Advancing Tools in Air Quality Analysis

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US EPA, **Office of Research and Development**,
Center for Environmental Measurement and Modeling,
Air Methods and Characterization Division

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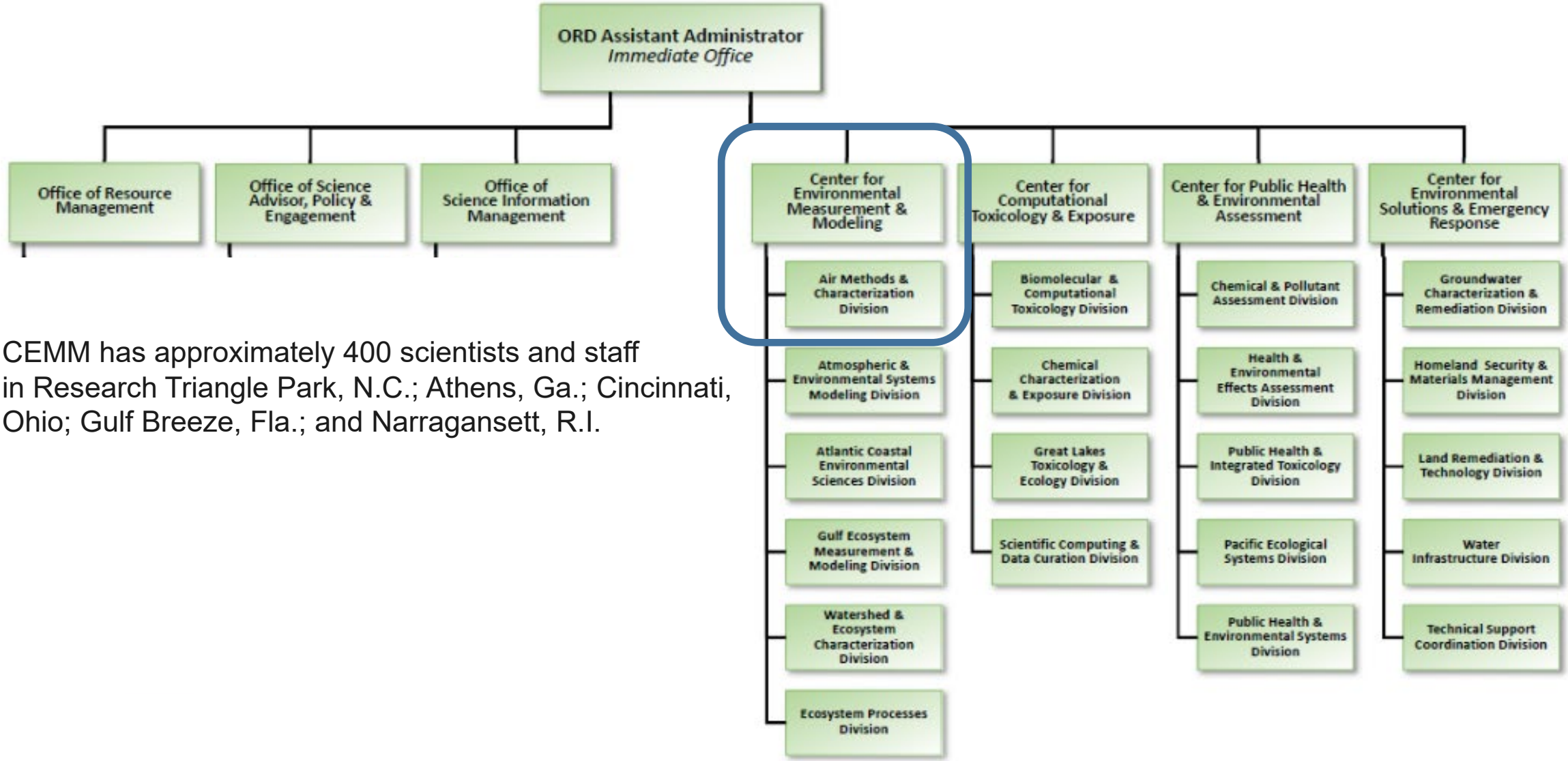
Organizational Focus - ORD



CEMM has approximately 400 scientists and staff in Research Triangle Park, N.C.; Athens, Ga.; Cincinnati, Ohio; Gulf Breeze, Fla.; and Narragansett, R.I.

SFSB Background

- Chief of the Source and Fine Scale Branch in CEMM, RTP, NC
- 20 staff members mostly scientists (chemists, engineers, physicists, and data scientists, microbiologist)
- Research and Development to characterize pollutants (source, near-source, and ambient air)
  - No policy or regulatory decision-making, no enforcement
- Research portfolio (field and laboratory components)
  - Sensors performance and deployment
  - Next Generation Emissions Monitoring (NGEM)
  - PM and aerosol characterization (LC-MS and GC-MS)
  - Ethylene Oxide (EtO) and VOC characterization (GC-MS, FT-IR, spectroscopy, *etc*.)
  - PFAS, PAH, and PCBs in consumer products and dusts
  - Microbiology in air (wildfires, flooding, etc.)

