# Atmospheric Science and Chemistry mEasurement NeTwork (ASCENT): Advanced, Ground-based Aerosol Measurement Network Across the U.S.

ASCENT
Atmospheric Science and Chemistry mEasurement NeTwork

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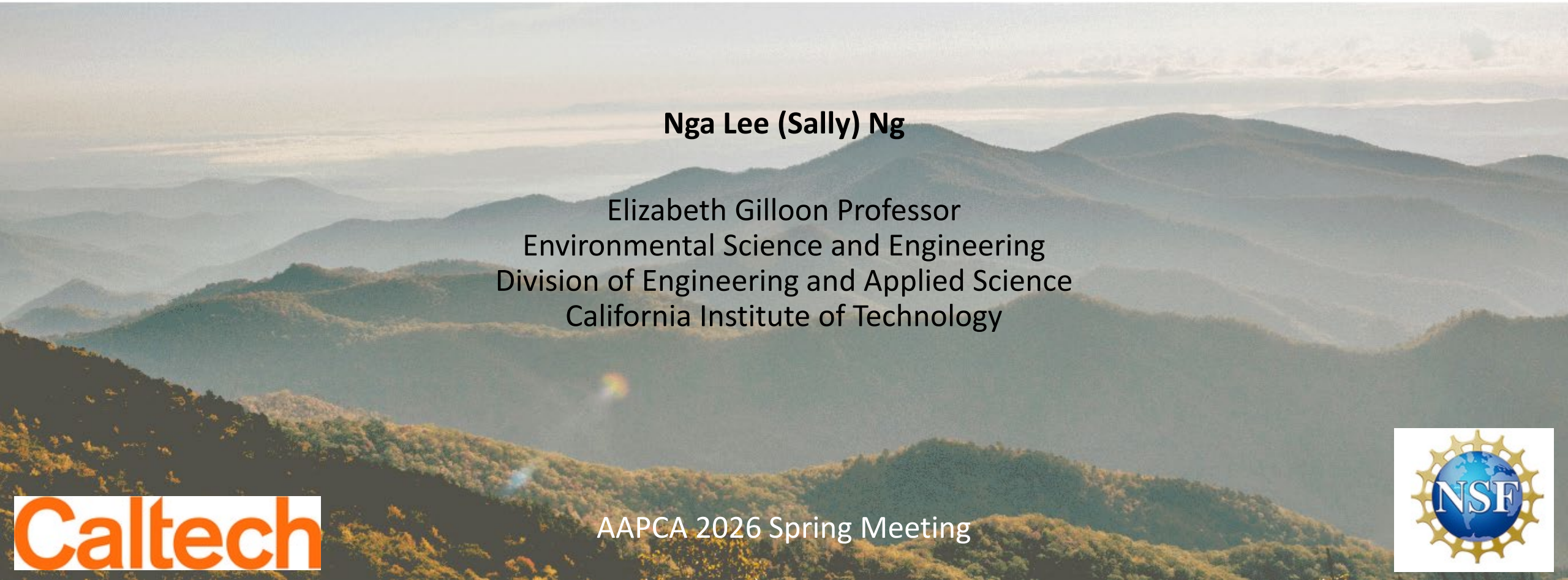


**Nga Lee (Sally) Ng**

Elizabeth Gilloon Professor
Environmental Science and Engineering
Division of Engineering and Applied Science
California Institute of Technology

Caltech

AAPCA 2026 Spring Meeting

NSF

# Atmospheric Science and Chemistry mEasurement NeTwork (ASCENT): Advanced, Ground-based Aerosol Measurement Network Across the U.S.

ASCENT
Atmospheric Science and Chemistry mEasurement NeTwork



**PI: Nga Lee (Sally) Ng, California Institute of Technology**

**Steering Committee**:
Nga Lee (Sally) Ng, California Institute of Technology
Roya Bahreini, University of California, Riverside
Ann Dillner, University of California, Davis
Armistead Russell, Georgia Institute of Technology
Sean Raffuse, University of California, Davis

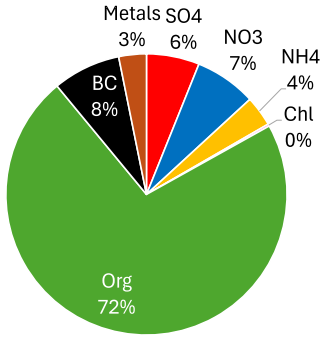
**Site/Instrument Mentors**: Richard Flagan (California Institute of Technology), James Flynn (University of Houston), Drew Gentner (Yale University), Robert Griffin (Roger Williams University), Lelia Hawkins (Harvey Mudd), Jose Jimenez (University of Colorado, Boulder), Jingqiu Mao (University of Alaska, Fairbanks), Shane Murphy (University of Wyoming), Albert Presto (Carnegie Mellon University), Allen Robinson (Carnegie Mellon University), John Seinfeld (California Institute of Technology), Jason Surratt (University of North Carolina, Chapel Hill), Joel Thornton (University of Washington)

**Database**: Sean Raffuse, Veronica Scott, Rudi De Marco (University of California, Davis); Bob Dattore (National Center for Atmospheric Research)

