze the air quality and visibility in Federally-protected lands such as National Parks, National Forests, and Wilderness Areas.



AQRV Summaries

View graphical summaries and reports of the status and trends of air-quality-related values (AQRVs) and other metrics that have been chosen by Federal Land Managers (FLMs) for assessing air quality in protected federal areas.



Webcams and Photographs

See live video from webcams at select rural and urban vistas, and examine sequences of photographs from selected monitoring sites that demonstrate the range of visual conditions at each site over time.



Data Visualization and Exploration

Use a variety of interactive tools and applications to visualize, explore, filter, and download raw and aggregated air quality data and relevant metadata from the integrated database in a variety of customizable formats.



Metadata and Reference

Find and explore detailed metadata about datasets, monitoring sites, parameters, sampling and analysis protocols, processing methods, data flags, and other aspects of the air quality data in the integrated database.



Database Query Wizard

The query wizard allows you to selectively download data and metadata from the FED integrated database by specifying datasets, monitoring sites, parameters, date ranges, data quality flags, and other criteria. You can request data in variety of output formats.



Web Services and Tools

Discover web services, online utilities, and developer tools for accessing data and metadata from the database, and learn about the low-level components of the FED infrastructure that can be used for creating mashups of your own.

Featured Substance

Iron

Name:	Iron
FormulaHTML:	Fe
CASNum:	7439-89-6
ACXNumber:	X1002535-7
Density:	7.86
DOTNumber:	NA 1383; UN 3089
Comments:	MOISTURE SENSITIVE.
MolecularWeight:	55.845
MeltingPoint:	1535
BoilingPoint:	3000 - 3500

Featured Term

MOU

Memorandum of Understanding.

Air Quality News

Lungs of the planet reveal their true sensitivity to global warming

Predicting a low carbon future for Toronto

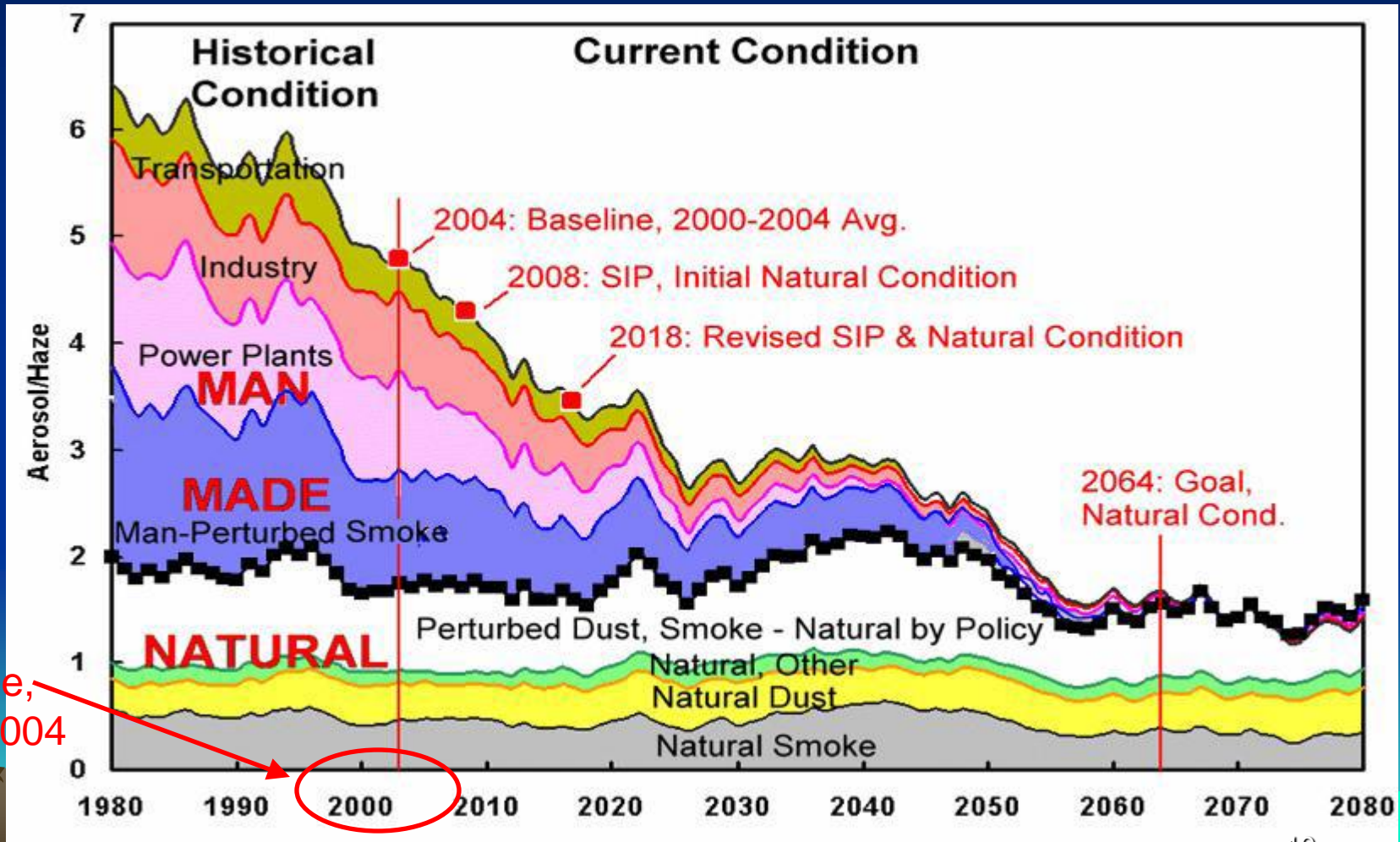
Air pollution primes children for asthma-related cockroach allergy