Environmental Challenges

- Biogeochemical cycles
  - wildfire
  - methane
  - nitrogen/carbon balance/cycles

- Anthropogenic contributions
  - PFAS, EtO
  - methane, climate forcers
  - PM, VOCs, and metals

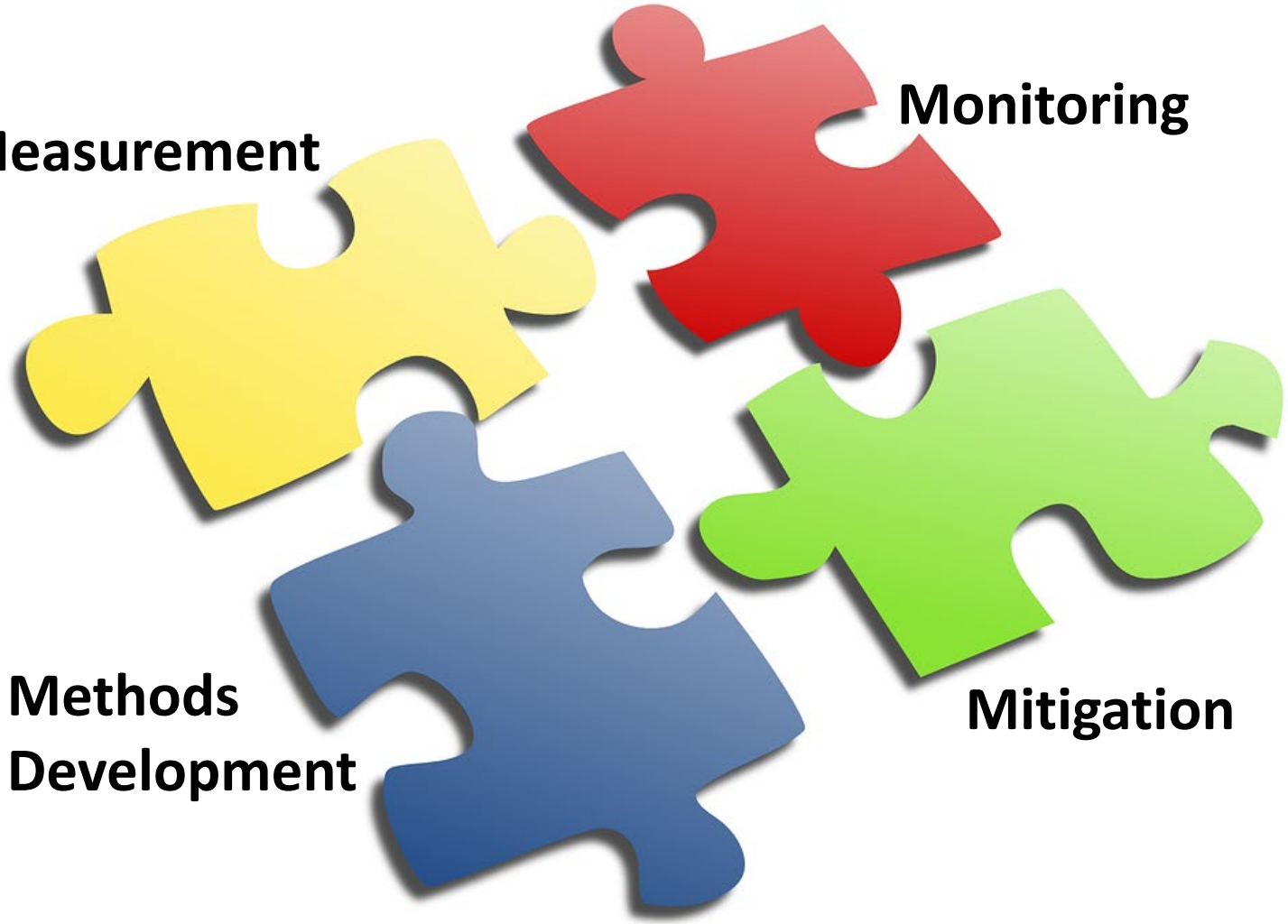
- Communities (exposure)
  - applications
  - communication
  - regional partnerships
  - business

Understanding Environmental Challenges

What do we do?

Unique technical approaches required across these areas and depending on pollutant types - Interdisciplinary.