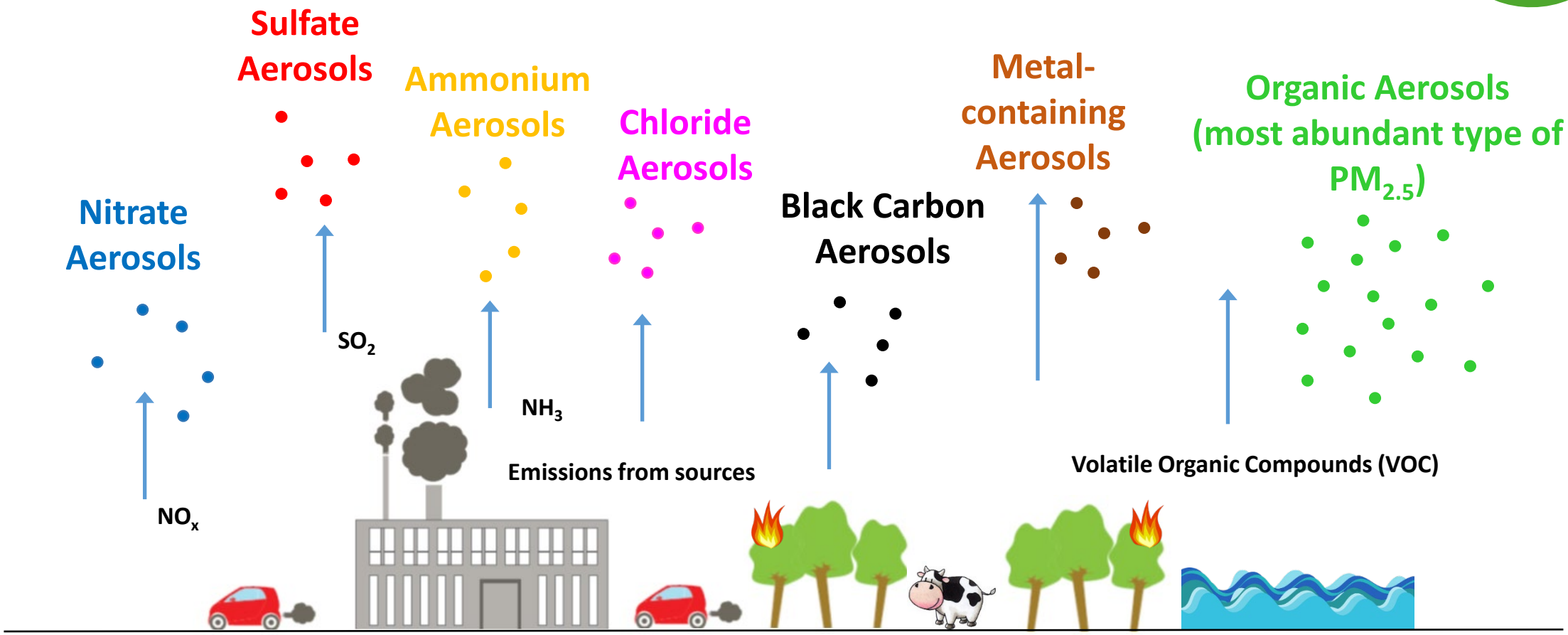
**Collaboration Networks**: NCore, IMPROVE, PAMS, SCAQMD, NEON, HNET, CASTNET, NATTS, AERONET, ACTRIS

NSF

# Chemical Diversity of $PM_{2.5}$




Data from Atlanta



# Objectives

- Establish a **new, long-term, ground-based aerosol monitoring network** in the US for comprehensive and high time-resolution (minutes) characterization of aerosol chemical composition and physical properties

- Develop a standardized framework for advanced aerosol measurement **protocols**, create a **database** for data discovery and visualization, and long-term data preservation

- **Enhance training** of students and current professionals engaged in atmospheric, climate, and air quality research

- Catalyze and support future development of an integrated and long-term atmospheric observation research infrastructure for aerosols and trace gases in the US and to **strengthen collaborations with international atmospheric observation networks**

