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

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IMPROVE Steering Committee Meeting, November 9-10, 2021, virtual
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)
ASCENT: Atmospheric Science and Chemistry mEasurement NeTwork

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

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

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

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Model and Manufacturer</th>
<th>Measurements</th>
<th>Typical Data Rate</th>
<th>Detection limit (30 min)</th>
<th>Calibration Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerosol Chemical Speciation Monitor (ACSM)</td>
<td>ToF-ACSM, Aerodyne Research</td>
<td>Organics, sulfate, nitrate, ammonium, chloride</td>
<td>10 min</td>
<td>&lt; 30 ng m⁻³</td>
<td>Quarterly</td>
</tr>
<tr>
<td>Xact</td>
<td>625i, Cooper Environmental</td>
<td>Trace metals: Sb, As, Ba, Cd, Ca Cr, Co, Cu, Fe, Pb, Hg, Mn, Ni, Se, Ag, Sn, Ti, Tl, V, Zn, more available</td>
<td>15-240 min</td>
<td>&lt; 10 ng m⁻³ for key metals</td>
<td>Quarterly</td>
</tr>
<tr>
<td>Aethalometer</td>
<td>AE33, Magee Scientific</td>
<td>Wavelength-dependent absorption; black and brown carbon</td>
<td>1 sec or 1 min</td>
<td>5.5 ng m⁻³ of BC (5 lpm)</td>
<td>Quarterly</td>
</tr>
<tr>
<td>Scanning Mobility Particle Sizer (SMPS)</td>
<td>3938L89, TSI</td>
<td>Particle number size distribution, number concentration</td>
<td>3 min (full scan)</td>
<td>&lt; 1 cm⁻³</td>
<td>Quarterly</td>
</tr>
</tbody>
</table>
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

(Courtesy of Odelle Hadley)
Site Operators

• Involved in decision to include site in network
• Site mentors and graduate students will train 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
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.
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
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)
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 apportionment 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