Air and Energy (A-E) Board of Scientific Counselors Subcommittee Meeting Overview

February 17, 2021
Bryan Hubbell, A-E National Program Director

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Air and Energy National Research Program

National Program Director Team

Bryan Hubbell
National Program Director

Sherri Hunt
Principal Associate National Program Director

Angie Shatas
Associate National Program Director

Andy Miller
Associate National Program Director for Climate
(Away on Detail)

Connections to Centers, Offices, and Regions

Center for Environmental Measurement and Modeling (CEMM)

Tim Watkins
Director

Beth Hassett-Sipple
Assistant Center Director
(for A-E)

Tiffany Yelverton
Assistant Center Director
(for A-E)

Center for Public Health and Environmental Assessment (CPHEA)

Wayne Cascio
Director

Tom Long
Assistant Center Director
(for A-E)

Darrell Winner
Senior Science Advisor

Peter Beedlow
Ecologist, Pacific Ecology Systems Division

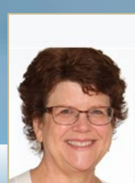
Office of Science Advisor, Policy, and Engagement (OSAPE)

Serena Chung
Extramural Research Lead for A-E (Acting)

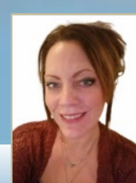
Region 10

Rob Elleman
Region 10 Science Liaison
(Lead Region for Air)

Program Support



Ann Brown
Communications Lead for A-E Related Topics



Michelle Latham
Outreach/Engagement Lead for National Research Programs

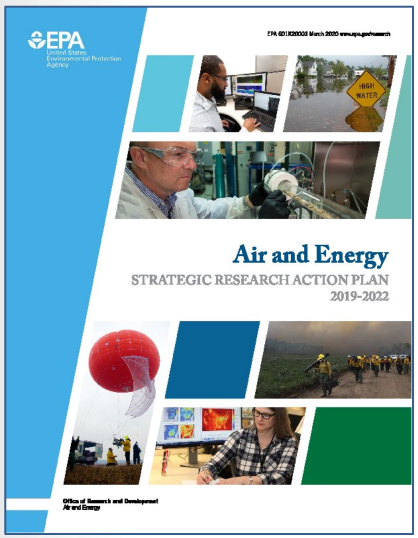
Annelise Hill
Science Support for National Research Programs

Lynn Tran
Internal Media Developer
(A-E Contractor, ORAU)

Elisa Lazzarino
Engagement & Social Science
(A-E Contractor, ORAU)

StRAP to Implementation to Delivery

Planning



- National programs lead
- Strategic focus
- Resources allocated at Research Area level

RACTs

Implementation

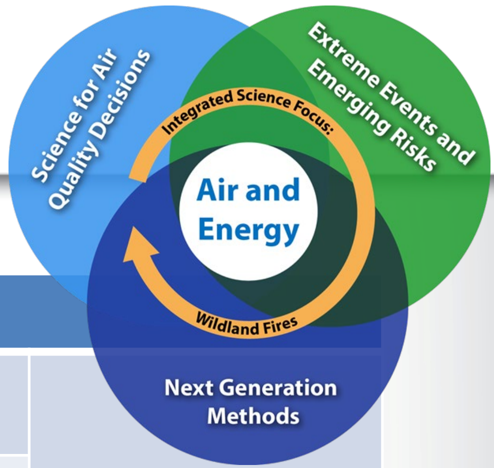
Research Area Implementation Plans

- Center lead
- Tactical focus
- Resources allocated for specific products

Delivery

- Includes data, models, methods, EPA and journal publications
- Joint activity of National Programs and Centers

Program Structure



Topic	Research Areas	
Science for Air Quality Decisions	#1: Approaches to support air quality management programs for multiple pollutants at multiple scales	#9: Wildland Fires (Integrated Science Focus)
	#2: Approaches for characterizing source emissions, air quality, exposure, and mitigation strategies	
	#3 Public health and environmental responses to air pollution	
Extreme Events and Emerging Risks	#4: Public health and ecosystem exposures and responses to emerging air pollutants and sources	
	#5: Methods to evaluate environmental benefits and consequences of changing energy systems	
	#6: Methods to enable resilience to future environmental stressors	
Next Generation Methods to Improve Public Health and the Environment	#7: Emerging approaches to improve air quality and exposure characterization	
	#8: Novel approaches to assess human health and ecosystem impacts and risks	

Scope of This Meeting

- Emphasis on implementation phase of the research cycle
- The A-E research program is highly integrated – across scientific disciplines and ORD Research Centers
  - Activities related to a specific focus area often occur across multiple A-E Research Areas (RAs)
- Two focus areas will be showcased to illustrate A-E's integrated and innovative approaches for addressing priority research needs
  - Informing development, review, and attainment of national ambient air quality standards (NAAQS)
  - Understanding health and ecological impacts of wildland fires to inform strategies aimed at decreasing negative impacts
- These focus areas include research activities in RAs 1, 2, 3, 7, 8, and 9

Next Meeting

- The Fall 2021 meeting will highlight additional research activities in Research Areas 2, 4, 5, and 6
  - Developing measurement methods to address both known and emerging pollutants and sources of concern
  - Enhancing our understanding of approaches to improve resilience at multiple levels (community, organizational, institutional, ecological)
  - Increasing our ability to plan for future energy or climate conditions

Meeting Format

Days 1 and 2

- Description of key challenges and program response
- General approaches to implementing research to address challenges
- Panel discussions
- Meet the Scientists sessions
- Questions from the BOSC subcommittee
- Closed BOSC subcommittee discussion

Day 3

- Focused discussion on environmental justice challenges
- A-E engagement strategy update
- BOSC subcommittee comments
- Closed BOSC subcommittee discussion

Panel Discussions

- Four 60-minute discussions (2 each on Day 1 and Day 2) providing:
  - Additional details on current and planned research activities (ORD senior managers)
  - Insights from Regional and Program Office Partners on the usefulness of A-E research deliverables and responsiveness to identified research needs

Meet the Scientist Sessions

- Two (one each on Day 1 and Day 2) 90-minute sessions for interaction with researchers in smaller groups
- Each 90-minute session will include three concurrent 30-min time blocks/virtual rooms, which will:
  - Focus on a specific topic
  - Include a moderator and 3 scientists with 3- to 5-minute presentations followed by discussion with the subcommittee members
- Each time block will be repeated three times with a different group of subcommittee members
- Subcommittee members will rotate and attend all three rooms

Charge Question 1

- Science needed to support the development, periodic review, and attainment of the national ambient air quality standards (NAAQS) is addressed in projects across the A-E research program.
- Much of this work is integrated across disciplines and Centers/Offices within ORD and the Agency.

➢ **What suggestion(s) or recommendation(s) does the Subcommittee offer regarding progress to date of research activities to develop measurement and modeling methods and strategies to reduce concentrations of criteria air pollutants? [RA1, RA2, RA7]**

➢ CQ1 is addressed in the first panel discussion and the Meet the Scientists session on Day 1

Charge Question 2

- The review of the NAAQS relies on understanding exposures and associated effects and impacts to human health and the environment, including identification of at-risk populations and lifestages.

- **What suggestion(s) or recommendation(s) does the Subcommittee offer on how to enhance implementation of the research portfolio to optimize health and environmental benefits, particularly regarding the identification and characterization of exposures and responses in at-risk groups? [RA3, RA8]**

- CQ2 is addressed in the second panel discussion and Meet the Scientists session on Day 1

Charge Question 3

- Recent increases in wildland fires activity have highlighted the challenges associated with protecting public health and environmental quality during these events.
- The A-E program is working to improve understanding of wildland fire impacts and to develop knowledge and tools to inform strategies aimed at decreasing negative effects.

➢ **What suggestion(s) or recommendation(s) does the Subcommittee offer on the progress of the research aimed at identifying and mitigating the health and environmental impacts of wildfires? [RA2, RA3, RA7, RA8, RA9]**

➢ CQ3 is addressed in the panel discussions and Meet the Scientists session on Day 2

ORD COVID-19 Research

- EPA is highly engaged in supporting the response to the COVID-19 pandemic.
- Much of EPA's efforts have been directed at detecting the virus and decontaminating surfaces.
- Related to air quality, there are some limited efforts to understand:
  - Impacts of the response to COVID-19 on emissions and air quality
  - Interactions between air quality and incidence and severity of COVID-19 related health impacts
- While these studies are not taking place as part of implementing the StRAP and are not covered in this meeting, ORD has expertise and has risen to the challenge to help address this national emergency.
- Dr. Wayne Cascio (CPHEA Center Director) will provide a brief overview of recent ORD COVID-19 activities for informational purposes.

Air and Energy (A-E)

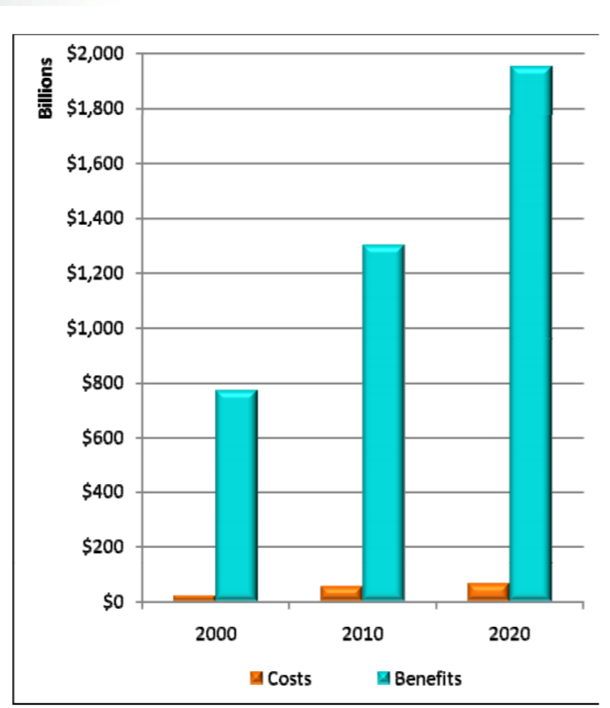
Science and the NAAQS

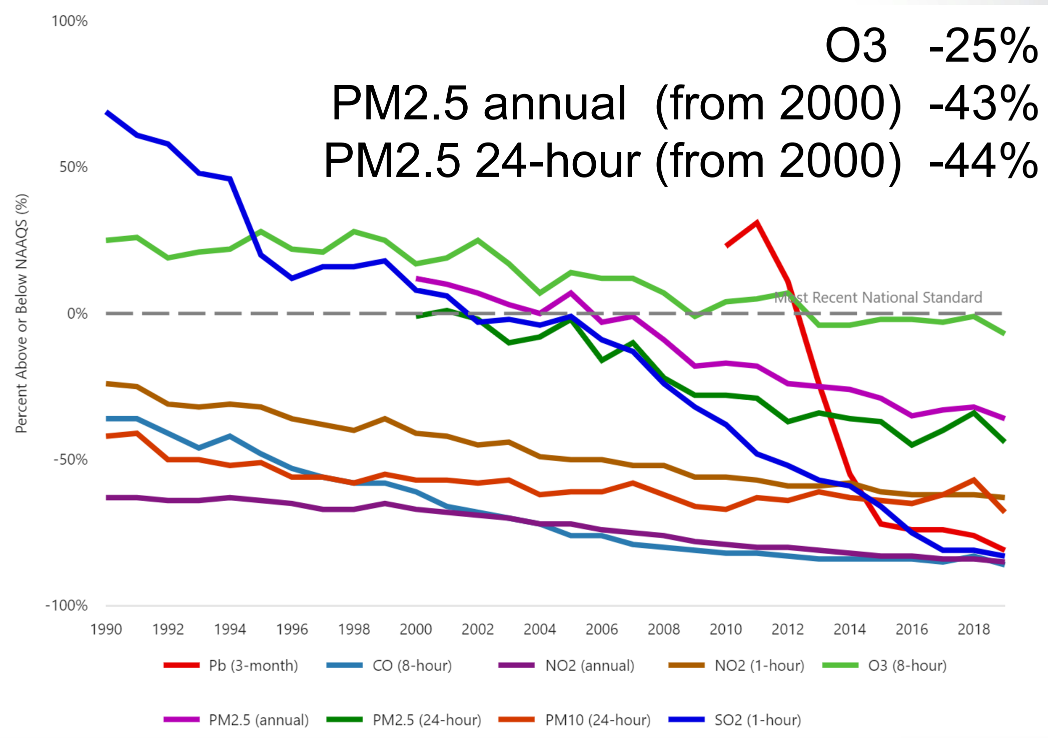
BOSC Subcommittee Meeting, February 17-19, 2021
Bryan Hubbell, A-E National Program Director

EPA

Motivation

Setting and attaining National Ambient Air Quality Standards remains one of the most important tools for achieving clean air and protecting public health.