# Project Timeline

**Oct 2021**

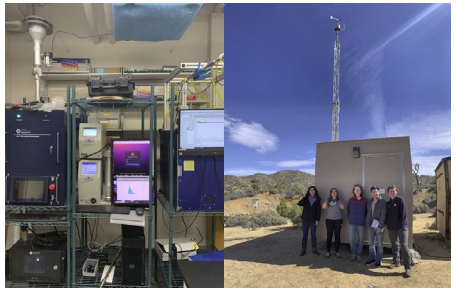
Phase 1 ($12M) started

**Dec 2022**

First site operational

**Jan 2023**

All instruments delivered to universities



**May 2024**

All sites operational

**Oct 2025**

Phase 2 ($13M) started

# ASCENT Site Map

**Leverage Existing Sites/Infrastructure**

**NCore**: National Core Network
- $PM_{2.5}$ mass and speciation; $O_3$, CO, $SO_2$, NO, and $NO_y$

**PAMS**: Photochemical Assessment Monitoring Stations, VOCs

**IMPROVE**: Interagency Monitoring of PROtected Visual Environment network
- $PM_{2.5}$ mass; gas-phase measurements

**SCAQMD**: South Coast Air Quality Management District

**NEON**: National Ecological Observatory Network

**HNET**: Houston Network of Environmental Towers

# Site Selection

| Site Number | Local Site Name | Current Network | Instrument Mentor | Comments |
|---|---|---|---|---|
| 1 | Delta Junction, AK | NEON, AERONET | Jingqiu Mao | Remote, arctic, background, boreal forest, intercontinental transport, EPSCoR |
| 2 | Cheeka Peak/ Makah | NCore, IMPROVE | Joel Thornton | Marine background/inflow, smoke at times, tribal site |
| 3 | Los Angeles-Pico Rivera | SCAQMD | Nga Lee Ng & Rick Flagan | Paired site 1: urban, anthropogenic, VCP, wildfires |
| 4 | Rubidoux | SCAQMD, NCore, PAMS | Roya Bahreini | Paired site 2: urban, anthropogenic, aged OA, wildfires |
| 5 | Joshua Tree | IMPROVE, CASTNET | Lelia Hawkins & Roya Bahreini | Paired site 3: aged OA, downwind of LA and Riverside |
| 6 | Yellowstone NP 2 | IMPROVE, CASTNET | Shane Murphy | Background site with wildfires, EPSCoR |
| 7 | La Casa | Ncore, CDPHE | Jose Jimenez | Urban, wintertime pollution, oil and gas, wildfires, agriculture |
| 8 | Houston-UH West Liberty | HNET, PGN | Jimmy Flynn & Robert Griffin | Urban, petrochemical industry, maritime shipping |
| 9 | Lawrenceville | NCore, IMPROVE, PAMS, NATTS, PGN | Albert Presto & Allen Robinson | Urban, oil and gas, fracking, heavy industry |
| 10 | Queens College 2 | NCore, AERONET, PGN | Drew Gentner | Urban, coastal, VCP |
| 11 | South DeKalb | NCore, IMPROVE, PAMS, NATTS, PGN | Nga Lee Ng | Paired site 1: urban, biogenic |
| 12 | Great Smoky Mountains NP - Look Rock | Ncore, IMPROVE, CASTNET | Jason Surratt | Paired site 2: background, biogenic |

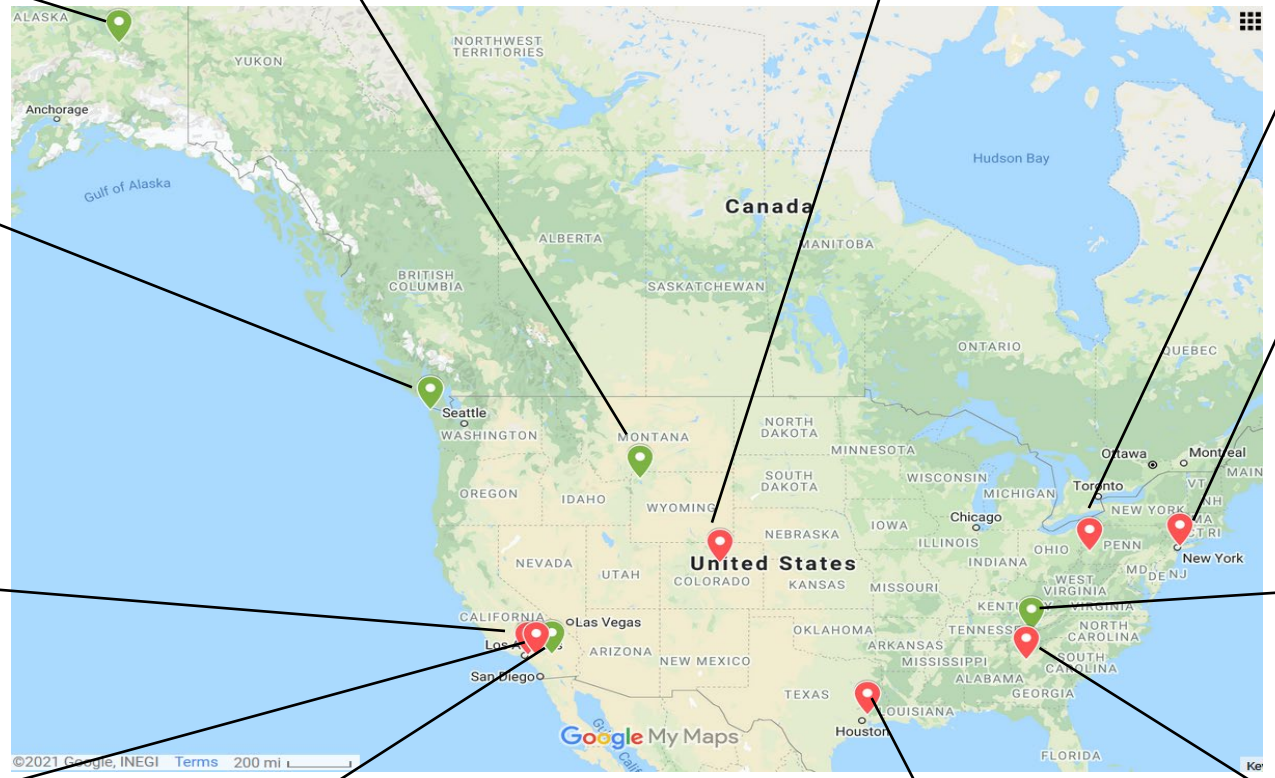

Delta Junction


Yellowstone


La Casa (Denver)


Lawrenceville (Pittsburgh)


Cheeka Peak/ Makah


ALASKA
NORTHWEST TERRITORIES
YUKON
Anchorage
Gulf of Alaska
Hudson Bay
Canada
ALBERTA
MANITOBA
BRITISH COLUMBIA
SASKATCHEWAN
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QUEBEC
Seattle
WASHINGTON
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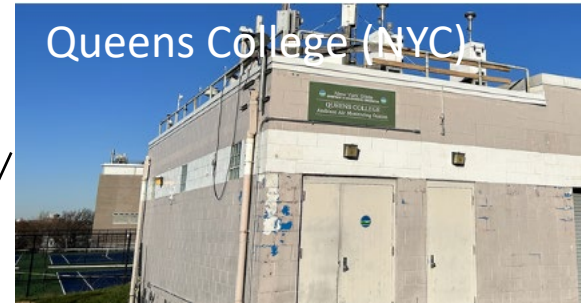

Queens College (NYC)


Los Angeles-Pico Rivera


Great Smoky Mountains


Rubidoux (Riverside)

