ASCENT (Atmospheric Science and Chemistry mEasurement NeTwork): A new long-term, ground-based high time-resolution air quality monitoring network

ASCENT Team:

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IMPROVE Steering Committee Meeting, November 9-10, 2021, virtual

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ASCENT: A new long-term, ground-based high time-resolution air quality monitoring network

- Long-term
    - 3 year NSF Infrastructure grant ($12M)
    - 10+ year plan with anticipated funding from NSF
- Ground- based
    - 12 sites measuring PM2.5 (map and list on following pages)
    - Use sites in existing networks
    - Leverage existing measurements, infrastructure, personnel
    - Provides additional data for these sites
    - IMPROVE, NCore/PAMs, SCAQMD, NEON (NSF National Ecological Observatory Network), HNET (Houston Network of Environmental Towers)

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IMPROVE sites:
Cheeka Peak/Makah, WA
Joshua Tree NP, CA
Yellowstone NP, WY
Great Smoky Mountain NP, NC

NCore/CSN sites/PAMS:
Rubidoux, CA
La Casa, Denver, CO
Lawrenceville, Pittsburgh, PA
Queens College 2, NYC, NY
South DeKalb, Atlanta, GA

NEON: Delta Junction, AK

SCAQMD: Los Angeles - Pico Rivera, CA

HNET: Houston, TX

https://research.gatech.edu/12-million-nsf-grant-will-establish-nationwide-atmospheric-measurement-network

Sites – why we chose these

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

EPSCoR = NSF designation of states, territories targeted for strengthening STEM capacity and capability.

VCP = Volatile Chemical Products (cleaning, personal care products)

High Time-Resolution Aerosol Instrumentation

Instrument	Model and Manufacturer	Measurements	Typical Data Rate	Detection limit (30 min)	Calibration Frequency
Aerosol Chemical Speciation Monitor (ACSM)	ToF-ACSM, Aerodyne Research	Organics, sulfate, nitrate, ammonium, chloride	10 min	< 30 ng m^{-3}	Quarterly
Xact	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	15-240 min	< 10 ng m^{-3} for key metals	Quarterly
Aethalometer	AE33, Magee Scientific	Wavelength-dependent absorption; black and brown carbon	1 sec or 1 min	5.5 ng m^{-3} of BC (5 lpm)	Quarterly
Scanning Mobility Particle Sizer (SMPS)	3938L89, TSI	Particle number size distribution, number concentration	3 min (full scan)	< 1 cm^{-3}	Quarterly

Aerosol Chemical Speciation Monitor (ACSM)

Continuous online measurements

Non-refractory PM

    organics aerosol (OA)

        HOA – hydrocarbon like

        OOA – oxygenated

    inorganic ions

Minimal maintenance and remote control/data acquisition
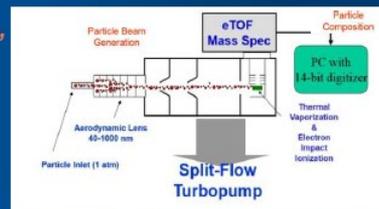
Simpler to maintain and operate than the AMS

First deployed ~10 years ago

Upgrade site infrastructure as needed

- New or upgraded trailer
- Wifi
- Power
- Meteorological measurements

Cheeka Peak/Makah site photo

IMPROVE trailer

old trailer, possibly usable, needs repairs

NCORE trailer

Unusable trailer

(Courtesy of Odelle Hadley)

Site Operators

- Involved in decision to include site in network
- Site mentors and graduate students will train to operate to operate and do simple maintenance on instrumentation
- Provide eyes at the site if something goes wrong
- Modest pay for additional work

Joshua Tree site

Data infrastructure developed during project

- open and free access to the ASCENT data
- automated data quality assurance/control
- upload/download
- discovery/visualization
- long-term data preservation
- Hosted by NCAR

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# FT-IR to enhance organics information from ACSM

- Organic functional groups measured from filters (except AK).

- Functional groups complementary to ACSM organics data

- Laboratory and smog chamber samples analyzed in parallel by FT-IR and ACSM will be used to:

  - Improve FT-IR functional group measurements

  - Develop parameterizations of ACSM data to increase the chemical resolution of OA from the ACSM

- Parameterizations incorporated into the routine ACSM data analysis tools for chemical composition and source apportionment as part of the ASCENT data infrastructure.
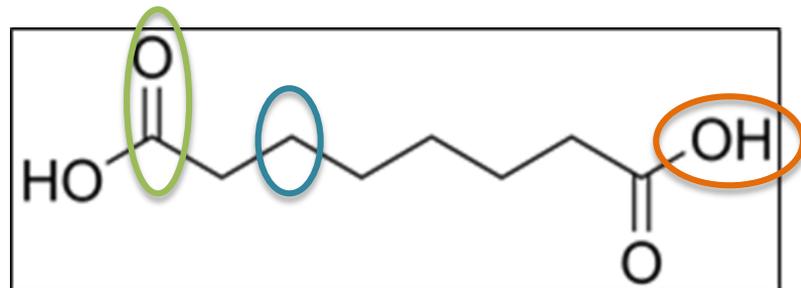
Real-time Source Apportionment