New coal technology harnesses energy without burning, nears pilot-scale development

Water purification on the cheap: System cleans 'produced water' from natural gas wells

The Regional Haze Rule

The Goal – Natural Visibility Conditions by 2064

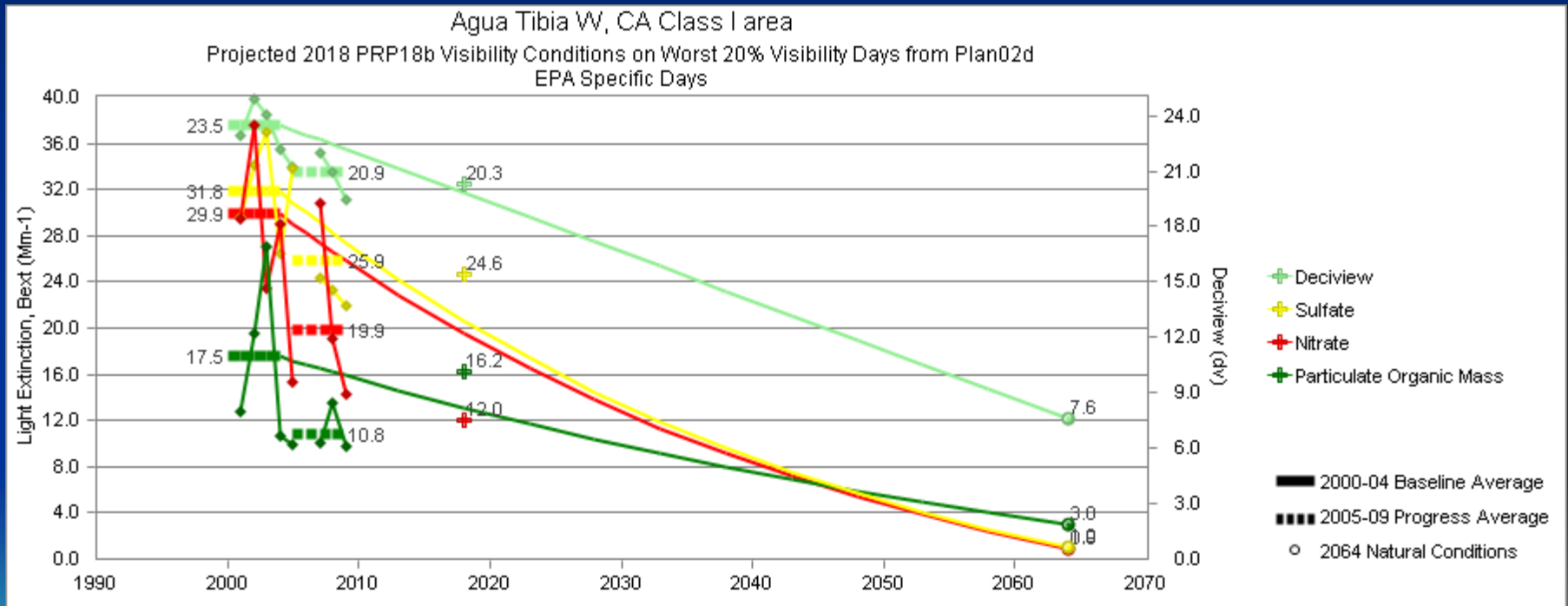


5 year
baseline,
2000-2004

IMPROVE Supports the Regional Haze Rule (RHR)