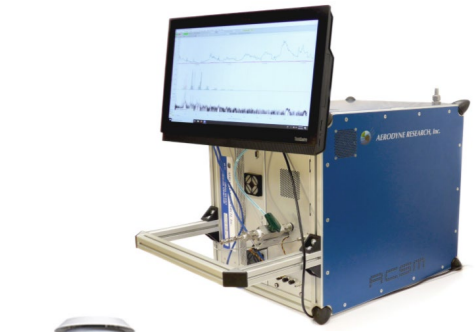

Joshua Tree


Houston


South DeKalb (Atlanta)

# ASCENT Instrumentation

| Instrument | Model and Manufacturer | Measurements |
|---|---|---|
| **Aerosol Chemical Speciation Monitor (ACSM), $PM_{2.5}$** | ToF-ACSM, Aerodyne Research | Organics, sulfate, nitrate, ammonium, chloride |
| **Xact, $PM_{2.5}$** | 625i, Cooper Environmental | Trace metals: Sb, As, Ba, Cd, Ca Cr, Co, Cu, Fe, Pb, Hg, Mn, Ni, Se, Ag, Sn, Ti, Tl, V, Zn, more available |
| **Aethalometer, $PM_{2.5}$** | AE33, Magee Scientific | Wavelength-dependent absorption; black and brown carbon |
| **Scanning Mobility Particle Sizer (SMPS), $PM_1$** | 3938W89, TSI | Particle number size distribution, number concentration |



# Aerosol Chemical Speciation Monitor (ACSM)

- Quantitative, continuous measurement of non-refractory aerosols
  - Organics, Sulfate, Nitrate, Ammonium, Chloride
- Developed for long-term, autonomous, and routine monitoring of ambient aerosols
- Outputs time-resolved mass concentration of each aerosol species and mass spectra
- Separation and quantification of different types of organic aerosol components

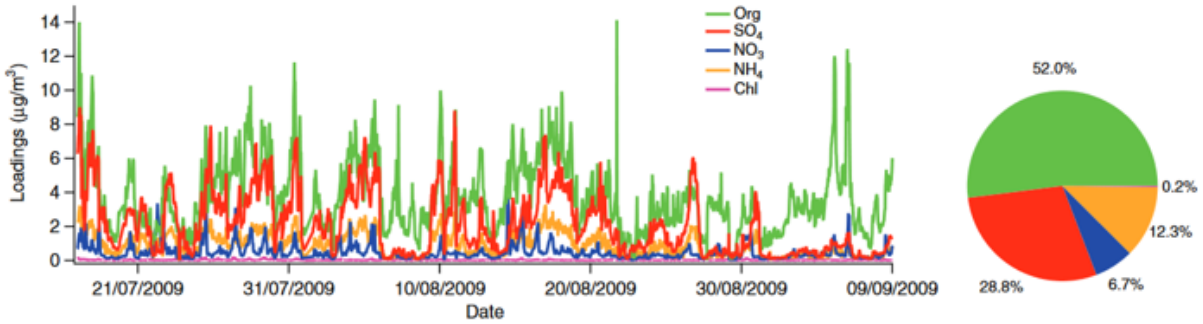
*Aerosol Science and Technology*, 45:780–794, 2011

ISSN: 0278-6826 print / 1521-7388 online
DOI: 10.1080/02786826.2011.560211

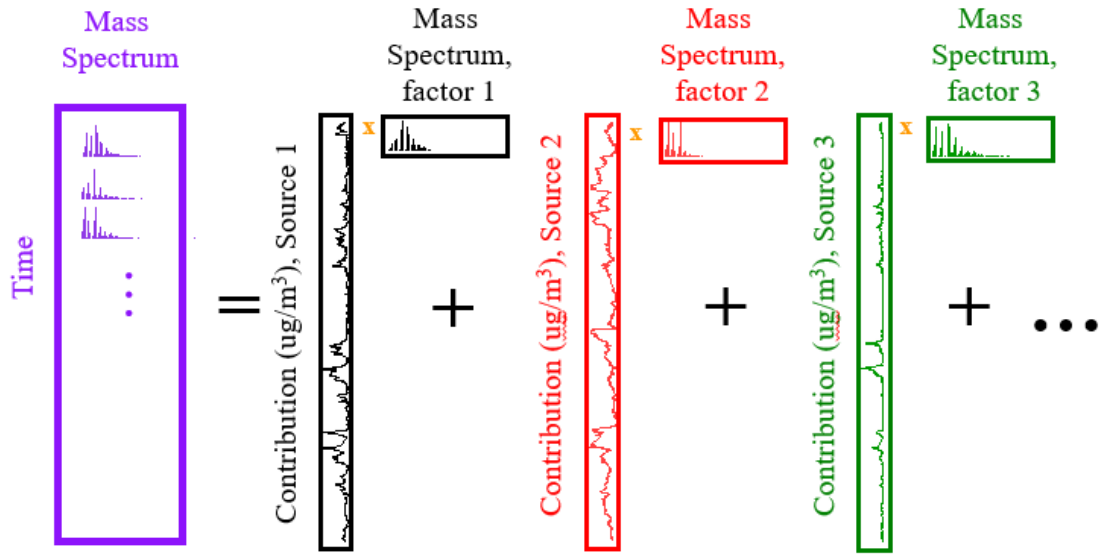
**An Aerosol Chemical Speciation Monitor (ACSM) for Routine Monitoring of the Composition and Mass Concentrations of Ambient Aerosol**

N. L. Ng,[1] S. C. Herndon,[1] A. Trimborn,[1] M. R. Canagaratna,[1] P. L. Croteau,[1] T. B. Onasch,[1] D. Sueper,[1,2] D. R. Worsnop,[1] Q. Zhang,[3] Y. L. Sun,[3] and J. T. Jayne[1]

[1]*Aerodyne Research, Inc., Billerica, Massachusetts, USA*
[2]*CIRES, University of Colorado, Boulder, Colorado, USA*
[3]*Department of Environmental Toxicology, University of California, Davis, California, USA*



# Source Apportionment of Organic Aerosols




Unique mass spectral features, diurnal trends, correlations with external tracers, etc.