- SoFi (Source Finder software, Datalystica)

- utilizes data from ACSM, Xact, aethalometer, and SMPS

- uses gas phase data available at all sites

- performs deconvolution by applying the PMF algorithm governed through the multilinear engine (ME-2)

Example of Source Apportionment from AMS data
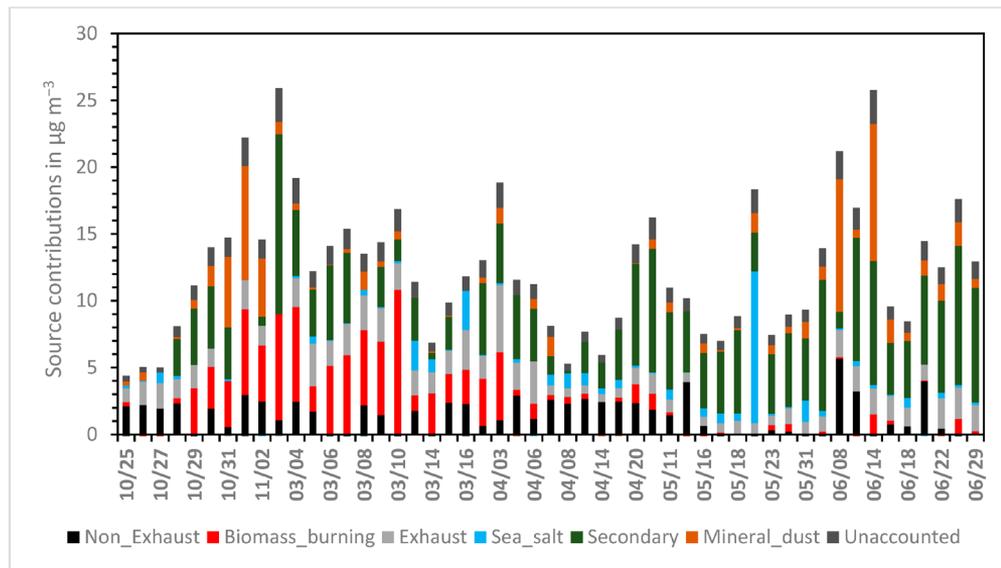
Manousakas et al., 2020

Science and Outreach

- Data from ASCENT will address questions related to:
    - changes in composition and abundance of aerosols,
    - changes in sources, for example
        - modernization of electrical production (coal to NG to renewable)
        - transportation (gasoline to electric vehicles)
    - process-level understanding of aerosols in response to changes in infrastructure, energy systems, and land use/coverage
    - impacts on health and climate-relevant variables
- Education and outreach
    - Career development for grad students, focus on underrepresented
    - At Cheeka Peak/Makah, train tribal air quality staff and perform outreach to interested tribal members.

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ASCENT organizational chart
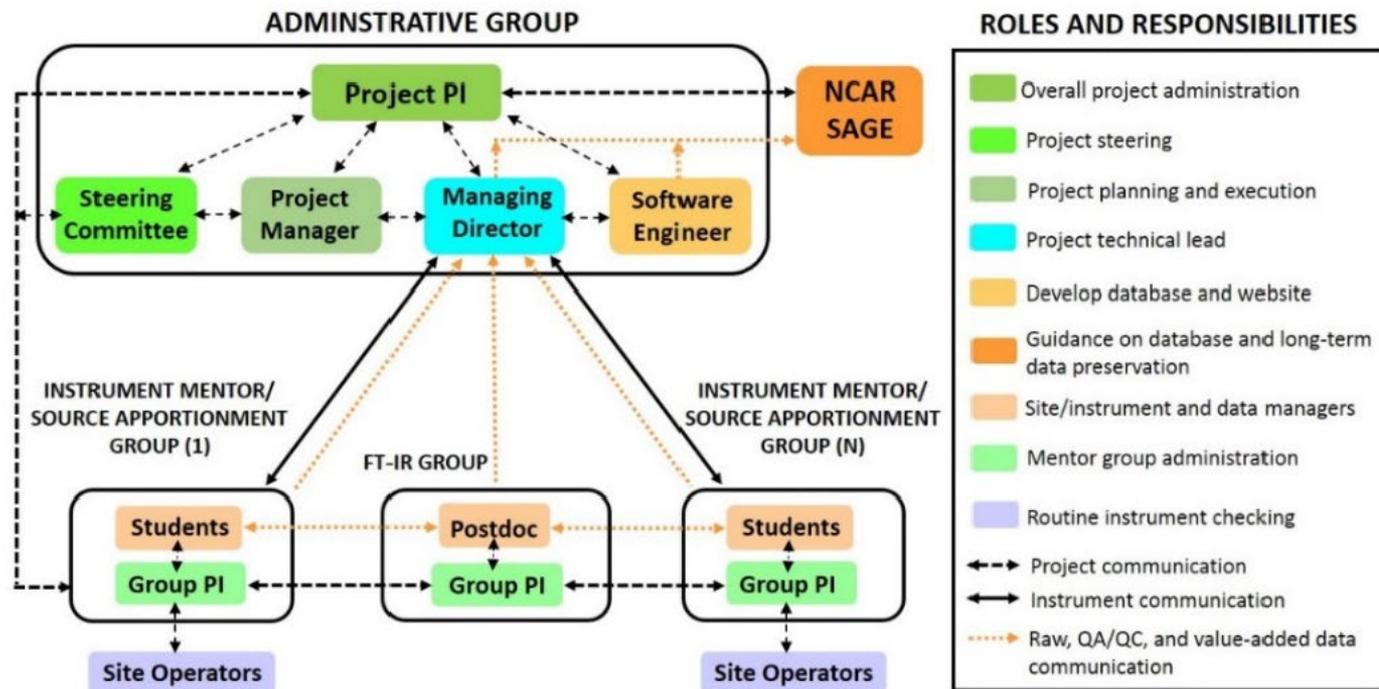
Timeline