- Establishes baseline conditions for visibility-protected areas such as National Parks
- IMPROVE designed to support the RHR
 - Many sites to characterize haze near each protected area
 - Multi-year data to evaluate long-term trends
 - Samplers designed to measure clean environments
 - PM_{2.5} and PM₁₀ measurements to characterize the particles important to visibility impairment

Goals are set for reaching natural conditions



Improving IMPROVE

Technology has evolved since the beginning of IMPROVE

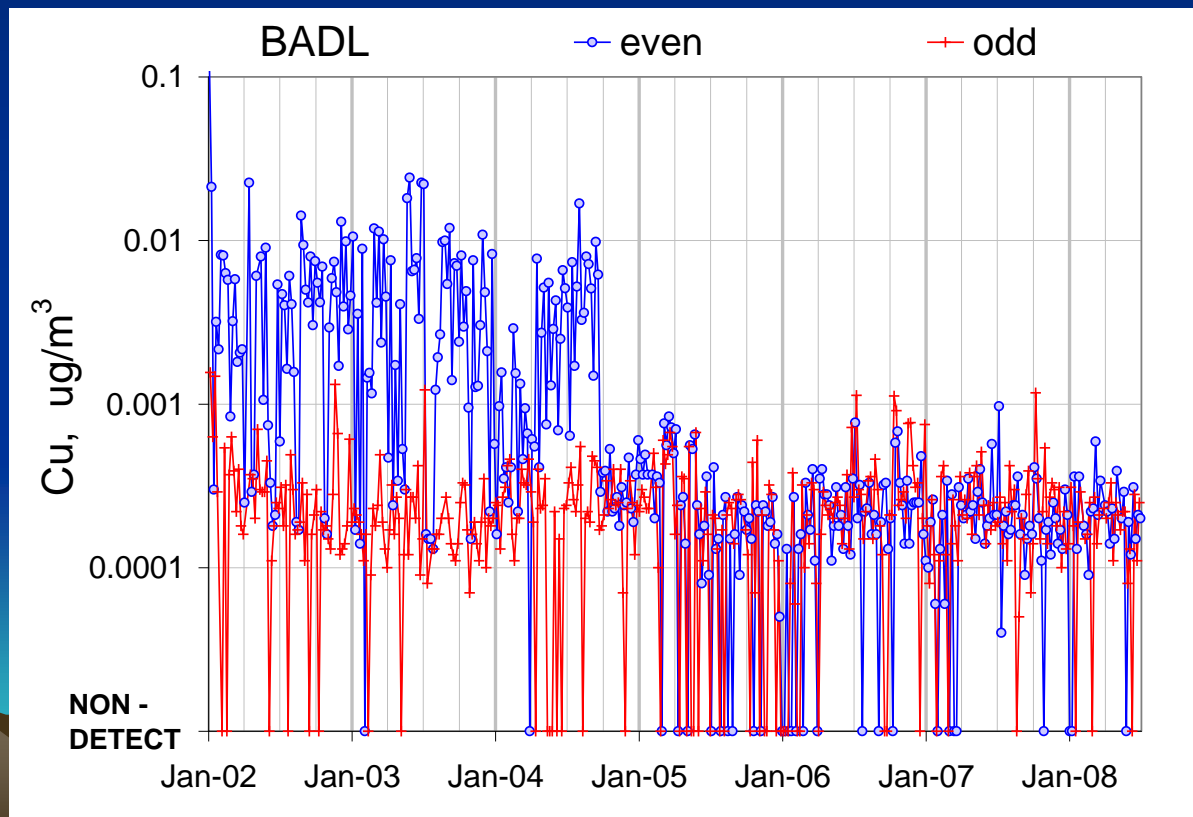
- Continuous recording of flow data initiated in 1999
- Switched to cleaner nylon filters in 2004
- Recent improvements
 - New XRF instruments in 2011
 - New balances in 2011
 - Ability to prepare our own XRF standards in 2011
- Improvements under development
 - New sampler controllers with remote communications
 - Add multiple wavelengths to light absorption measurement
 - IR absorption to estimate organic mass on each filter

IMPROVE Research & Data Analysis

Investigations can lead to better
understanding and improvements of
the measurements