**Positive Matrix Factorization (PMF)** is a bilinear mixing model in which a dataset matrix is assumed to be comprised of the linear combination of factors with constant profiles that have varying contributions across the dataset.

Ulbrich et al. 2009, ACP

**Different Subtypes of Organic Aerosols**

- BBOA: Biomass burning OA
- COA: Cooking OA
- HOA: Hydrocarbon-like OA

**POA**

- LO-OOA: Less-oxidized oxygenated OA
- **MO-OOA: More-oxidized oxygenated OA**
- **Isop-SOA: Isoprene-SOA (biogenics)**

**SOA**

# Xact

- High time-resolution **multi-metals** monitoring of ambient aerosols

- Uses reel-to-reel filter tape sampling and nondestructive energy dispersive X-ray fluorescence (EDXRF) analysis

# Aethalometer

- Provides simultaneous measurement of attenuation of transmitted light at wavelengths of 370, 470, 520, 590, 660, 880, and 950 nm

- **Black carbon and brown carbon mass concentrations**

- Discerning fossil fuel from biomass combustion including forest fires, prescribed burns, and wood burning stoves/fireplaces because of the high contribution of brown carbon to absorption in these emissions

# Scanning Mobility Particle Sizer (SMPS)

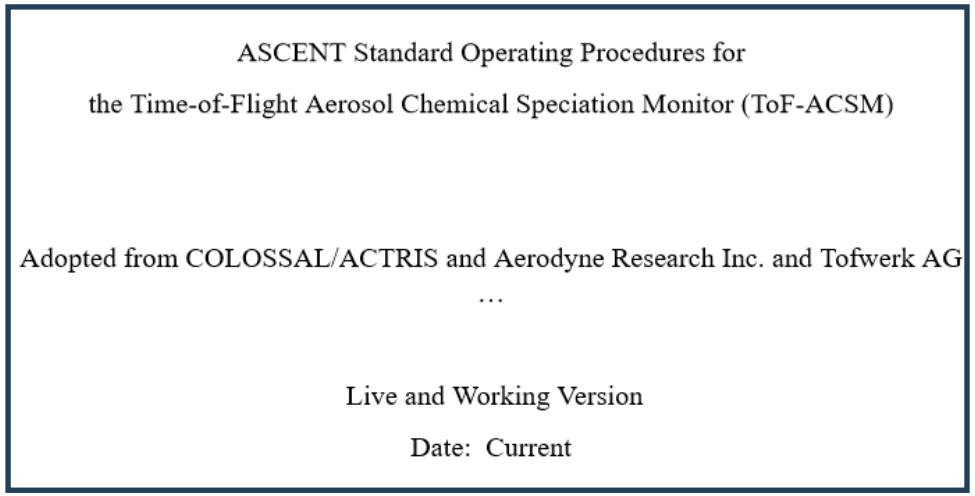
- Real-time measurements of **size distributions and volume concentrations** of aerosols in the 10-1,000 nm size range (mobility diameter)

- Consists of a Differential Mobility Analyzer (DMA) and a Condensation Particle Counter (CPC) – distilled water used as a working fluid

- A wide concentration range of up to $10^7$ particles/$cm^3$

# Standard Operation Procedures (SOP)

- SOP for instrumentation installation, QA/QC, calibration and maintenance
- SOP for networking and communication between instruments and central PC
- Weekly checklist and site visit checklist for each instrument
- Data analysis SOP
- Will release all SOP freely and openly on ASCENT website in the near future


ASCENT Standard Operating Procedures for

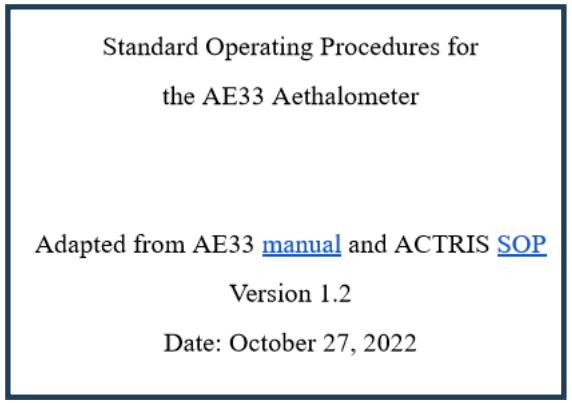
the Time-of-Flight Aerosol Chemical Speciation Monitor (ToF-ACSM)