Year 1 – purchase, test and install instruments at sites, web page, database development begins

Year 2 – instruments operational, begin training operators, FT-IR lab and smog chamber studies, database operational, source apportionment work begins

Year 3 – instruments operational, continued training of operators, FT-IR parameterization development, database development, source apportionment work finalized

Deliverables from ASCENT

- 12 sites with operational ACSM, Xact, aetholometer, SMPS instruments
  - Support infrastructure such as power, wifi, weather data
  - Trained operators
- Database and user interface
  - High-time resolution organics (with FTIR parameterization), sulfate, nitrate, ammonium, chloride, trace metals, light absorption, black and brown carbon, size distribution and number concentration
  - High-time resolution source apportionment

Data to be used by researchers to answer science questions

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ACTRIS - Aerosol, Clouds, Trace gases Research Infrastructure
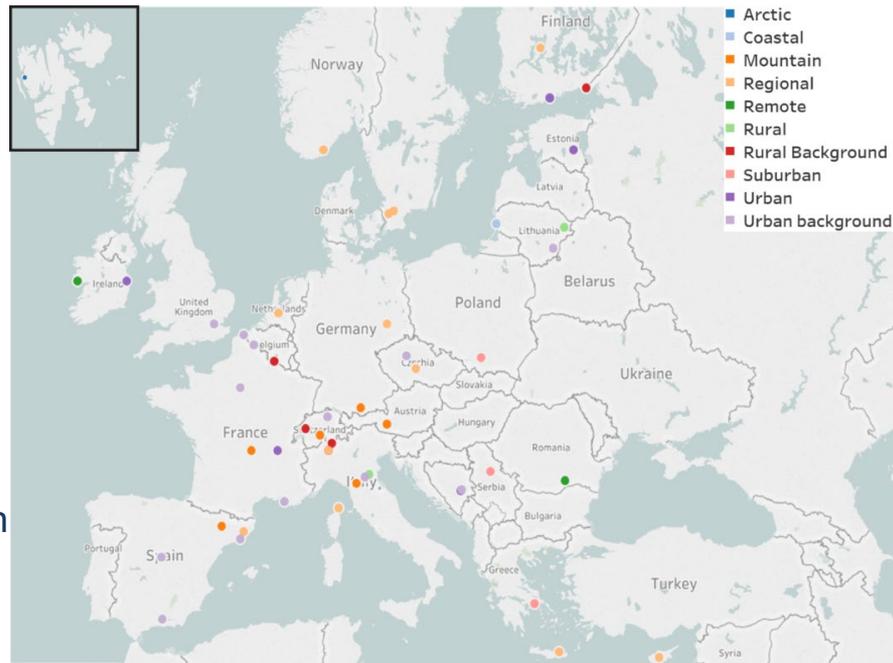
Pan-European network, ~110 sites

Essential part of the agenda is the coordinated long-term measurement of aerosol chemistry with ACSMs

In situ aerosol measurements (various)

- ACSM (21 sites)
- Aetholometer (27 sites)
- Integrating Nephelometer
- Various particle size and concentration instr.
- Thermo-optical method on quartz filters
- Filter-based XRF/PIXE/ICP_OES/ICP_MS
- Filter-based IC, GC-MS HPLC-MS, LC/MS