Exploratory Data Analysis Can Uncover Unanticipated Problems

- Contamination from copper brushes on adjacent Hi-vol pumps on 1-in-6 day schedule



Data Advisories Document Important Data Quality Findings

Posting type

Advisory

Subject

S interference in XRF determination of Si

Module/Species

A/ Si

Sites

entire network

Period

starting 12/1/01

Recommendation

Distrust reported Si concentrations when $[S] \gg [Si]$, and disregard reported uncertainties and MDLs

Submitter

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Supporting information

The primary XRF peak for sulfur has a shoulder that overlaps the primary XRF peak for silicon, as illustrated in Figure 1.

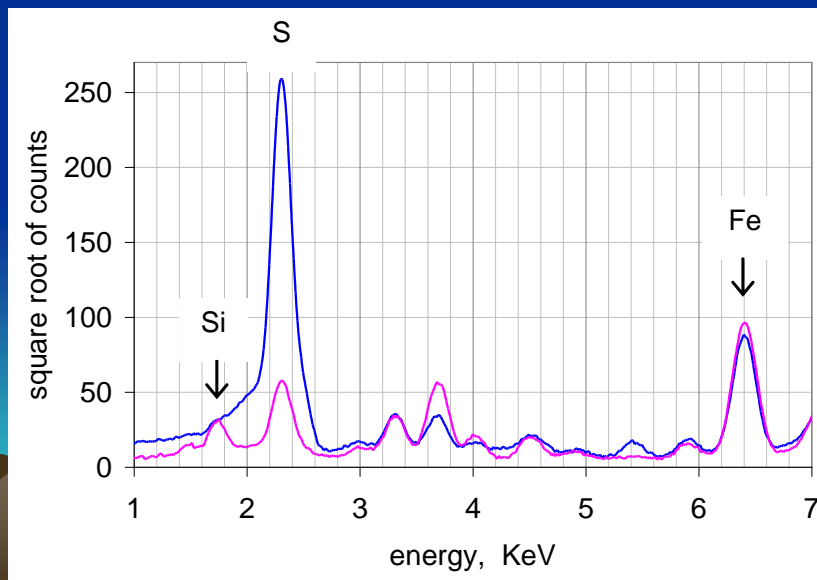


Figure 1. XRF spectra for two samples with differing S/Si ratios.

Creating XRF Calibration Reference Filters

- Reference filters prepared using IMPROVE or Partisol[®] sampler
- Provides reference filters at relevant concentrations
- XRF benchmark independent of commercially available standards
- Reference filters for S, Na, Cl, and K are used in current UC-Davis XRF calibrations
- Pb standards have been prepared to support EPA health effects measurements