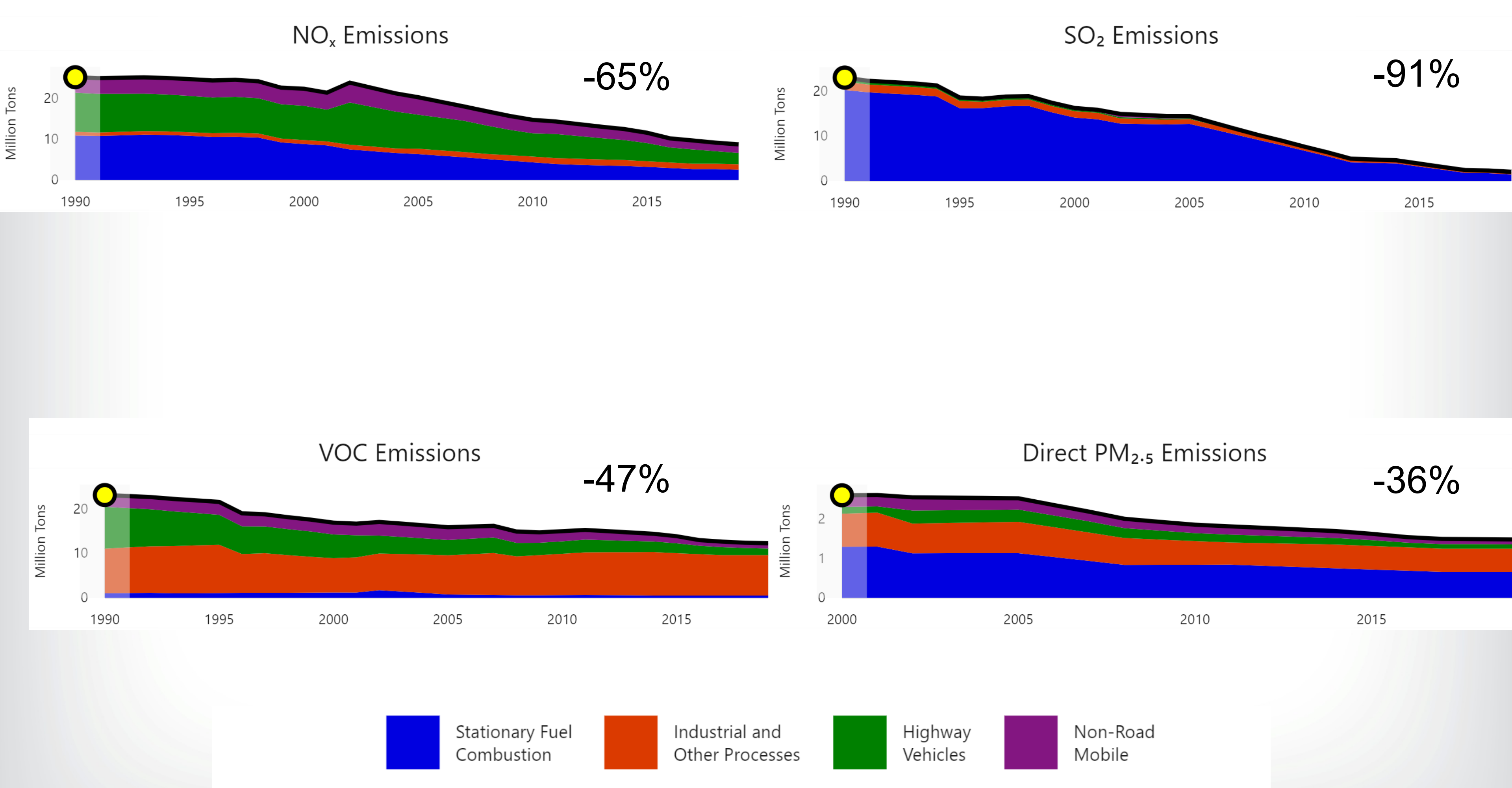




Source: *EPA Our Nation's Air report*

US EPA. The Benefits and Costs of the Clean Air Act from 1990 to 2020: Summary Report

Emissions Have Declined

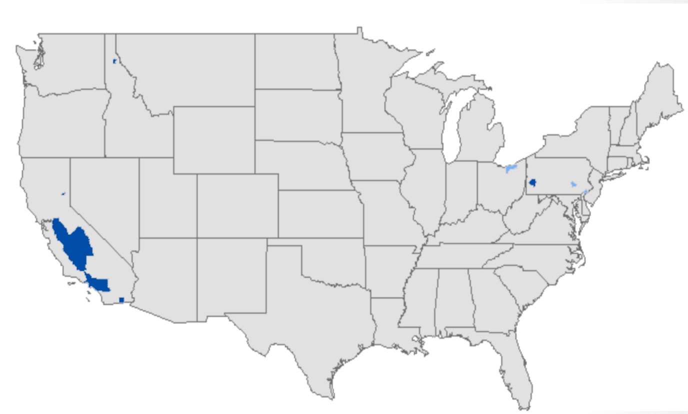


Source: *EPA [Our Nation's Air](#) report*

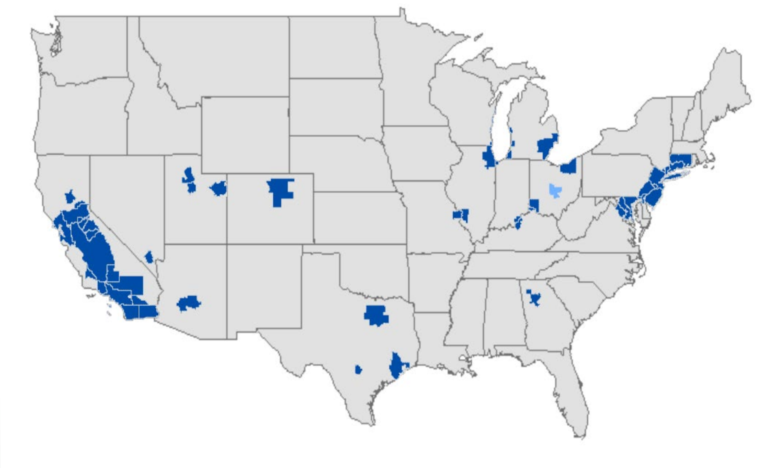
There is Still More to Do

- *"Approximately 82 million Americans lived in counties with air quality concentrations above the level of one or more NAAQS in 2019" – EPA Our Nation's Air report*
- NO_2, CO, and Pb standards are being met throughout the U.S.
- Most counties are in attainment with the SO_2 and annual and 24-hour $PM_{2.5}$ standards.
- A larger number of counties are not attaining the 2015 ozone standards.

2012 $PM_{2.5}$ Annual Standard (12.0 μg/m^3) Nonattainment Areas



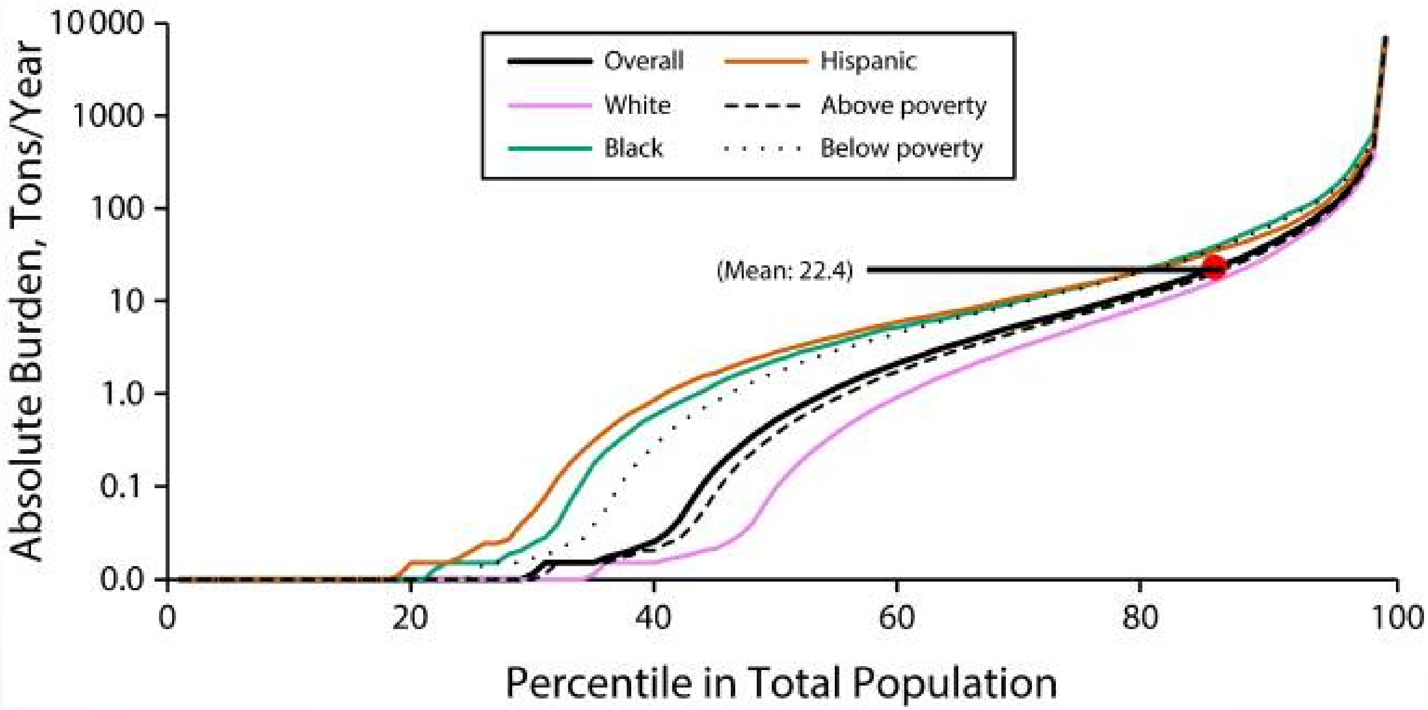
2015 O_3 8-hour Standard (70 ppb) Nonattainment Areas



Source: *EPA Our Nation's Air report*

Inequality in Exposures Persists

Distribution of Absolute Burdens of $PM_{2.5}$ Emissions From Nearby Facilities in the 2011 National Emissions Inventory, Stratified by Race/Ethnicity and Poverty Status: American Community Survey, United States, 2009–2013



Mitkati et al, 2018. Disparities in Distribution of Particulate Matter Emission Sources by Race and Poverty Status. Am J Public Health. 2018 April; 108(4): 480–485.

The Role of ORD Research

- The Air and Energy program does ***not*** set the NAAQS, but it does provide the foundation of scientific evidence and the tools for our partners to set the standards and for others to determine how to meet them.

Our Science is...

- Improving air quality models to address
  - Complex atmospheric chemistry, topography, meteorology, and contributions from international transport and non-anthropogenic sources
  - Impacts of climate change, including increased temperatures, increased wildfire frequency and severity, and changes to the nation's electricity generation and transportation systems
- Improving our ability to measure ambient and near source concentrations of pollutants

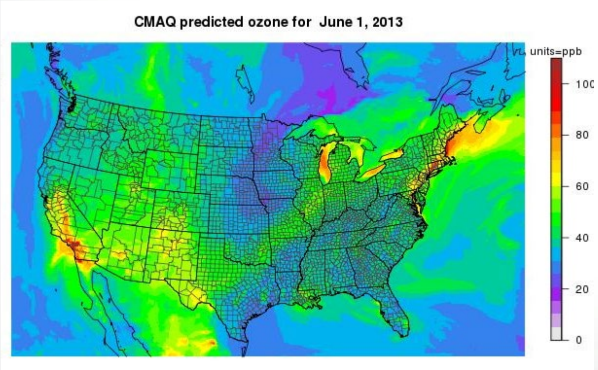
Our Science is... (continued)

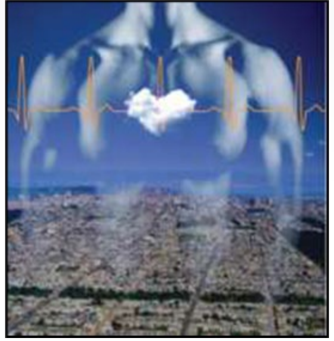
- Characterizing effects of differences in duration and timing of exposure to multiple air pollutants on health responses
- Improving understanding of health effects of ozone and $PM_{2.5}$ for vulnerable/at-risk populations, including for understudied neurological and reproductive health endpoints
- Increasing understanding of interactions between climate change and air pollution in their effects on human health and the environment
- Reducing uncertainty in the relationship between air quality, deposition, and ecosystem services

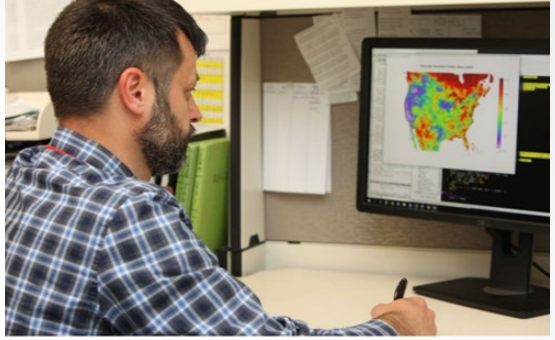
Program Implementation

- ORD scientists from the Center for Environmental Measurement (CEMM) and Modeling and the Center for Public Health and Environmental Assessment (CPHEA) are addressing these scientific challenges.