ASCENT will leverage ACTRIS experience, especially on

- Database of high time res data (ACSM)
- Real-time source apportionment (SoFi)

Legend:
- Arctic
- Coastal
- Mountain
- Regional
- Remote
- Rural
- Rural Background
- Suburban
- Urban
- Urban background

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ASCENT: Atmospheric Science and Chemistry mEasurement NeTwork

- New PM network
- 12 sites
- Open access to high time-resolution data
- Evaluate trends, impact of policy, change in energy strategy
- Provides data and source apport. resources for researchers, policy makers, public
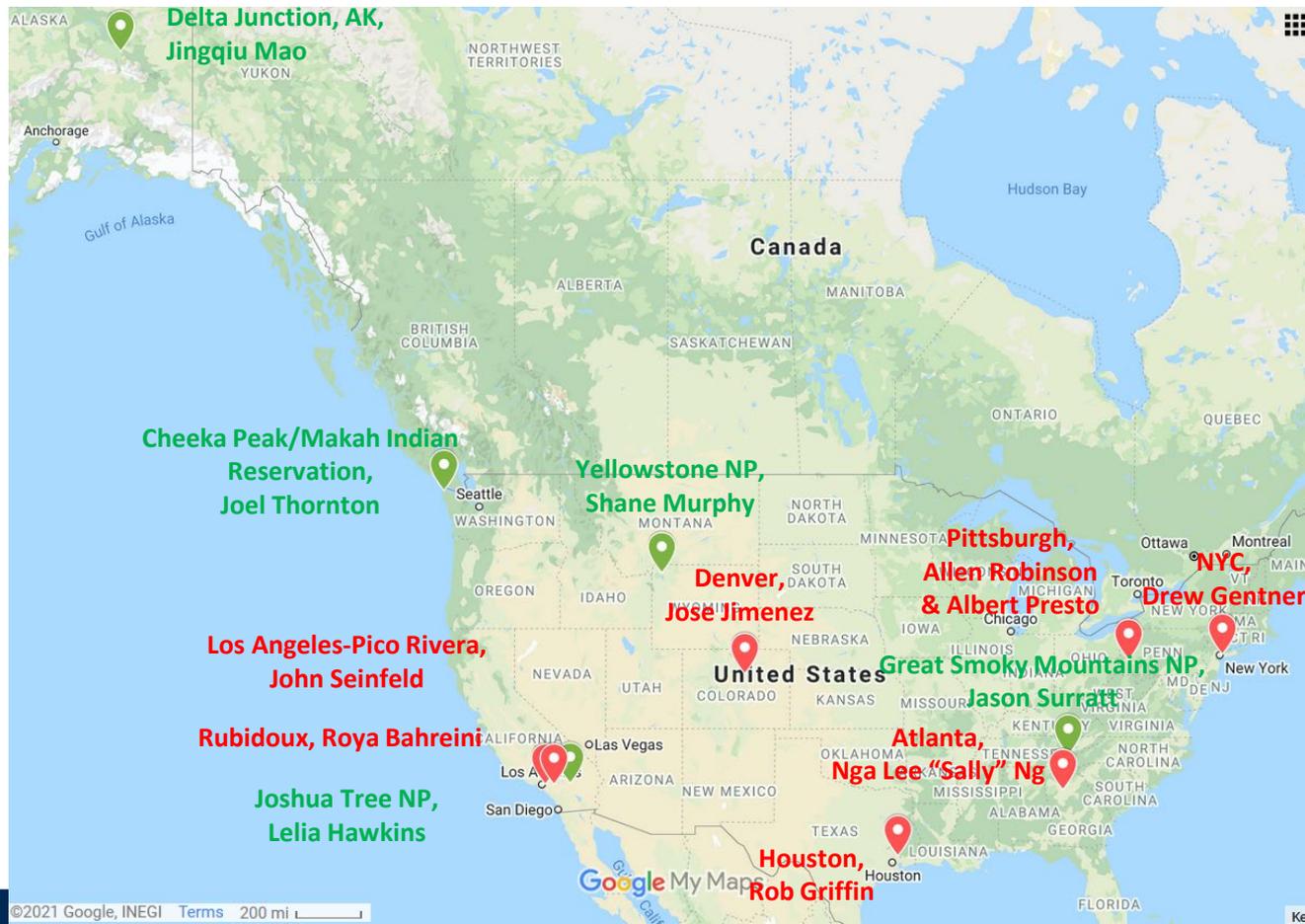
Thanks for assistance with site selection:

Bret Schichtel, Scott Copeland, Tony Prenni and John Vimont (IMPROVE)

Joann Rice, Melinda Beaver, Tim Hanley (EPA – NCore)

Rommel Zulueta (Battelle, NEON)

Rene Burmudez (SCAQMD)

Jimmy Flynn (University of Houston, HNET)

Site operators