Ambient Air (‘the atmosphere’)
Source emissions
Near-source Emissions
Collaborative Partnerships



Characterization

Advanced Emissions Measurement Tools

Versatile sampling platforms to achieve unprecedented access to emissions sources

- Aerial drones
  - Vertical emissions profiles
  - Payload limited
  - Temporal limits
  - sensors

- Land rovers
  - Dangerous of difficult to reach areas
  - Wildfires
  - Tough but limited mobility

- Geospatial mapping
  - Large spatial areas
  - Variety of instrumentation
  - Temporally limited if moving

Stationary Next Generation Emissions Measurement Tools (NGEM)

Multiple RAREs, RESES, RSTIP

Aligns with ACE, SHC

Regional Science

- Sensors, triggering mechanisms (remote, apps, concentrations, wind)
- Real time pollutant and meteorological data (different detectors)
- Fence-line applications, variety of deployments, solar powered
- Field based but laboratory measurements are often required for confirmation

Field Gas Chromatographs

Passive Samplers

SPod Fenceline Sensor

VOC Emissions Tracker (VET)

Remotely Operated Canister Sampler (ROCS)

Odor Explore App

Fenceline Methods

- Agency drivers / Partner needs:
  - Improved understanding of fugitive/stochastic emissions
  - New regulatory and compliance approaches
  - Near-source community protection
  - Transparency and empowerment
- Technical approach
  - Next-gen sensors and instruments
  - New source emission models
  - Optimally-acquired laboratory samples
  - Metadata fusion – Source Feedback
- Results:
  - Commercial version of EPASPod fenceline sensor
  - New in-plant leak detection tools
  - EPAOdor Explore cell phone app (pilot phase)
  - 120 compound canister and 325 A/B passive sampler methods

CEMM Point of Contact: R. Duvall, I. George, E. Thoma

Role of Air Sensors

- There is a desire for community level monitoring and mobile platform measurements that may be filled by a new class of complementary air sensors technology
- Offer smaller and/or more portable devices at a lower cost
  - Personal or ambient
- Measurements for non-regulatory use
- Data used for informational purposes
- Demonstrated accuracy or precision is "good enough" for intended application
- Provide real-time data at high time resolution

Regulatory Monitoring Site

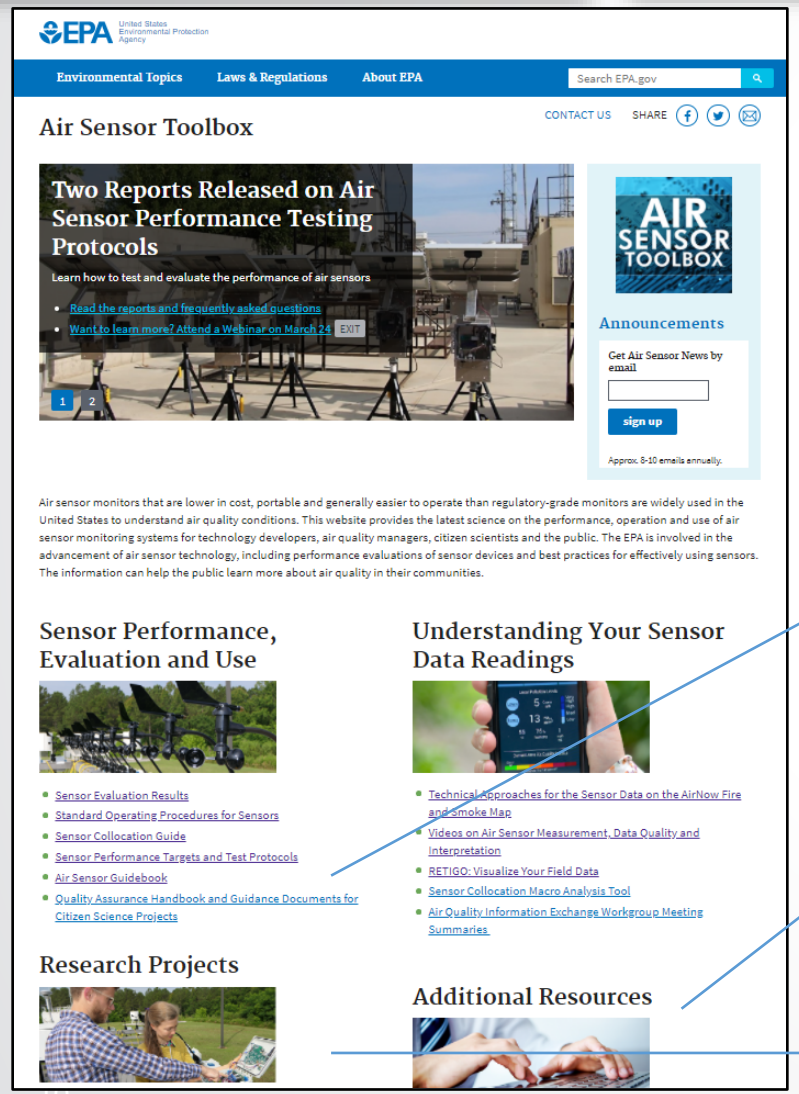
More local measurements and temporary sites