- Next, Tim Watkins will provide an overview of the Centers' scientific approaches to deliver outputs and products related to the NAAQS.







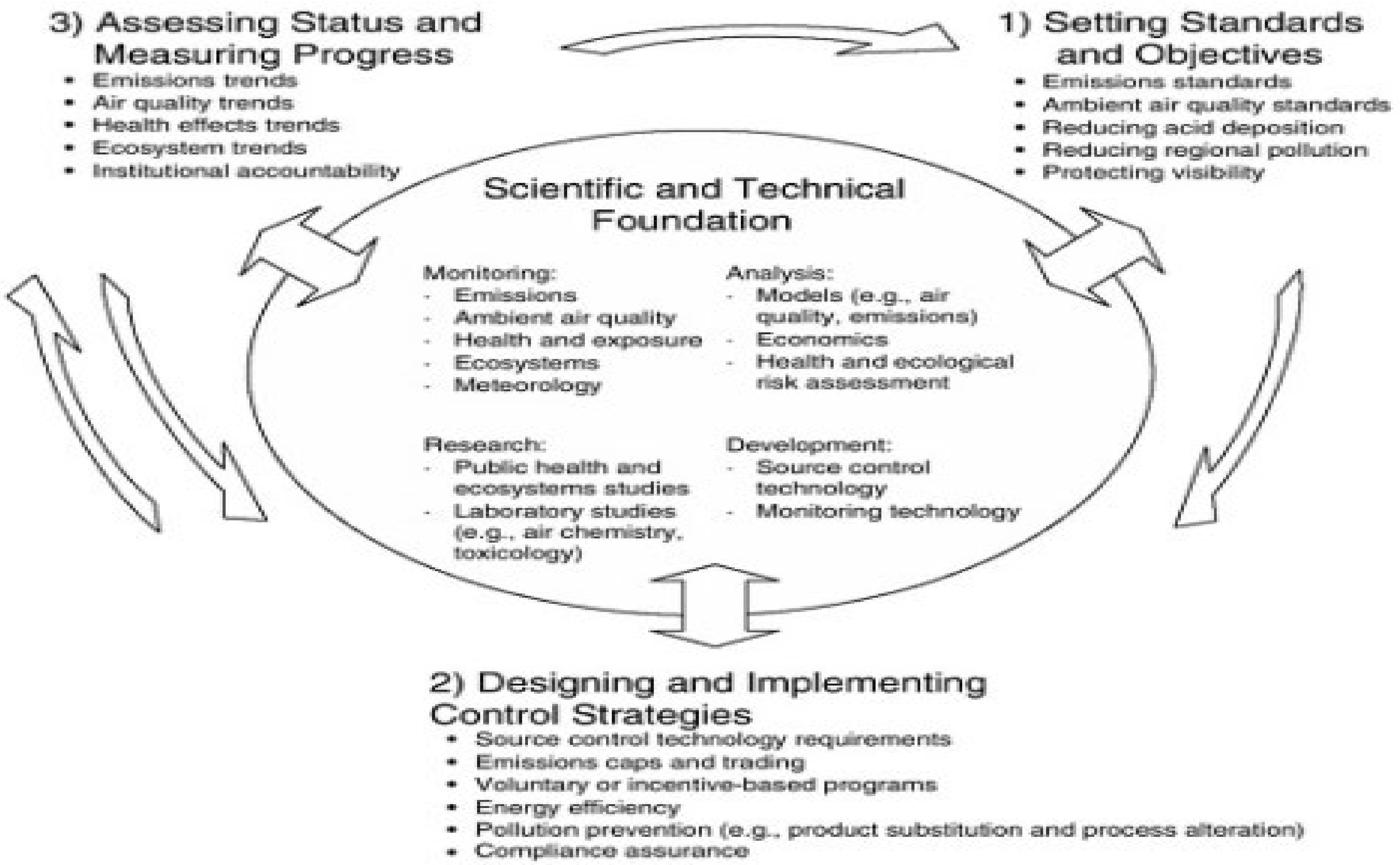
Approaches for Addressing Scientific Challenges and Key Uncertainties for NAAQS: Development, Review, and Attainment

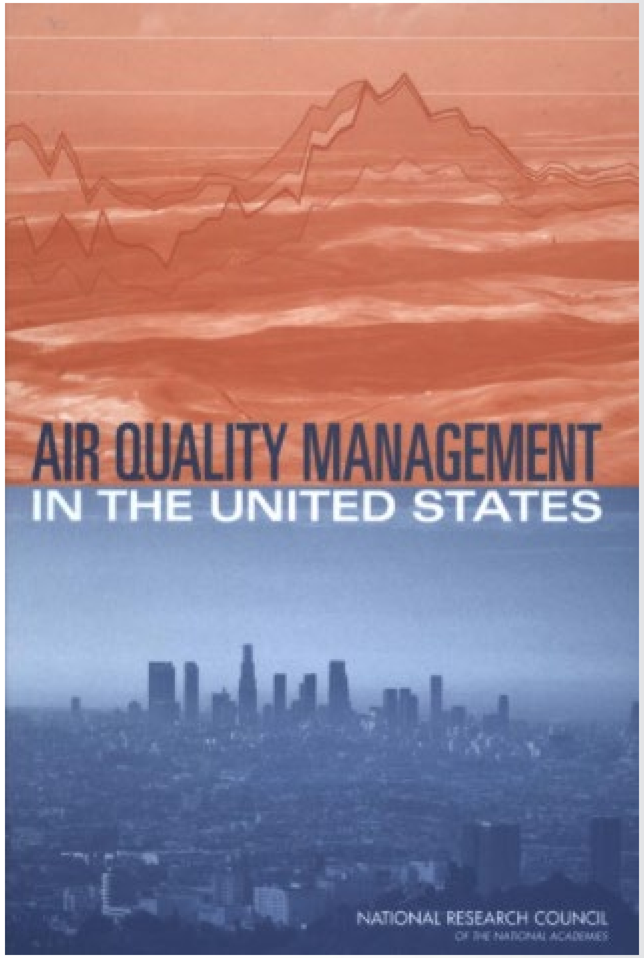
Tim Watkins
Director, CEMM

Air and Energy BOSC Subcommittee Meeting
February 17, 2021

Office of Research and Development
Center for Environmental Measurement and Modeling (CEMM)
Center for Public Health and Environmental Assessment (CPHEA)

Longstanding Importance of Science for NAAQS





NAS. *Air Quality Management in the U.S.* 2004

Figure 1-3. Setting air quality standards and objectives

Implementing Research to Support Solutions

Complex and Evolving Scientific Challenges

- Many Scientific Uncertainties Remain and New Emerging Issues May Increase Complexity
  - Air pollution continues to present significant impacts on public health and environment – especially in at-risk populations, including potential disproportionate impacts on EJ communities
  - Remaining NAAQS nonattainment areas face challenges due to complex atmospheric chemistry, topography, meteorology, and contributions from international transport and biogenic sources
  - Changes in energy landscape and climate are interconnected with air quality challenges
- Research Implementation Challenges
  - Positioning the Agency to take advantage of rapidly evolving technology and data sources
    - Paradigm for air monitoring is changing
    - Measurement and information systems are evolving
    - Access to new sources of public health data
  - Recognizing the importance of matching air quality scale (global to local) with specific science challenges

A-E Research Area 1

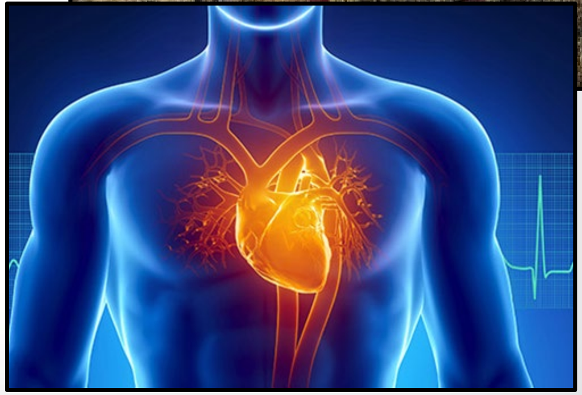
- Objective: Develop, evaluate, and apply air quality and multimedia models at multiple spatial scales for regulatory and research applications
- Challenges Addressed: complex nonattainment areas; global-to-local AQ scales
- Research Implementation to Support Solutions:
  - Models to understand state and sector contributions to NAAQS nonattainment
  - Enhance abilities to quantify role of background air pollution, including international transport
  - Improve approaches to evaluate interactions between emissions, meteorology, and chemistry at mesoscale to better understand complex nonattainment areas at very local scales
  - Improve capabilities to characterize near-source air quality, including improved local-scale air dispersion models
  - Enhance understanding of volatile consumer products (VCPs) and other organic species to form ozone and $PM_{2.5}$


A-E Research Area 2

- Objective: Advance research for methods to measure criteria pollutants; both source emissions and ambient air concentrations
- Challenges Addressed: complex nonattainment areas; changing technology and data sources
- Research Implementation to Support Solutions:
  - Advance Federal Reference and Equivalent Methods (FRM/FEMs) to inform compliance and ongoing public health and environmental assessments
  - Improve emissions measurement and characterization for high priority sectors and source categories to inform emission inventories and mitigation activities

A-E Research Area 3

- Objective: Identify factors affecting vulnerability of people and ecosystems including biological, exposure/deposition characteristics, and environmental justice
- Challenges Addressed: expanding understanding of public health and environmental impacts including at-risk populations
- Research Implementation to Support Solutions:
  - Advance knowledge of air pollution health effects in healthy and at-risk populations and lifestages and identify critical knowledge gaps
  - Evaluate health impacts of exposures to individual pollutants within complex, multi-pollutant mixtures and with chemical and non-chemical interactions, including long-term temperature changes
  - Improve understanding of role of exposure duration and timing of exposures to multiple pollutants, especially in at-risk populations
  - Reduce uncertainty in relationship between air quality, deposition, and ecosystem services



A-E Research Area 5

Note: This RA will be a primary focus for the Fall 2021 A-E BOSC SC meeting but connections with NAAQS-related research are included here

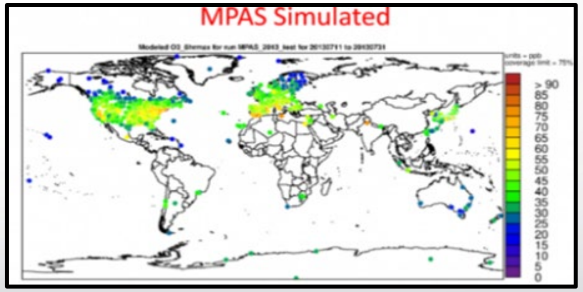
- Objective: Develop innovative methods and models to evaluate environmental benefits and consequences of a changing energy system
- Challenges Addressed: changing energy landscape and climate; interconnection of air-climate-energy
- Research Implementation to Support Solutions:
  - Evaluate emerging air quality trends within context of evolving U.S. and global energy systems
  - Report to Congress (triannual) on environmental and resource conservation impacts of production and use of biofuels, including impacts on air quality
  - Examine environmental consequences of new and emerging transportation technologies, policies, and paradigms




A-E Research Area 7

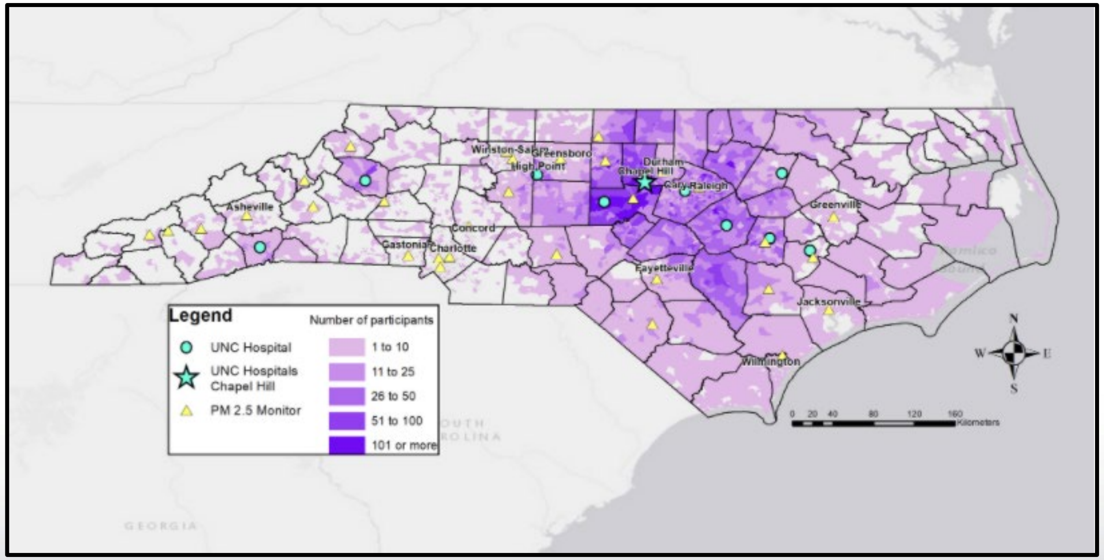
- Objective: Develop innovative and advanced approaches to measure and model air pollutants
- Challenges Addressed: changing technology and data sources; complex nonattainment areas; global-to-local AQ scales
- Research Implementation to Support Solutions:
  – Expand understanding of sensor technology performance
  – Improve understanding of spatial and temporal characterization of human and environmental exposures;
  – Explore data/model fusion techniques to improve characterization of air quality and exposures and to evaluate effectiveness of air pollution reduction strategies
  – Develop advanced air quality modeling platform that could lead to faster assessments of air quality impacts across multiple scales, including transport from global-to-local scale