Adopted from COLOSSAL/ACTRIS and Aerodyne Research Inc. and Tofwerk AG

…

Live and Working Version

Date: Current

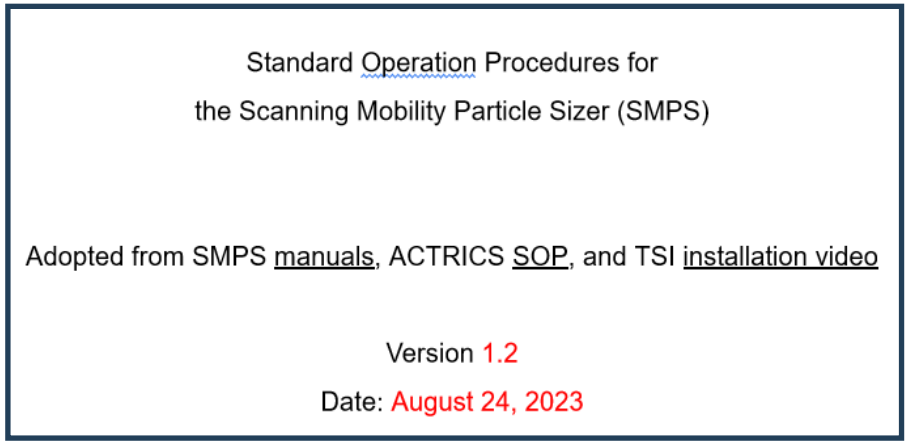

Standard Operating Procedures for

the AE33 Aethalometer

Adapted from AE33 manual and ACTRIS SOP

Version 1.2

Date: October 27, 2022

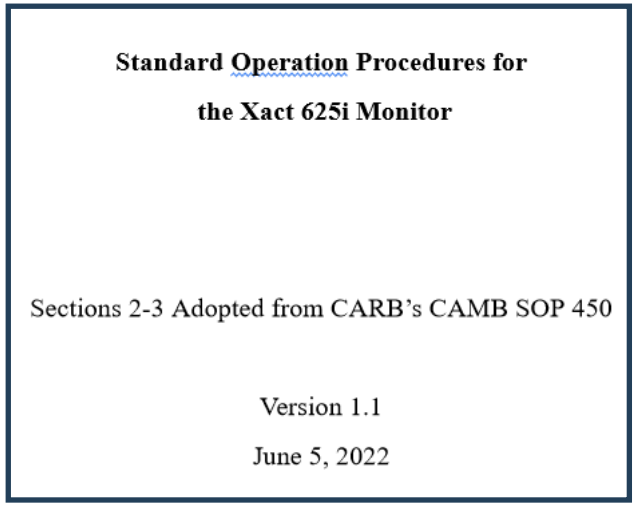

Standard Operation Procedures for

the Scanning Mobility Particle Sizer (SMPS)

Adopted from SMPS manuals, ACTRICS SOP, and TSI installation video

Version 1.2

Date: August 24, 2023

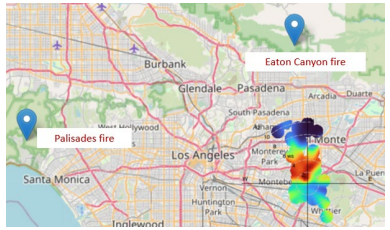

**Standard Operation Procedures for**

**the Xact 625i Monitor**

Sections 2-3 Adopted from CARB's CAMB SOP 450

Version 1.1

June 5, 2022




ASCENT LA Site at Pico Rivera

~14 miles south of Eaton Fire

CDC Morbidity and Mortality Weekly Report (*MMWR*)

# *Notes from the Field:* Elevated Atmospheric Lead Levels During the Los Angeles Urban Fires — California, January 2025

*Weekly* / February 20, 2025 / 74(5);69–71

Print

Haroula D. Baliaka[1]; Ryan X. Ward[1]; Roya Bahreini[2]; Ann M. Dillner[3]; Armistead G. Russell[4]; John H. Seinfeld[1]; Richard C. Flagan[1]; Paul O. Wennberg[1]; Nga L. Ng[4] (VIEW AUTHOR AFFILIATIONS)

View suggested citation

## Summary

**What is already known about this topic?**

Smoke is a complex mixture of gases and airborne particulate matter; urban fires and conventional wildfires emit different air pollutants. The Atmospheric Science and Chemistry mEasurement NeTwork (ASCENT), a new, advanced air quality measurement network, provides real-time measurements of the chemical constituents in fine particulate matter ($PM_{2.5}$).

**What is added by this report?**

During the January 2025 Los Angeles fires, ASCENT recorded an approximate 110-fold increase in $PM_{2.5}$ lead levels compared with values from the previous few days.

**What are the implications for public health practice?**

Urban fires emit air pollutants that pose risks different from those of conventional wildfires. It is important for epidemiologic studies to consider $PM_{2.5}$ composition when assessing the impacts of urban fire smoke exposure. Health officials should communicate protective measures to the public (monitor air quality forecasts and follow guidance by local emergency management officials).

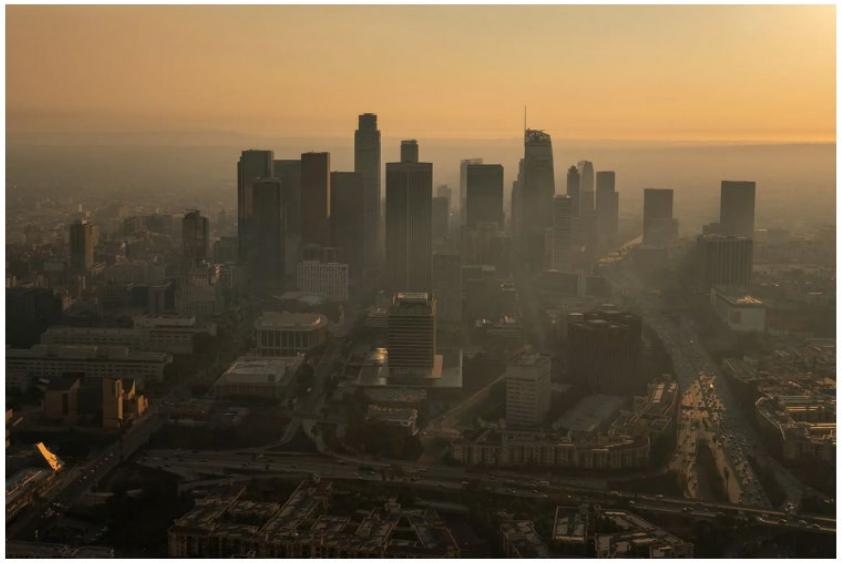
The New York Times

## *Airborne Lead and Chlorine Levels Soared as L.A. Wildfires Raged*

The findings give new insight into the dangers of urban wildfires that burn plastics and other chemicals in homes and property.