Aerosol generation system

Dilution Air

IMPROVE PM2.5 Module

Atomizer

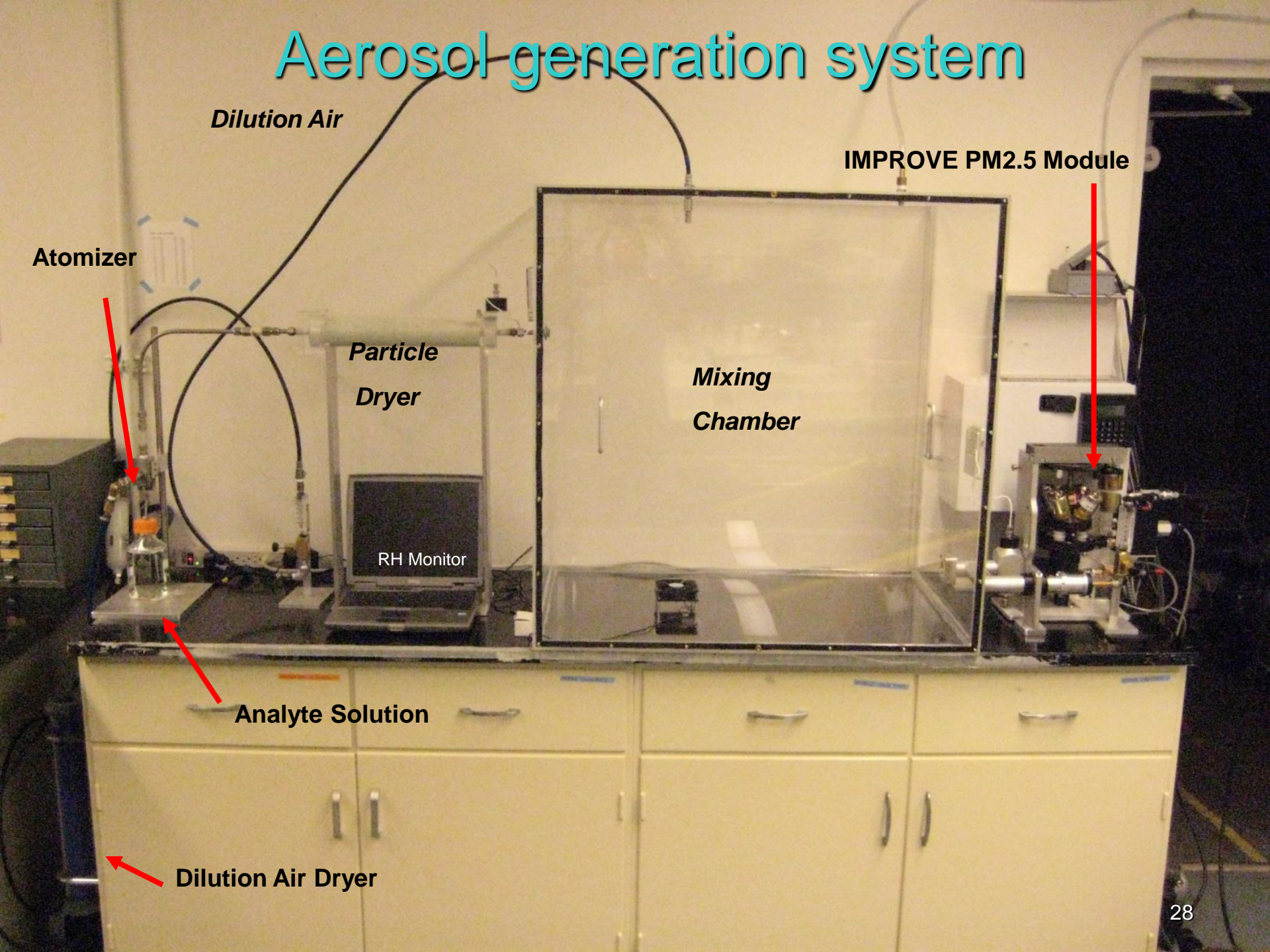
*Particle
Dryer*

*Mixing
Chamber*

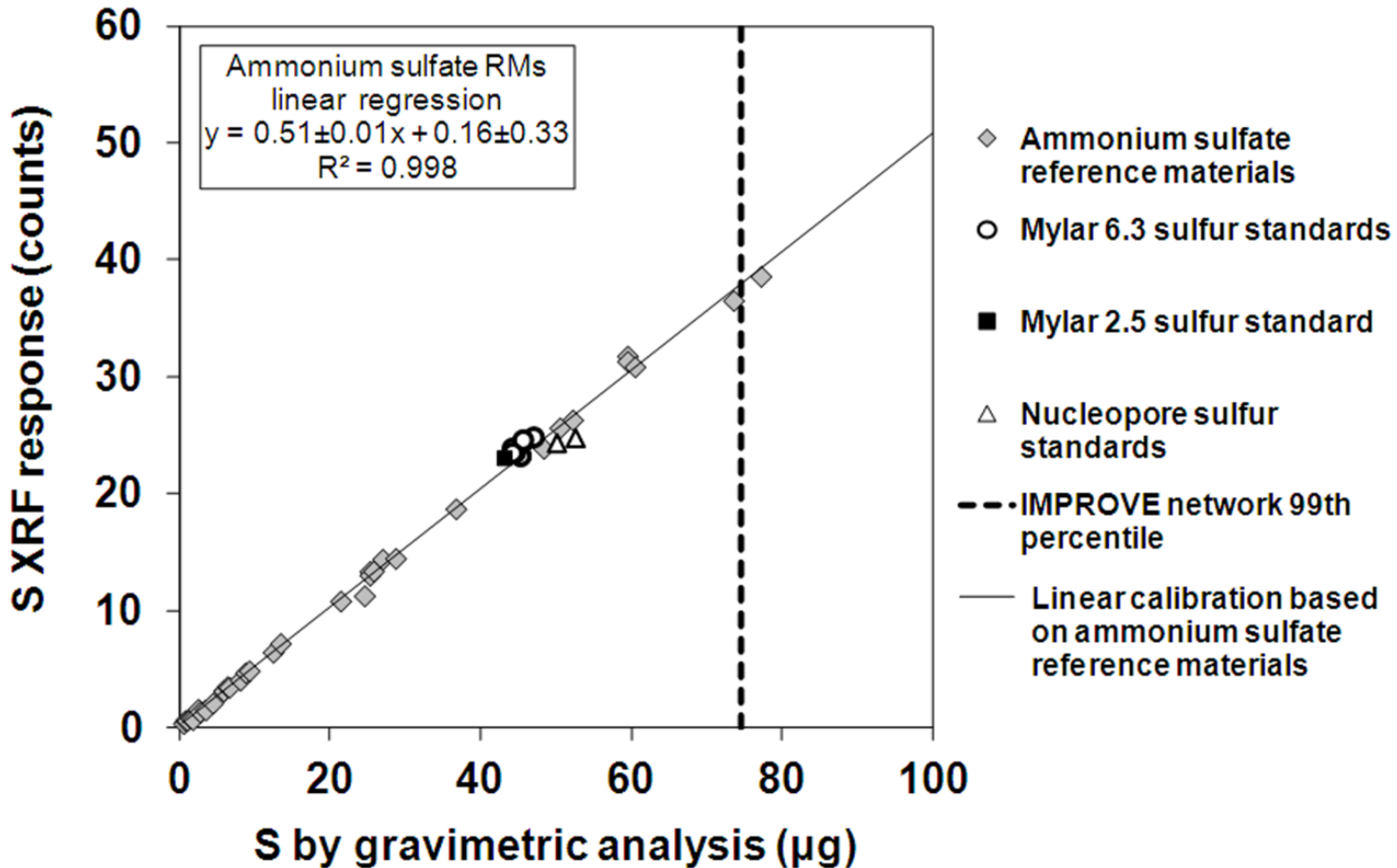
RH Monitor

Analyte Solution

Dilution Air Dryer



Sulfur Reference Filters over IMPROVE range



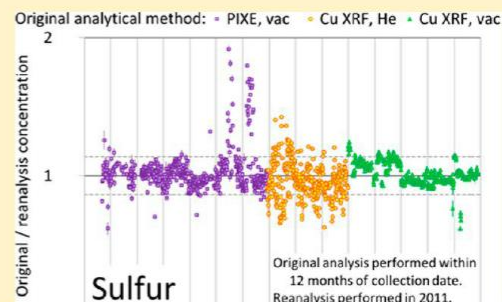