A-E Research Area 8

- Objective: Develop advanced capabilities to characterize public health and ecosystem risks
- Challenges Addressed: expanding understanding of public health and environmental impacts including at-risk populations; changing technology and data sources
- Research Implementation to Support Solutions:
  - Improve approaches and systems to better assess health and ecosystem impacts and risks associated with environmental stressors to inform periodic NAAQS reviews



Map of heart failure patients in NC; Ward-Caviness et al 2020
https://www.ahajournals.org/doi/10.1161/JAHA.119.012517

Addressing the Charge Questions

- Q1: What suggestion(s) or recommendation(s) does the Subcommittee offer regarding progress to date of research activities to develop measurement and modeling methods and strategies to reduce concentrations of criteria air pollutants?
- Q2: What suggestion(s) or recommendation(s) does the Subcommittee offer on how to enhance implementation of the research portfolio to optimize health and environmental benefits, particularly regarding the identification and characterization of exposures and responses in at-risk groups?
- As the A-E BOSC works to address these Charge Questions, specific insights on the following would be helpful:
  - Will the implementation of the ongoing A-E research activities address the key scientific challenges related to the review and implementation of NAAQS?
  - If not, are there recommendations or suggestions for mid-course corrections during research implementation?
  - Are there additional challenges related to the review and implementation of NAAQS that could be addressed by the implementation of ongoing A-E research activities?

What's Up Next…

The agenda for the rest of the day

Panel Discussions

- Panel 1: Research to Inform Decision Making and Plans to Meet NAAQS
  - Empirical and Computational Approaches to Inform NAAQS Compliance
  - Measurement Research to Inform NAAQS Decisions
  - Insights from Partners/Users of A-E Research
- Panel 2: Considerations to Maximize Public Health Benefits
  - Health Effects
  - Air Pollution Exposure
  - Insights from Partners/Users of A-E Research

Meet the Scientists Sessions

- Room A - Air Quality Modeling
  - Community Model for Air Quality (CMAQ) Modeling System
  - Long Island Sound Tropospheric Ozone Study (LISTOS)
  - Volatile Chemical Products (VCPs)
- Room B - Health Effects
  - Electronic Health Records
  - Epidemiology to Identify Environmental Justice Issues
  - Air Pollution Toxicology
- Room C – Deposition
  - Measurements
  - EPA's Air QUAlity TimE Series Project (EQUATES)
  - Critical Loads

Supplemental Information

Overview of NAAQS-related Research

	A-E Research Area	Example Research Products to Address NAAQS Scientific Challenges	Related Outputs
1	**Approaches to support air quality management for multiple pollutants at multiple scales**	• Release and evaluate updated Community Multiscale Air Quality (CMAQ) model and continue improvements • Advanced measurement technology studies in complex nonattainment areas (e.g., LISTOS) • Expand measurement-modeling integration • Improve fine scale assessment and mitigation (urban, near-freight yard, near-road) including wind tunnel studies and improvements to fine-scale models (e.g., AERMOD) • Increase understanding of volatile chemical products (VCPs)	1.1, 1.2, 1.3, 1.4, 1.5, 1.6
2	**Approaches for characterizing source emissions, air quality, exposure, and mitigation strategies**	• Develop and designate Federal Reference and Equivalent Methods (FRM/FEMs) • Advance near-source measurements (fenceline, fugitive emissions) • Improve source emissions characterization: on- and non-road mobile emissions, biomass combustion emissions, agricultural emissions, methane emissions from reservoirs, SPECIATE	2.1, 2.2, 2.3, 2.4, 2.5, 2.6
3	**Public health and environmental responses to air pollution**	• Expand understanding of health effects associated with criteria air pollutant exposures, especially in at-risk populations • Improve understanding of atmospheric deposition and critical loads; advance measurements of air-surface exchange and ecosystem exposure • Foster translation of science in a public and environmental health context	3.1, 3.2, 3.3, 3.5, 3.6
5	**Methods to evaluate environmental benefits and consequences of a changing energy system**	• Analyze alternative future energy scenarios and how different futures may yield varying outcomes in terms of costs, emissions, and air quality	5.1, 5.2, 5.3
7	**Emerging approaches to improve air quality and exposure characterization**	• Expand understanding of innovative air sensor measurement technologies: evaluation, non-regulatory applications, performance targets, and data management14 • Improve modeling science to develop advanced air quality modeling approaches (global to urban scales)	7.1, 7.2, 7.3, 7.4
8	**Novel approaches to assess human health and ecosystem impacts and risk**	• Develop new approaches to health research that take advantage of electronic health databases • Expand upon advanced cellular models	8.1

United States Environmental Protection Agency

Empirical and Computational Approaches to Inform NAAQS Compliance

Alan Vette, Director
Atmospheric and Environmental Systems Modeling Division
Center for Environmental Measurement and Modeling

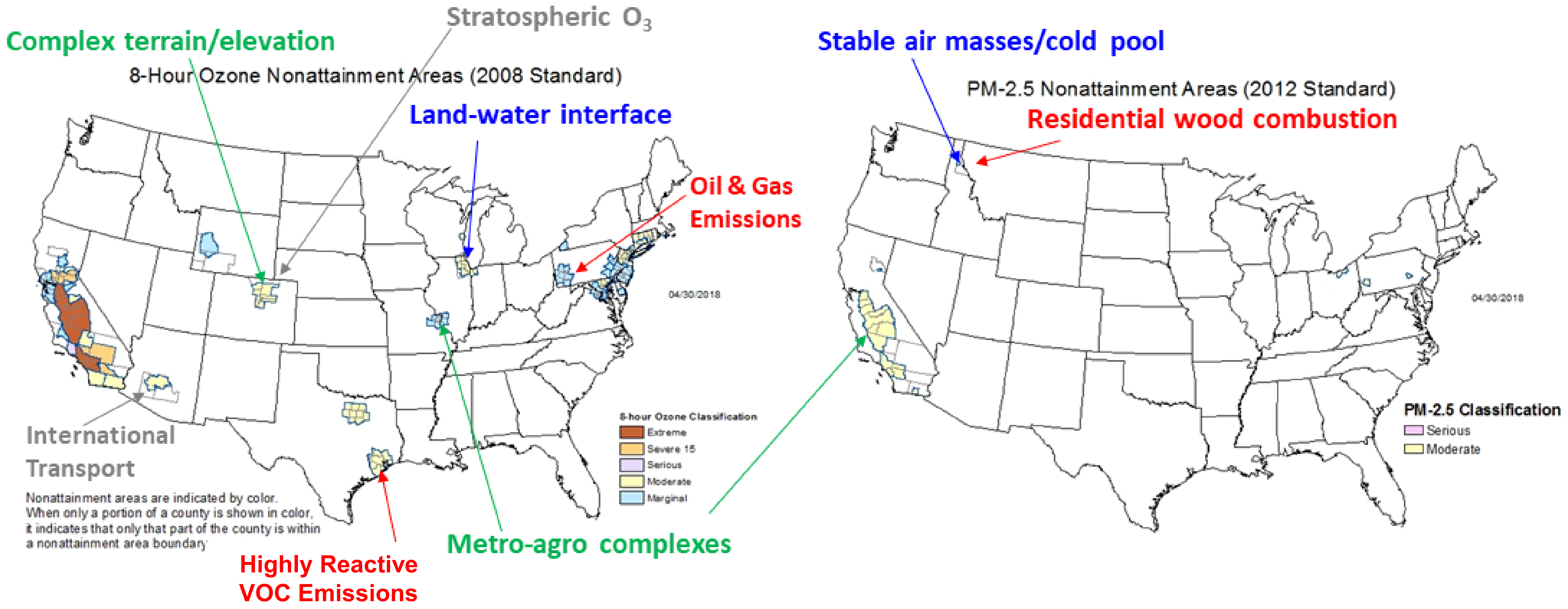
BOSC Subcommittee Meeting, February 17, 2021

Local nonattainment problems require *individualized* approaches

Local nonattainment presents ***unique process and modeling challenges*** due to a combination of unique emission sources, meteorological conditions, geographical features, and/or non-controllable sources.

Nonattainment Classification: O_3

Nonattainment Classification: $PM_{2.5}$



➡ **Fine-scale air quality modeling capabilities developed for a particular nonattainment area may not necessarily be transferable to another area**

Near-Road Fine Scale Modeling

Development of Algorithm for Solid Noise Barrier for Use in Dispersion Models

Product:
AE.1.5.1
David Heist, CEMM

Science for Air Quality Decisions

Product Type: Journal Article and Presentation

Description: Wind tunnel study that characterizes effects of roadside noise barriers on downwind concentration distributions and proposes algorithm for including in dispersion models.

Agency Need: Dispersion model capable of simulating impact of barriers on nearby pollutant concentrations.

Results:

- Improved ability to determine edge effects and maximum concentration at the end of roadway barriers.
- Determined adjustments to the surface friction velocity, initial dispersion pattern, and a well-mixed region below the barrier height.

Expected Use: New algorithms will be included in AERMOD when evaluating noise barriers for mitigating exposures to pollutants from roadways.

Read the Product Summary

Page Road Wind Tunnel Facility in RTP

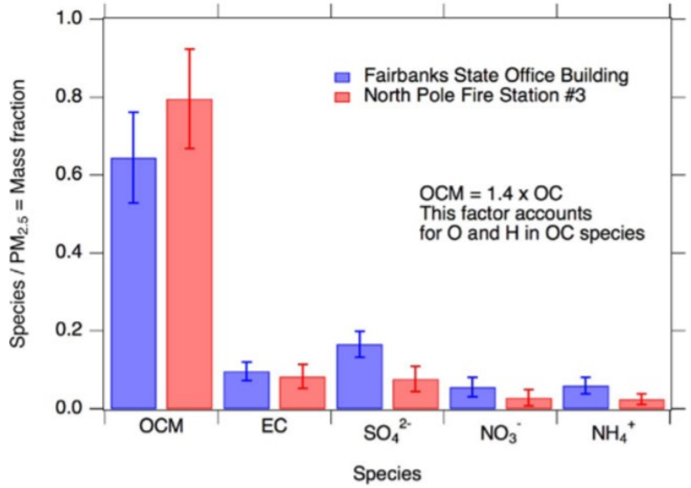
8

Product 1.5.1 FY20Q4

Fairbanks, AK $PM_{2.5}$ Nonattainment

- **Fairbanks, Alaska – designated serious nonattainment for 24-hour $PM_{2.5}$**
- **During exceedances, $PM_{2.5}$ consists of 65-89% C and up to 20% sulfate**
- **Multiple types of sources**
  - **Home heating – wood combustion and oil furnaces**
  - **Motor vehicles**
  - **Large industrial point sources (coal and oil-fired power generation)**
- **Collaborating closely with EPA Region 10, State and academics**
- **Upcoming ALPACA (Alaskan Layered Pollution and Chemical Analysis, https://alapaca.community.uaf.edu)**

$PM_{2.5}$ composition



Simpson et al., 2019
ALPACA White Paper

Approach:

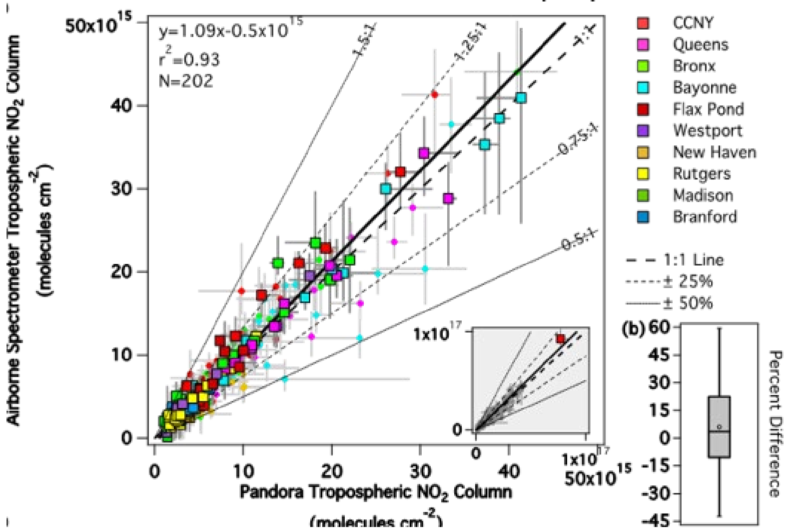
1. **Characterize sulfur-containing fossil fuels used in Fairbanks**
2. **Volatility resolved characterization of woodstove emissions**
3. **Characterize sulfur budget in Fairbanks using state-of-the-science algorithms for sulfur formation and multi-scale modeling of $PM_{2.5}$**

Product 1.2.3 FY22Q4
(Denver O_3 1.3.1, FY21Q4)

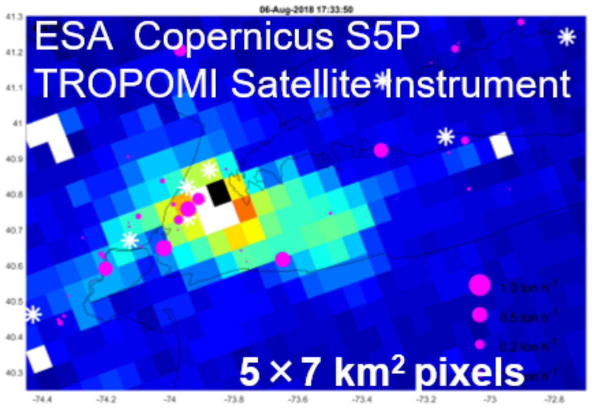
Long Island Sound Tropospheric Ozone Study (LISTOS)

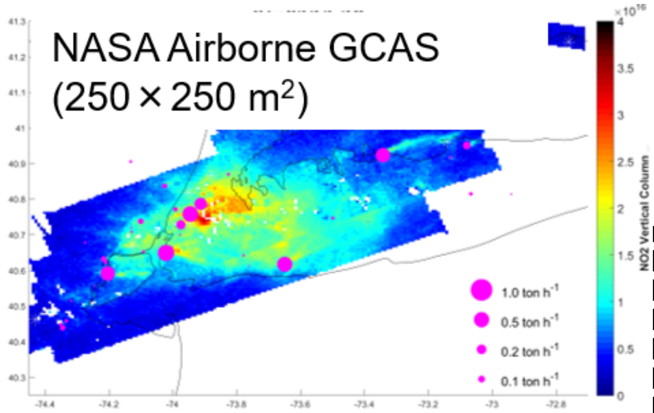
EPA and NASA are placing Pandoras, sun tracking UV/Visible spectrometers, at air monitoring sites under the Photochemical Assessment Monitoring Stations network. **No uncertainty in light path.**

Judd et al., *in prep*



The Pandora instruments were placed at 10 sites in NYC region, providing validation for and enhanced confidence in spatial mapping spectrometers →



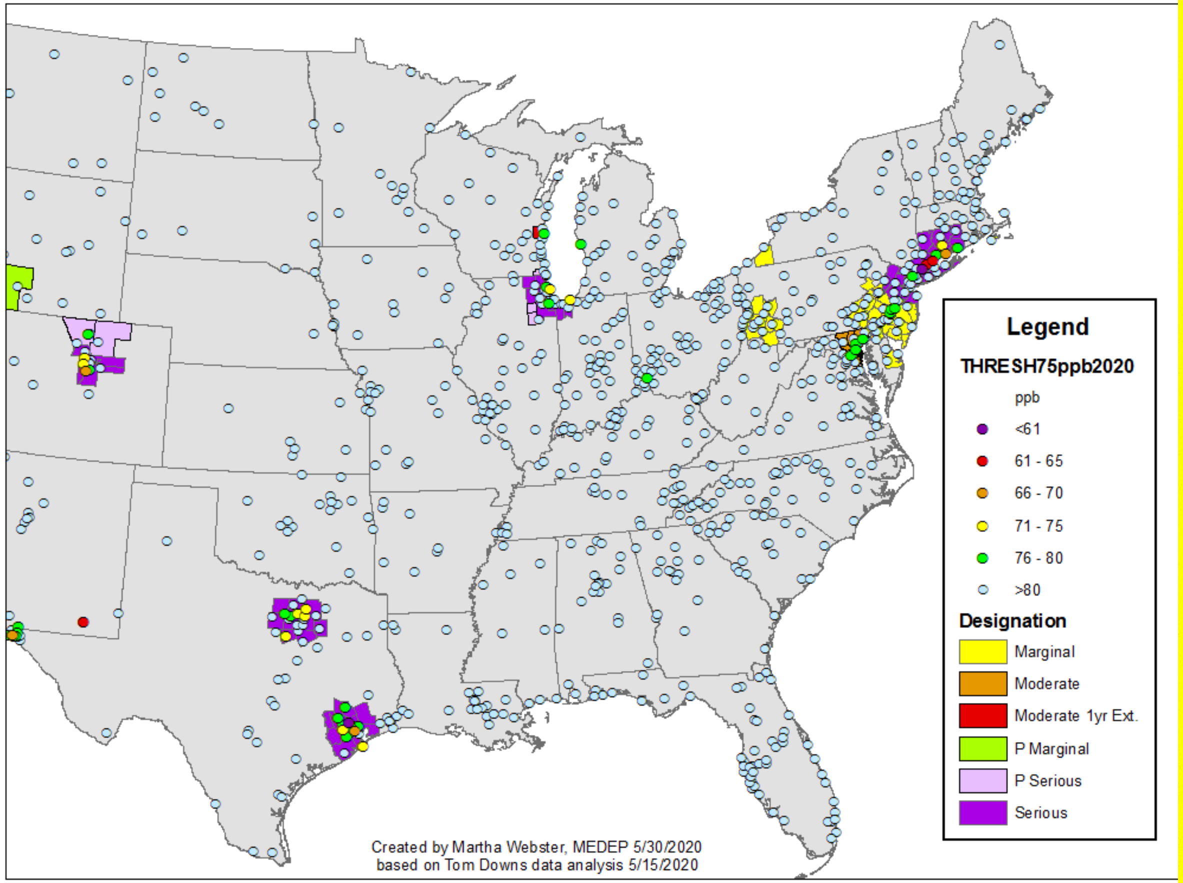


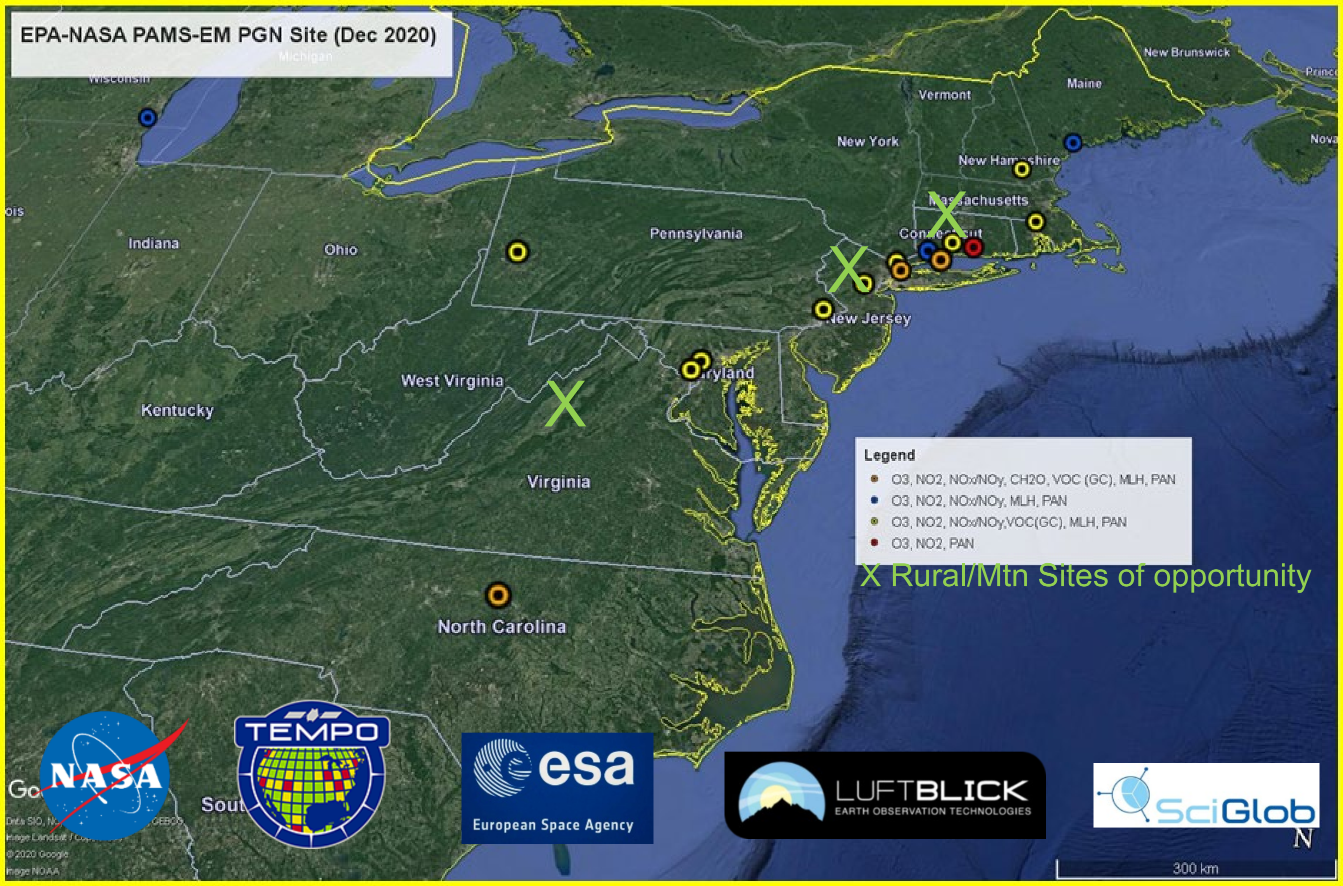
Product 1.4.1 FY21Q4
(Mesoscale study 1.4.6, FY22Q4)

Initial Deployments Focus on "Ozone Transport Region"

Pandonia Global Network (PGN) – collaboration with NASA to expand capabilities of ground-based monitoring at PAMS sites

2020 Ozone Threshold 75 NAAQS with 2008 Ozone Nonattainment Areas



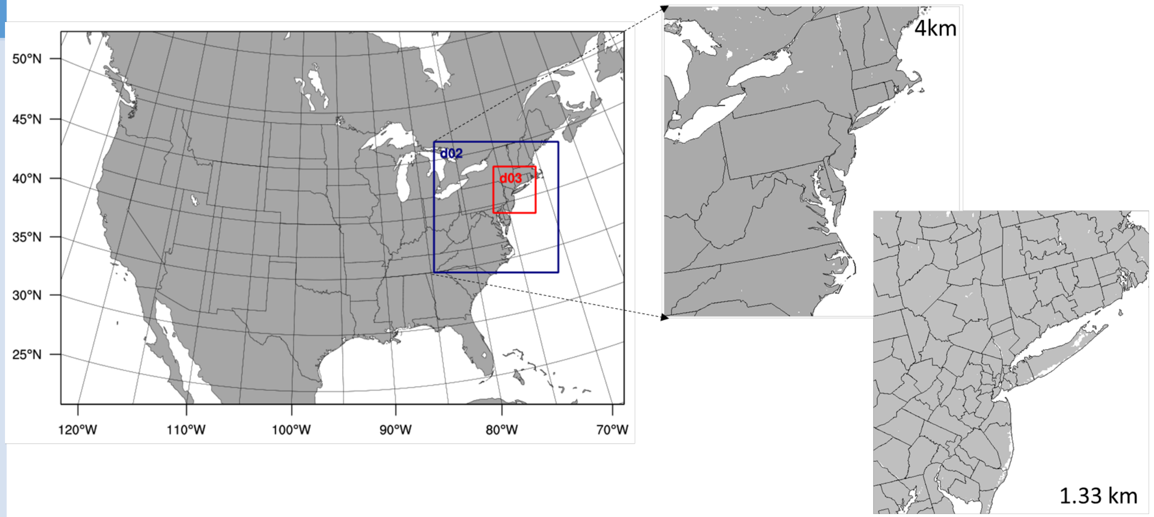


Products 1.4.2,3,5 FY21Q4

LISTOS Modeling Approach

Model LISTOS summer 2018 field study with latest versions of WRF-CMAQ (WRF 4.1.1, CMAQ 5.3.1)