Educational exploration

Mobile measurements carried by individuals

Mobile measurements using vehicles

Air Sensor Toolbox



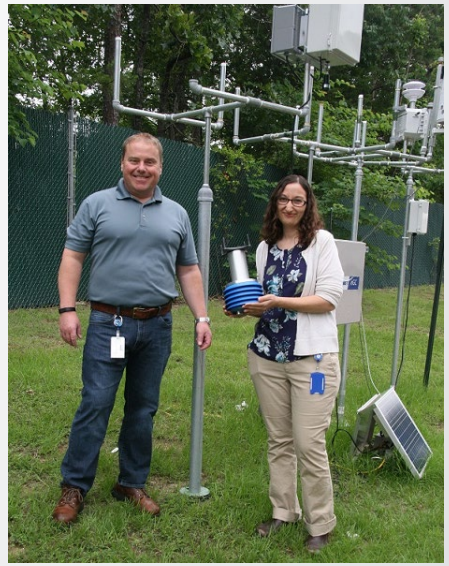
https://www.epa.gov/air-sensor-toolbox/air-sensor-performance-targets-and-testing-protocols

https://www.epa.gov/air-sensor-toolbox/conferences-workshops-and-webinars-air-sensor-technology

https://www.epa.gov/air-sensor-toolbox/epa-air-sensor-research-overview

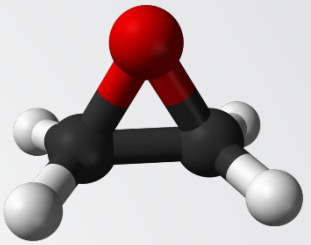
and

https://www.epa.gov/air-sensor-toolbox/technical-reports-and-journal-articles-air-sensor-technology



https://www.epa.gov/air-sensor-toolbox

EtO-Background



- Ethylene oxide (C_2H_4O; EtO) is a colorless, flammable, and reactive gas
- EtO is listed as one of 188 hazardous air pollutants (HAPs) regulated under the Clean Air Act
- EtO is widely used by the chemical manufacturing industry as a chemical intermediate to produce a range of chemicals (e.g., antifreeze, plastics) It is also used by hospitals, medical industry, and spice manufacturers to sterilize medical equipment and to fumigate spices

EtO Measurement Challenges

Accurate EtO measurement poses significant challenges for ambient/near source monitoring and source/fugitive emissions testing measurement regimes

Source Emissions

Source emissions characterization of EtO in complex sampling conditions

Fenceline Monitoring

Fast, real-time EtO measurements for fugitive emissions detection and fenceline monitoring

Ambient Monitoring

Sensitive EtO methods (<10 pptv) for ambient air monitoring

Current EtO focus

- Field Evaluation of Current EPA Method TO-15A Analysis for Ambient Monitoring of EtO
- Future testing of EtO emissions from a variety of sources
- Characterization of Atmospheric Chemistry of EtO
- Instrumentation and Measurement Capabilities for Background and Near-Source Emissions of EtO
- EtO standards stability and determination of method detection limits (MDLs)
- Examination of time-integrated and real-time EtO measurements

Source → Fenceline → Ambient

Instrument Model	Operating Principle	Measurement Rate	MDL (5 minute)
Aeris Ultra & Pico	Mid-Infrared Laser Absorption Spectroscopy	1 sec	2 ppb
Aerodyne	Quantum Cascade – Tunable Infrared Laser Differential Absorption Spectroscopy (QC-TILDAS)	1 sec	0.1 ppb
AromaVOC	Preconcentration/CRDS	5 min. sampling / ~30 min cycle	10 ppt
Picarro G2920 &G2910	Cavity Ringdown Spectroscopy (CRDS)	1 sec	0.1 ppb / 0.2 ppb
MAX Analytical Starboost	Fourier Transform Infrared Spectroscopy	1 min	5 ppb

Why are wildfire smoke emissions important to EPA?

- Increasing fire size & intensity
- Community & fire fighter health
  - PM, Toxics
  - Susceptible Subpopulations
- Ambient air quality
  - PM, O_3, NOx, NH_3, CO, VOCs
- Global climate
  - CO_2, CH_4, BC, Organic Aerosols, NOx, N_2O

Research challenges

- Science is constantly evolving
- Novel, innovative technology develops at a rapid pace
- Pollutants are measured at levels undetected previously
- Emerging environmental issues and contaminants of concern

Questions

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