Multi-year sample reanalysis to assess measurement influence on trends

Reanalysis of Archived IMPROVE PM_{2.5} Samples Previously Analyzed over a 15-Year Period

Nicole P. Hyslop,^{*,†} Krystyna Trzepla,[†] and Warren H. White[†]

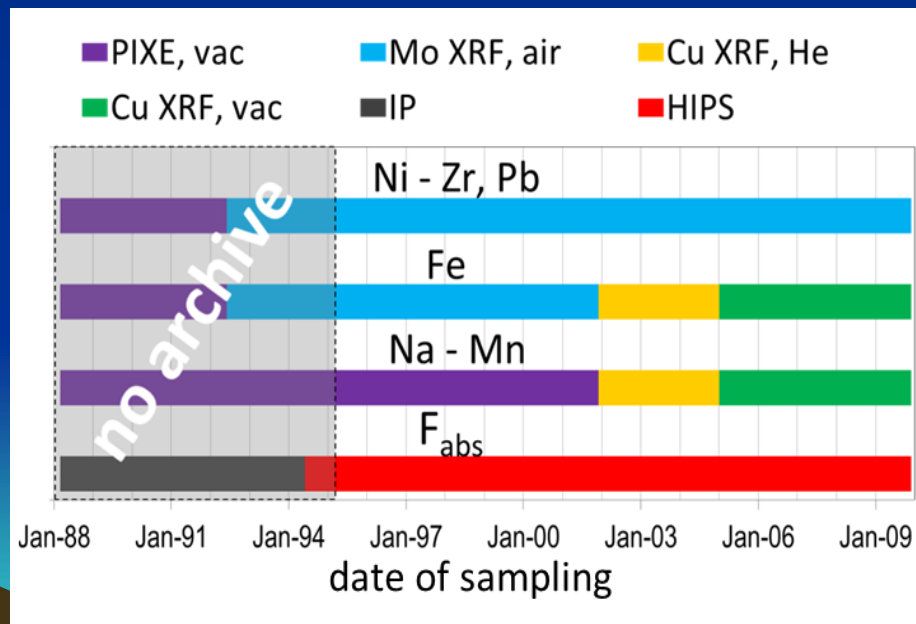
[†]Crocker Nuclear Laboratory, University of California, Davis, California, United States