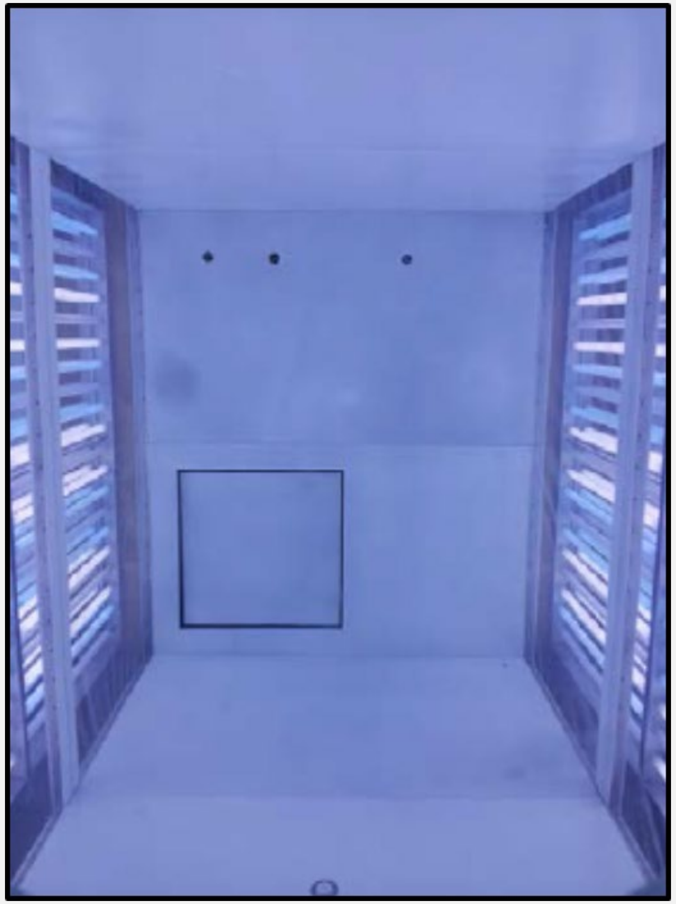
- Nested domains – **12 km/4 km/1.33 km** grid resolution
- Key aspects of meteorology modeling
  - High resolution surface data: GHRSST (1 km), UnRestricted Mesoscale Analysis (URMA) (2 km)
  - Surface data assimilation of URMA through PX LSM soil moisture and temperature nudging
  - High resolution land use from 2016 NLCD including impervious surfaces and tree canopy coverage
- Key aspects of emissions
  - Onroad mobile sources – Run MOVES with county specific updated VMT, age distribution, temporal profile from 201
  - Marine – hourly GPS ship data from 2017 (adjust for day of week for 2018)
  - VCPs – previously not accounted for properly in urban emissions



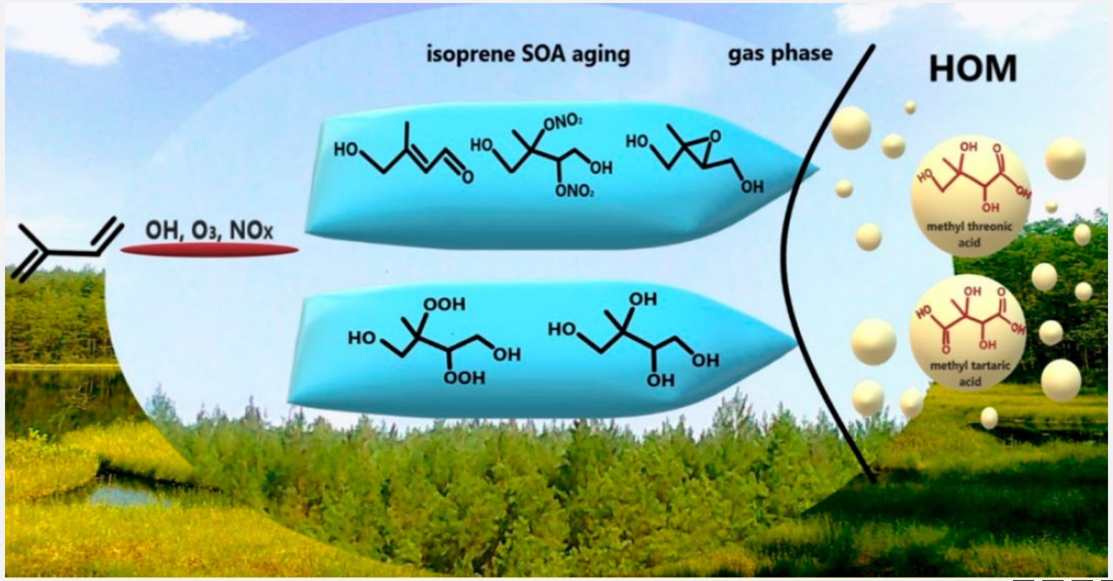
Products 1.2.2, 1.4.1
FY21Q4

LISTOS – Luke Valin
CMAQ – Christian Hogrefe
Meet the Scientists Session #1
Room A

Chemical Mechanisms & Kinetics



- Extensive analytical capabilities for gas and particle speciation
- Recent focus on secondary organic aerosol (SOA) formation
- Reaction rates, mechanisms and tracer identification
- Examining role of volatile chemical/consumer products (VCPs) on gas and aerosol formation
- Connections with STAR grant on chemical mechanisms



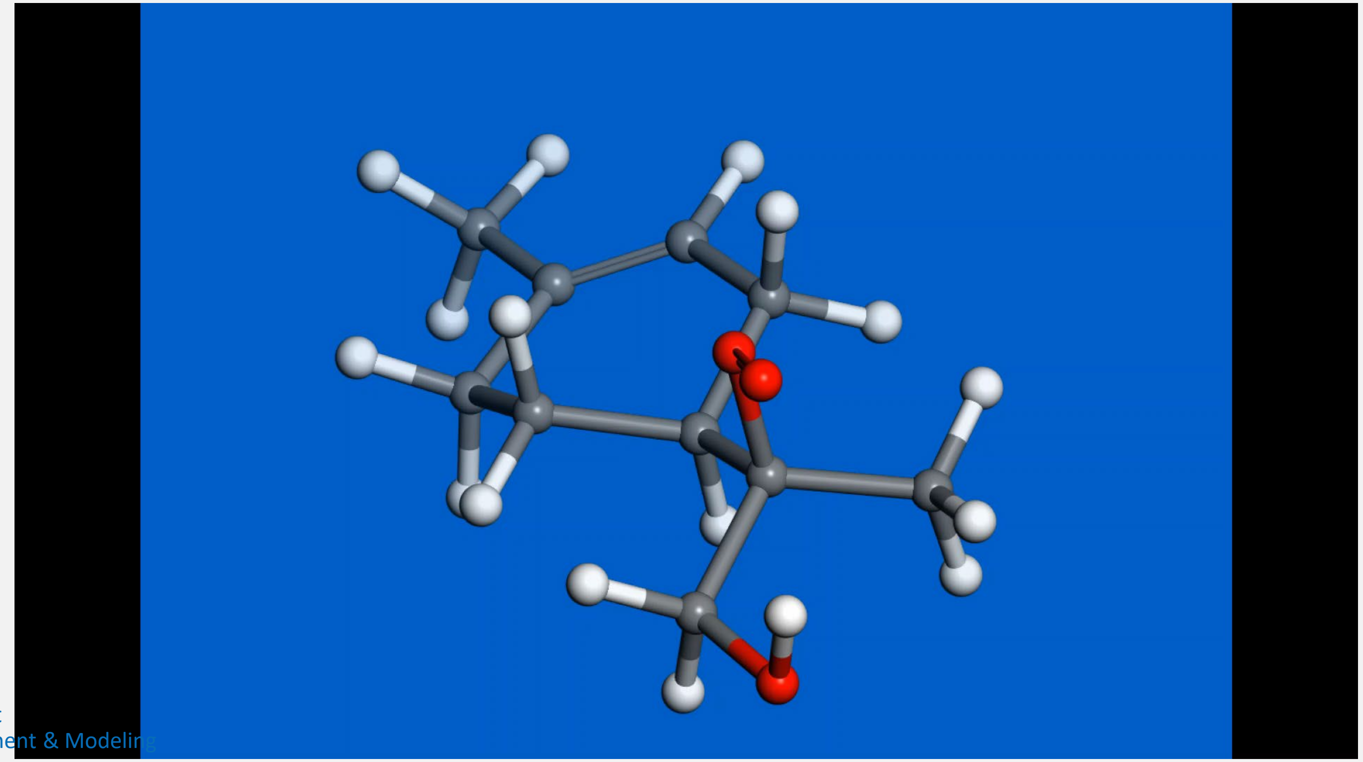
Jaoui et al. ES&T 2019

Products 1.6.x FY20-22

Computational Quantum Chemistry

- Limonene – volatile chemical product (VCP) with high reactivity and great propensity to **autoxidize**
- Some **autoxidation** reactions are *much faster* than previously thought and can rapidly give rise to highly oxidized molecules (HOMs)

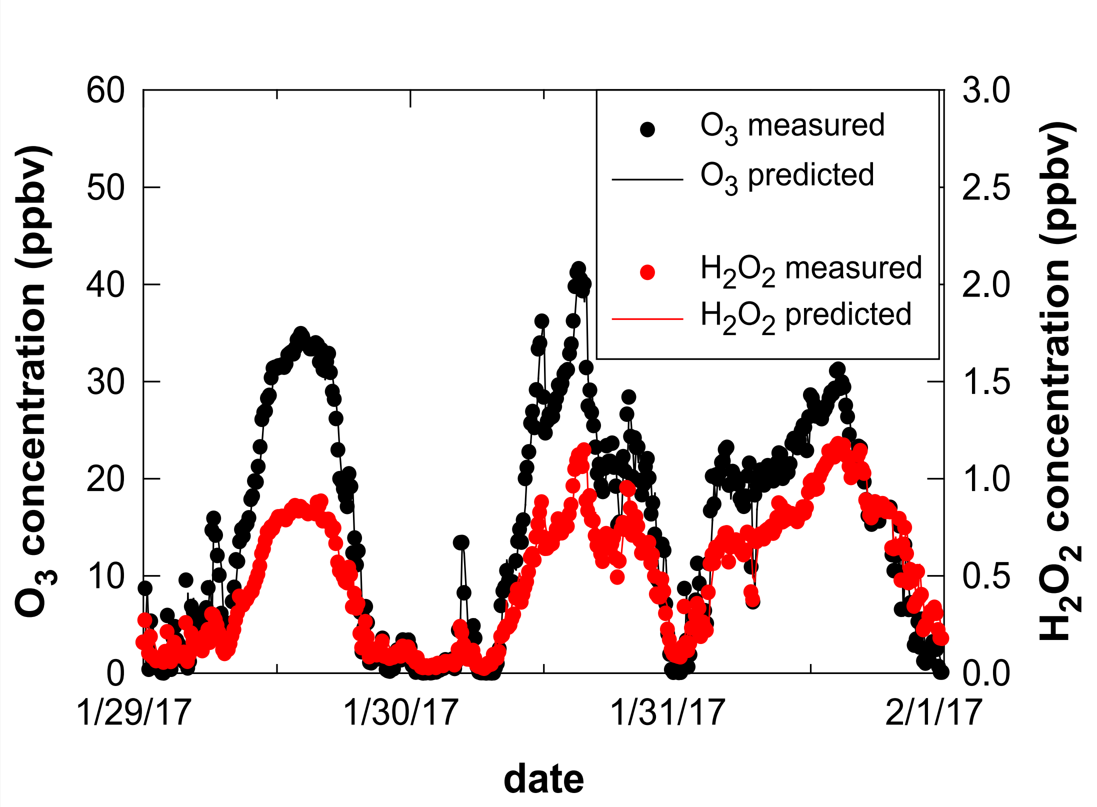
Limonene autoxidation: sequential H-shifts and O_2 additions



Product 1.6.3 FY21Q4

Machine Learning

- Wintertime O_3/NO_x
  - 1-month CIMS sampling (Utah)
  - Included: H_2O_2, N_2O_5, HONO, and $ClNO_2$
  - Vector autoregressions
- Reaction mechanism approximations
  - α-pinene autoxidation (Pye et al., *PNAS*, 2019)
- Model improvements
  - Model parameters, run-time