Listen to this article · 3:01 min Learn more

Share full article



Researchers used a new network of sensors to track chemicals in the Los Angeles air in real time. Loren Elliott for The New York Times

Morbidity and Mortality Weekly Report (*MMWR*)

Search

# *Notes from the Field:* Elevated Atmospheric Lead Levels During the Los Angeles Urban Fires — California, January 2025

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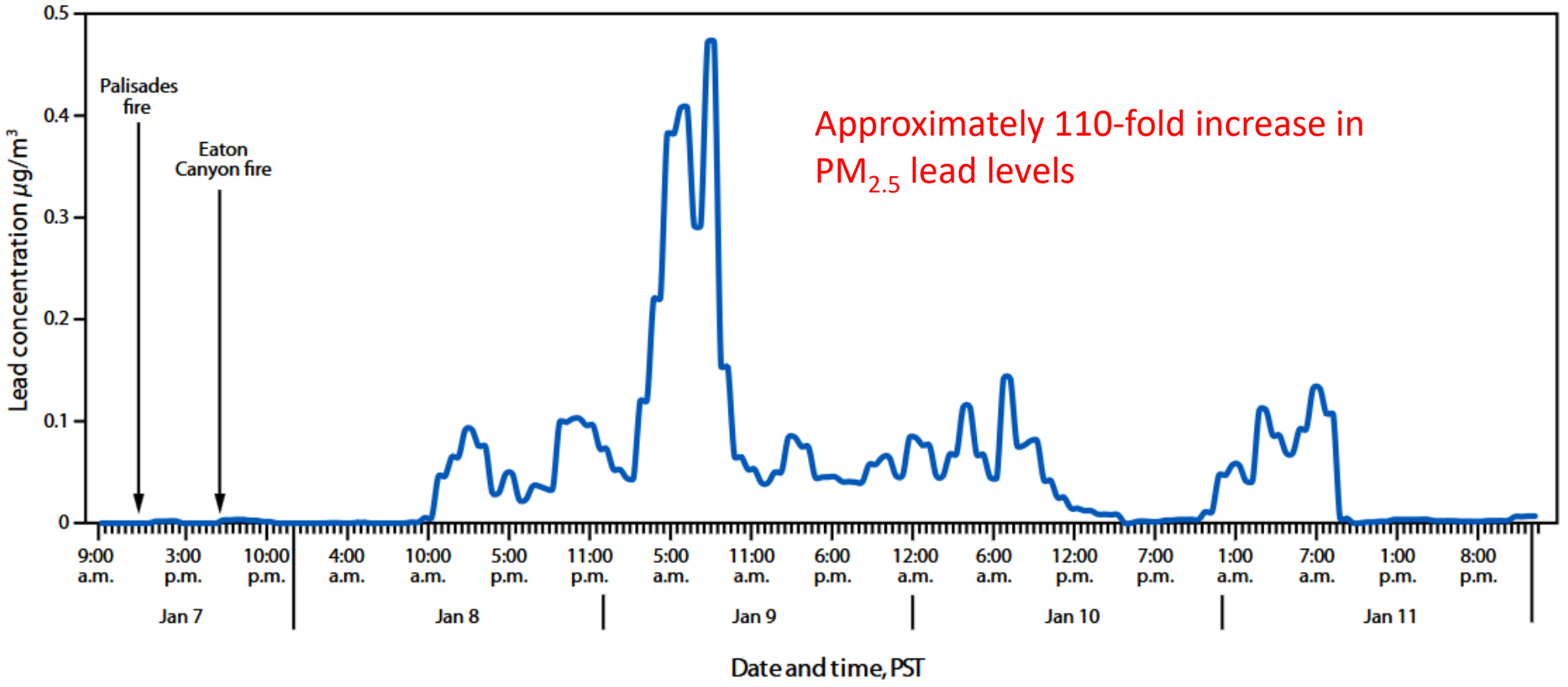
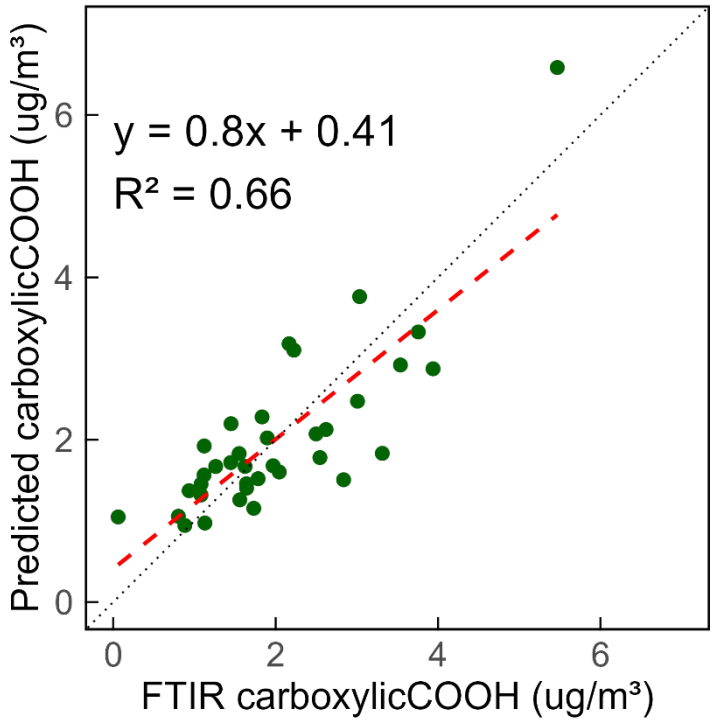