ABSTRACT: The IMPROVE (Interagency Monitoring of Protected Visual Environments) network has collected airborne particulate matter (PM) samples at locations throughout the United States since 1988. These samples have been analyzed for elemental content using analytical methods that evolved over the years. Changes in analytical methods sometimes introduced shifts in reported concentrations that are evident in the historical record. We sought to illuminate the effects of methodological changes by reanalyzing archived samples with current methods. To test the feasibility of this approach, the 15-year archive of PM samples from Great Smoky Mountains National Park was selected for reanalysis as a single analytical batch using a



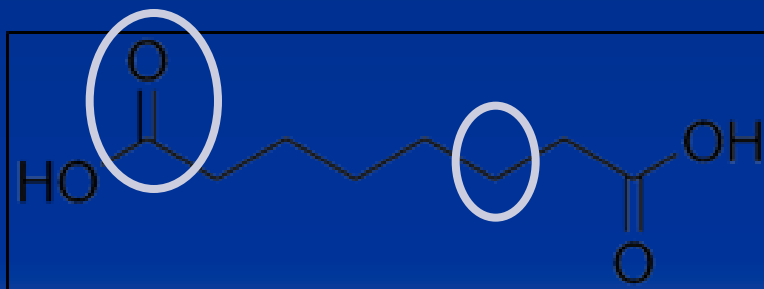
Reanalysis of 15 years of Archived Filters

- Great Smoky Mountains, Mount Rainier, Point Reyes
- Reanalysis under stable conditions and calibration
- Long-term uncertainties not reflected in our precision or collocated measurements



Developing a new carbon measurement: Fourier Transform Infrared (FT-IR) Spectroscopy

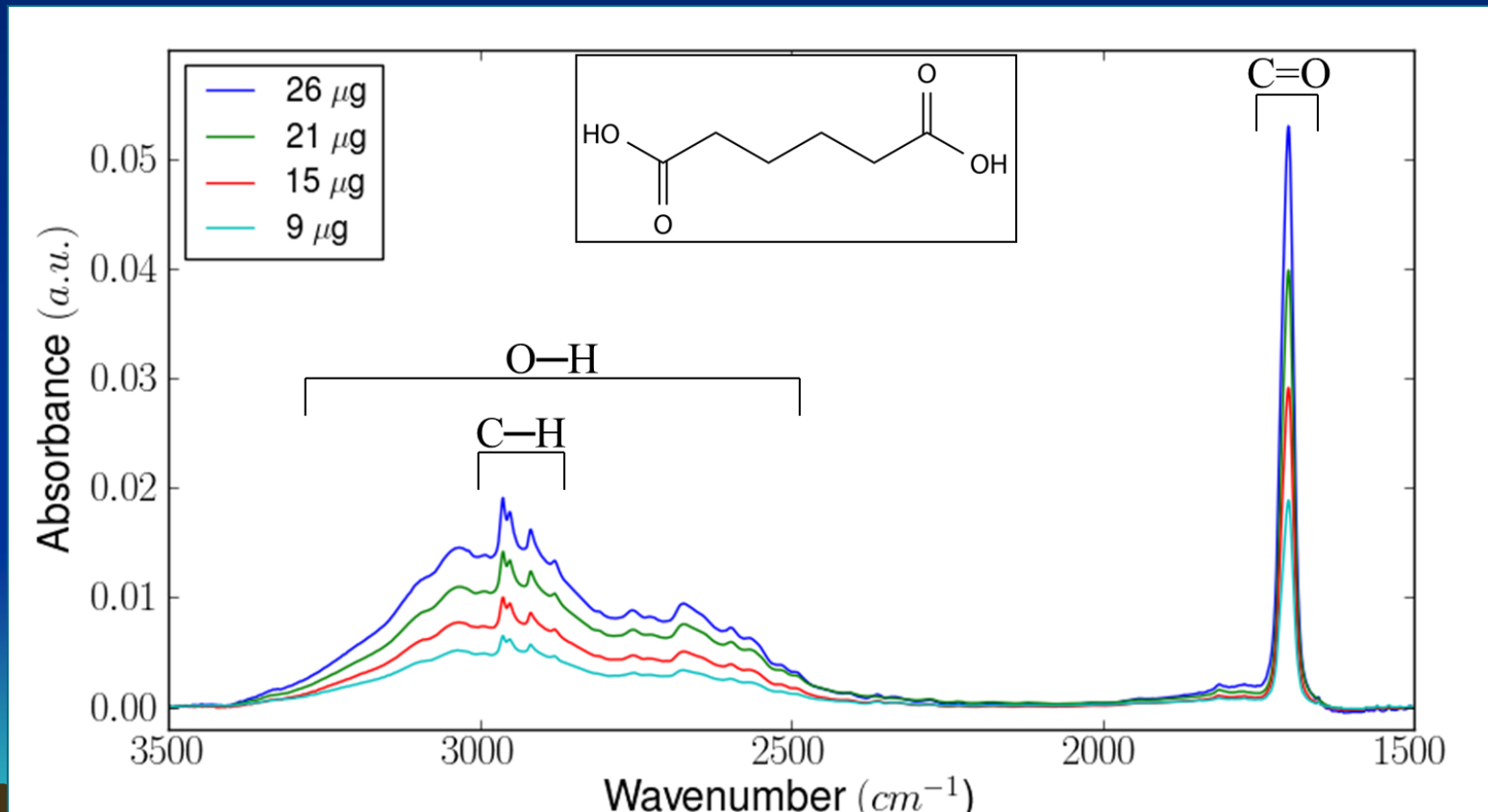
- **Non-destructive** analysis of Teflon[®] filters
- IR absorbances correspond to organic functional groups