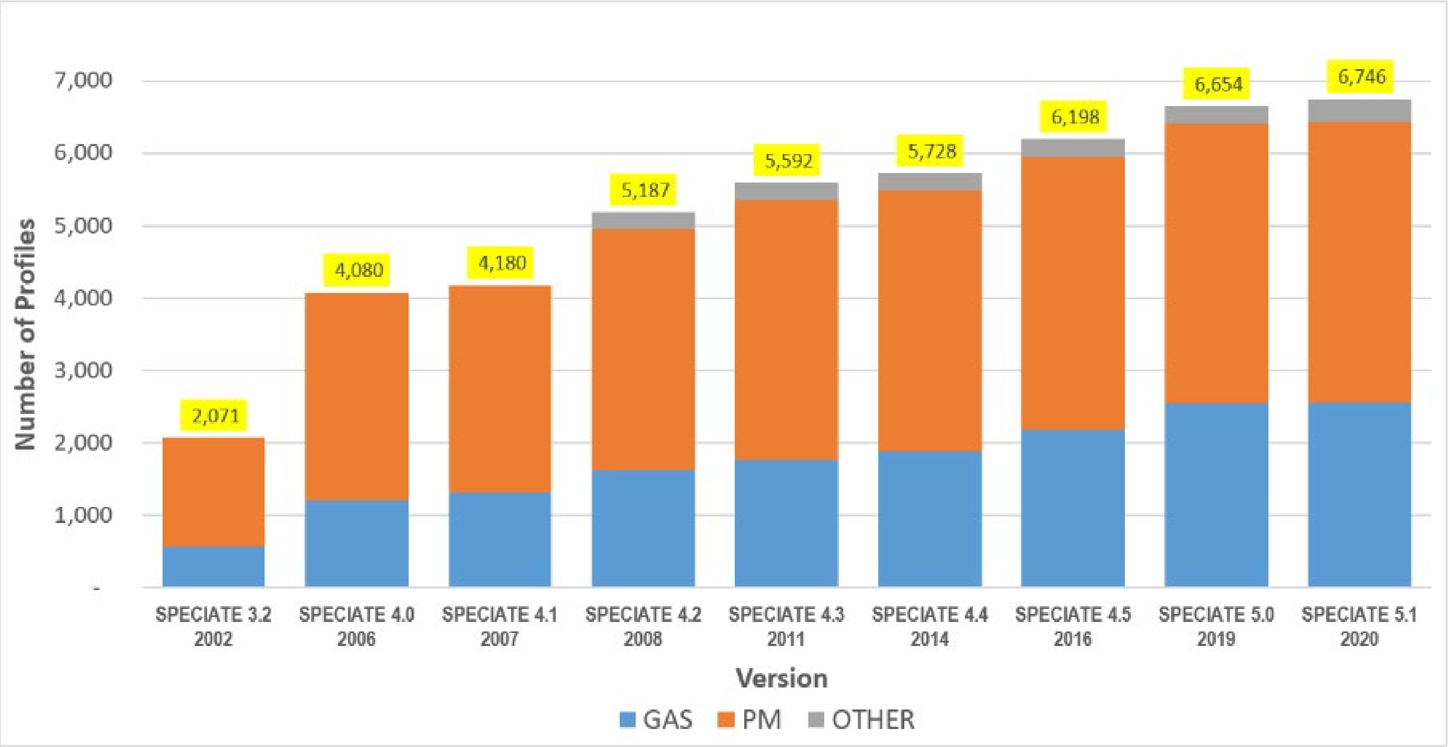
Olson et al., *Atmos. Environ.* (2019)

Product 1.2.9 FY23Q4

Volatile Chemical Products (VCPs)
Havala Pye
Meet the Scientists Session #1
Room A

SPECIATE 5.1: Database Expansion

- Gas and PM speciated emissions profiles
- Research model development & regulatory applications



SPECIATE 5.1
6,746 profiles
# of Profiles Added:
16 Gas,
18 $PM_{2.5}$
58 mercury

Each version is a cumulative update of the previous version

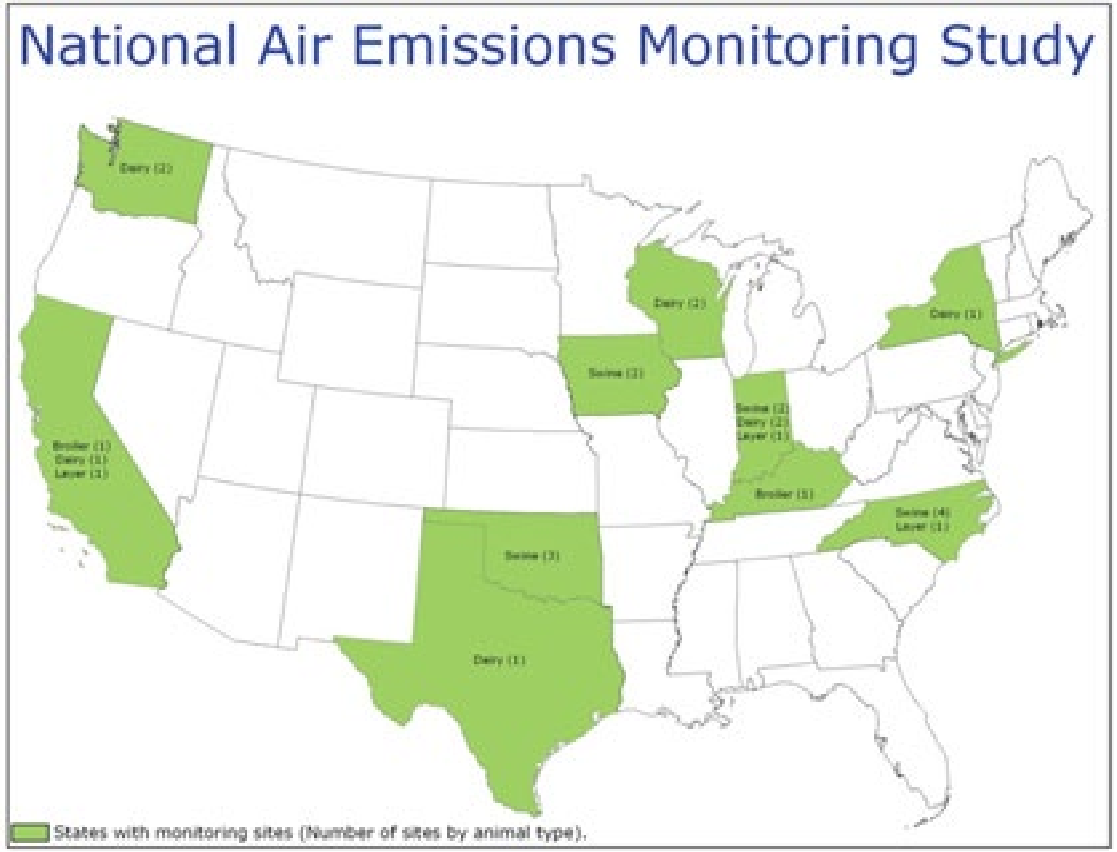
Product 2.1.6 FY22Q4

United States Environmental Protection Agency

SPECIATE
George Pouliot
Meet the Scientists Session #2
Room B

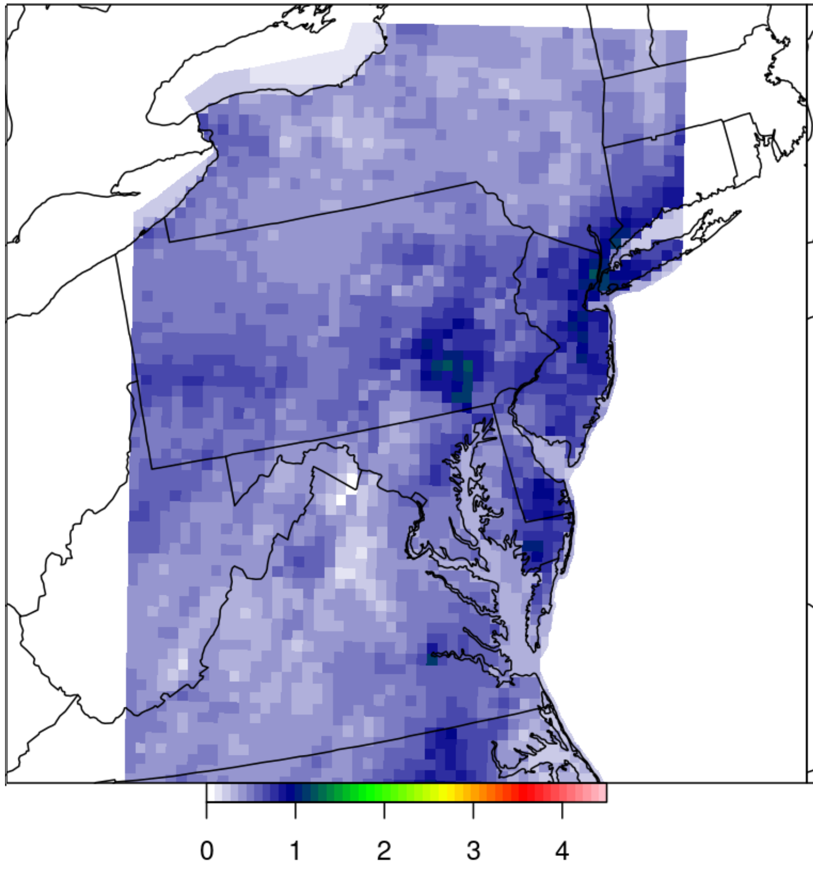
NAEMS Overview

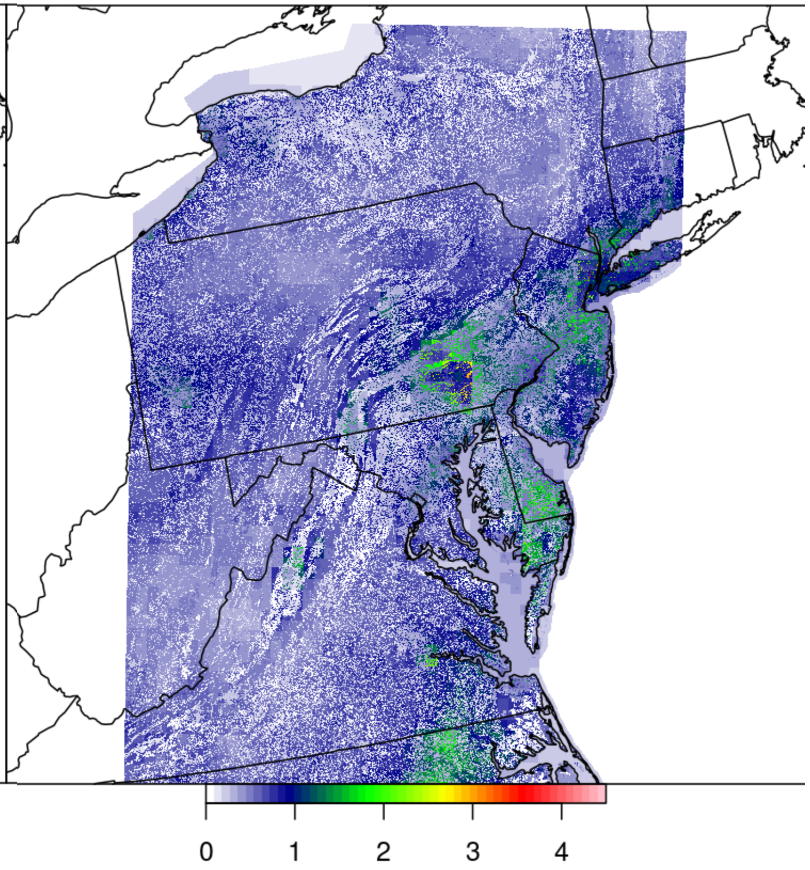
- Two-year, industry-funded study resulting from Consent Agreement
- Monitored 25 sites (e.g., barns and lagoons) for H_2S, NH_3, PM and VOCs
- Species: Swine, dairy, egg-layers and broilers; beef cattle and turkey are not included in this study
- Sites selected based on representation of animal species and geographic location
- Data used to develop emissions estimating methodologies (EEMs)