Approximately 110-fold increase in $PM_{2.5}$ lead levels

# Value-Added Products

- Develop parameterizations of ACSM data to increase the chemical resolution of organic aerosols from the ACSM
  - Analyze organic functional groups in parallel by FT-IR (filter samples)
  - Predict functional groups from ACSM mass spectra




*Na Mao, Ann Dillner*

- Near real-time source apportionment
  - Started source-apportionment analysis (offline)

# ASCENT Data Infrastructure

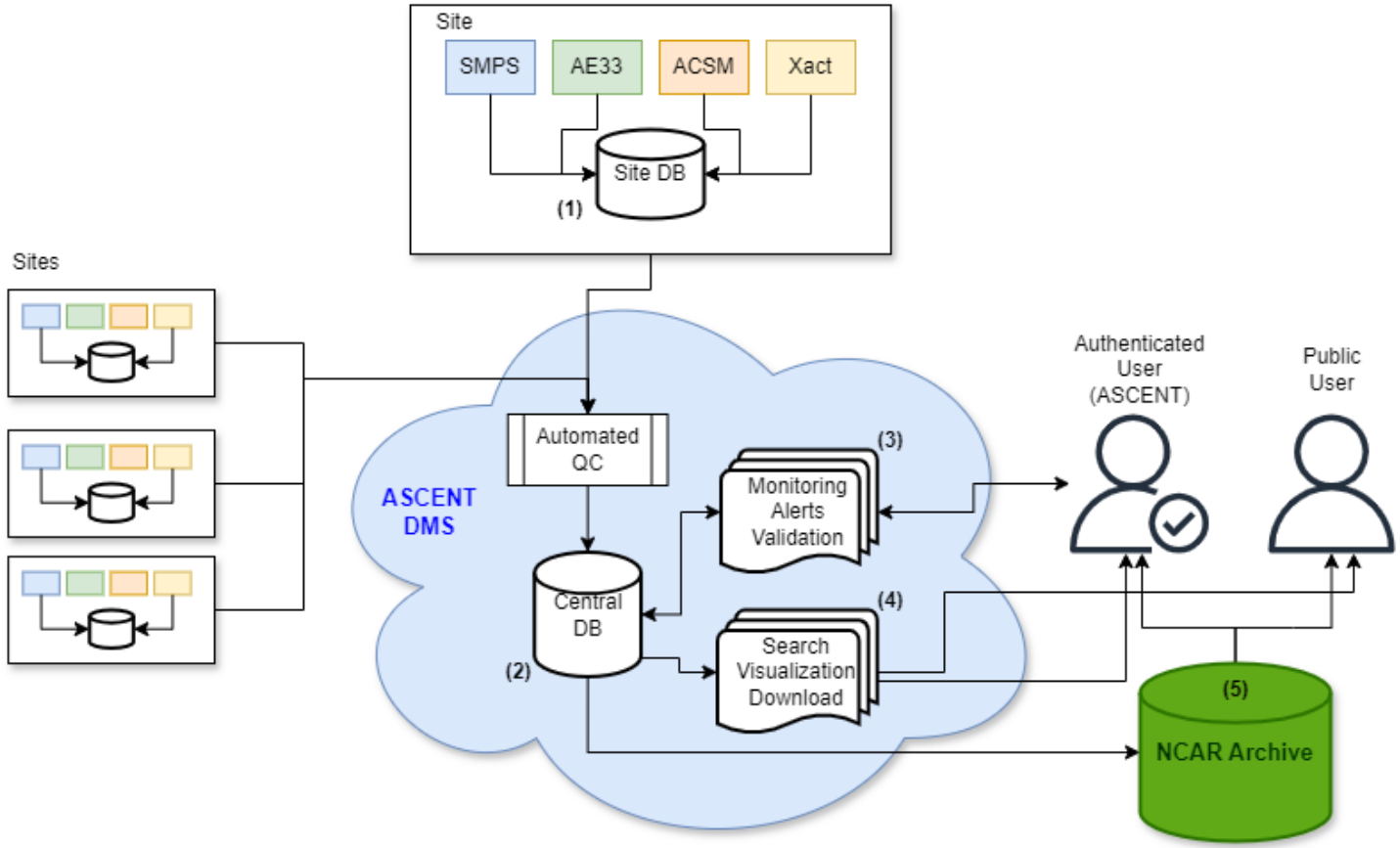
Four data levels

(0) raw data

(1) real time data with automated QA/QC

(2) annual validated data at native and hourly time resolutions

(3) value-added data products



# Summary and Outlook

- As of May 2024, all sites were established and sampling; data analysis ongoing

- Substantial effort spent on instrument SOP, data analysis SOP, and intercomparison SOP
  - Instrument intercomparison; Comparison of data with those from existing networks

- Data Management System
  - Preliminary data can be requested via ASCENT website
  - Developing data transfer to NCAR
  - Aim to have data publicly available in Spring/Summer 2026

- ASCENT Phase 2: 2025-2030
  - Operation and management of the network
  - Conduct scientific studies to investigate aerosol sources and properties across all ASCENT sites
  - Continue to build collaborations with academia, government, industry, and public

# Thank you!