Aliphatic C-H
Carbonyl (C=O)
Acid O-H
Alcohol O-H
Organonitrites
Amines
Organosulfate

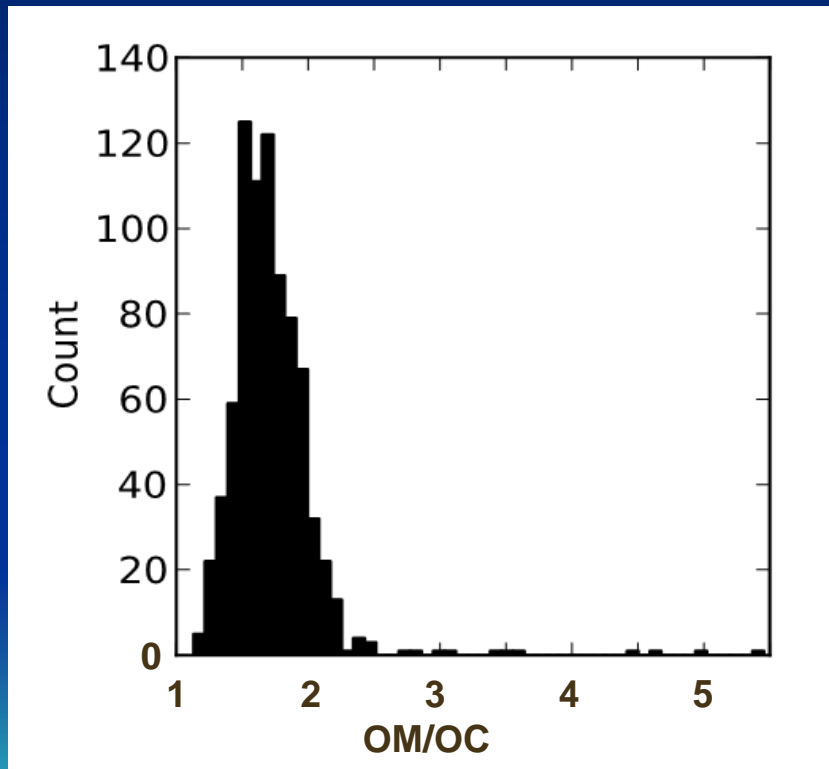
- Sum of functional groups = OM
- Obtain **OM/OC** per sample

FT-IR Spectra – each functional group has a characteristic absorbance



OM/OC varies by sample

Samples for eight
IMPROVE sites in 2011



- OM/OC – annual
 - Median = 1.67
 - IMPROVE uses 1.8
 - 25th percentile = 1.53
 - 75th percentile = 1.86
- OM/OC – site
 - Mesa Verde NP, CO and Olympic NP, WA highest at ~1.8
 - Phoenix, AZ lowest at 1.55
- OM/OC – season
 - Winter (1.6) lower than other seasons (~1.7)



IMPROVE: Our legacy is clear skies