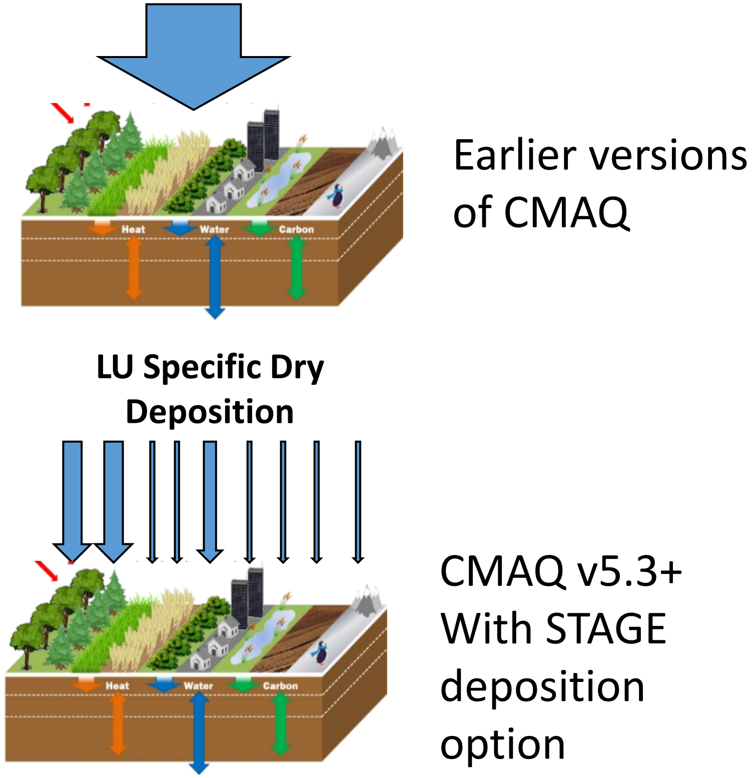


Product 2.5.1 FY22Q1

Land Use Specific Deposition – CMAQ v5.3







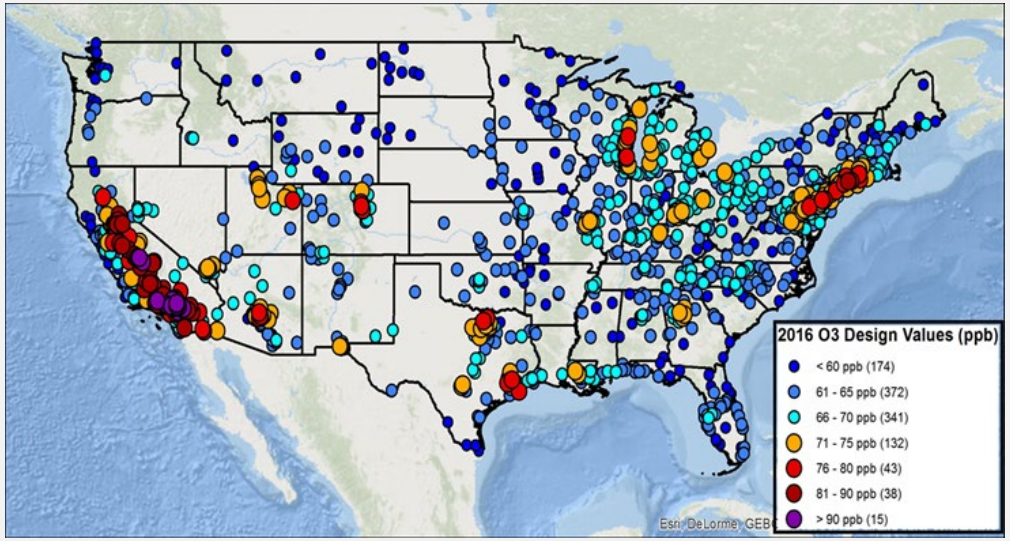
Product 1.2.5 FY22Q3
(AQMEII-4 1.2.6 FY22Q4; Approaches 1.4.4 FY22Q4)

Deposition Measurements – John Walker
EQUATES – Kristen Foley
Meet the Scientists Session #1
Room C

United States
Environmental Protection
Agency

Increasing Need to Quantify Natural Contributions and Anthropogenic Enhancements

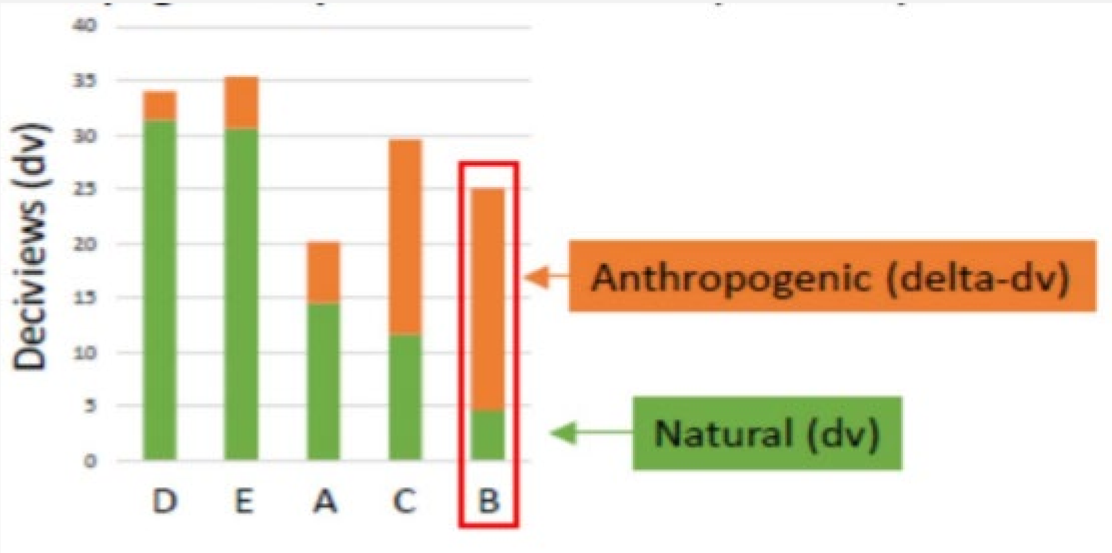
O_3 NAAQS



2016 Daily-max 8-Hour Ozone (DM8O_3) Design Values across the US

< 60 ppb 61-65 ppb 66-70 ppb 71-75 ppb 76-80 ppb 81-90 ppb >90 ppb

Regional Haze

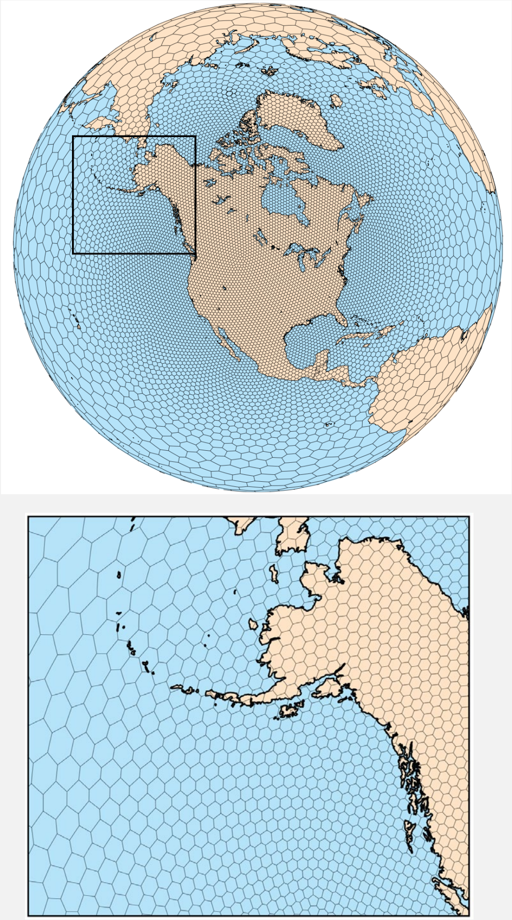


- Updated standards place ***greater/renewed emphasis*** on the ability of models to
  - Simulate the *entire spectrum of concentrations*
  - Accurately represent *(smaller) contributions from numerous sources*
  - Represent atmospheric physics and chemistry over *larger space and time scales*
  - Incorporate *uncertain emissions* from (i) regions outside the US; (ii) sectors (international shipping, soil NO_x)
  - "Anthropogenic impairment" vs. natural contributions
  - Aerosol optical properties (composition & *size*)

Products 1.2.4 FY22Q2, 1.3.2,3,5 FY21,22Q4

MPAS-CMAQ: Advanced Air Quality Modeling System

- Model for Prediction Across Scales (currently MPASv7.0) coupled with Community Multiscale Air Quality (CMAQv5.3.2) Model
- CMAQ is called as module in MPAS with 2-way data transfer through a coupler analogous to MPAS coupler for WRF Physics
- Advection of chemical species in MPAS identical to meteorological scalars
  - Advection in CMAQ is turned off when coupled to MPAS
  - No need for mass adjustment for continuity in CMAQ
- MEGANv3.1 is inline for global biogenic VOC and soil NO emission modeling
- CMAQ includes detailed treatment of halogen chemistry
- Upper boundary ozone (stratospheric) from CAMS reanalysis

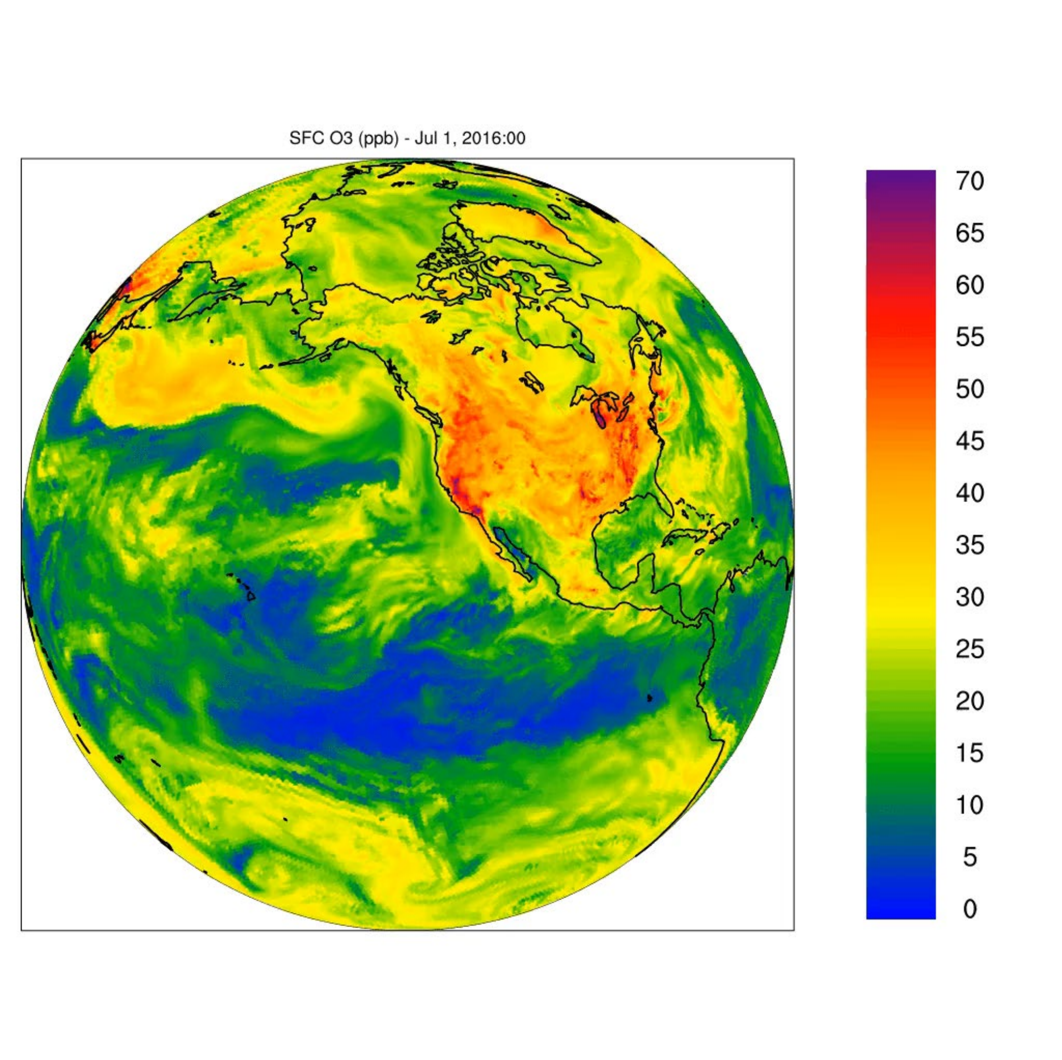


MPAS

Products 7.4.x FY20-22

MPAS-CMAQ global surface ozone concentration

- Intercontinental transport of ozone
  - Asia to North America
  - North America to Europe
- Higher concentrations in high elevations
- Detailed halogen chemistry reduces ozone over oceans especially tropics
- More detail in North America where mesh resolution is 25 km

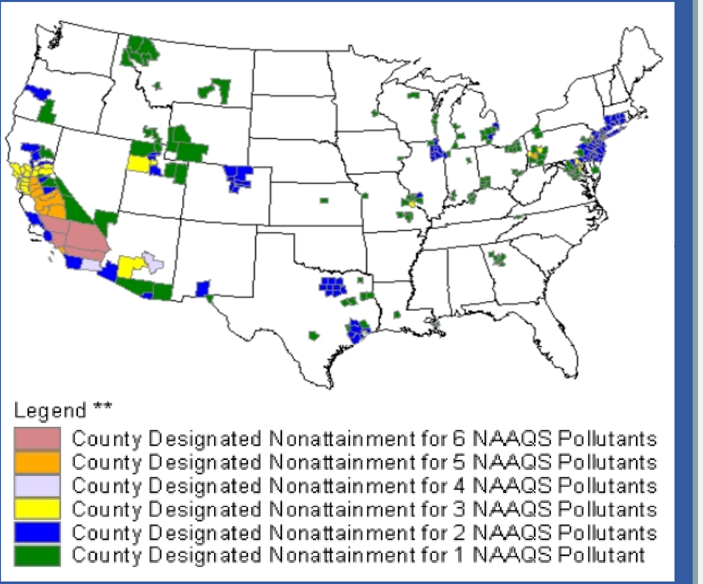


Products 7.4.x FY20-22

Energy modeling and the NAAQS

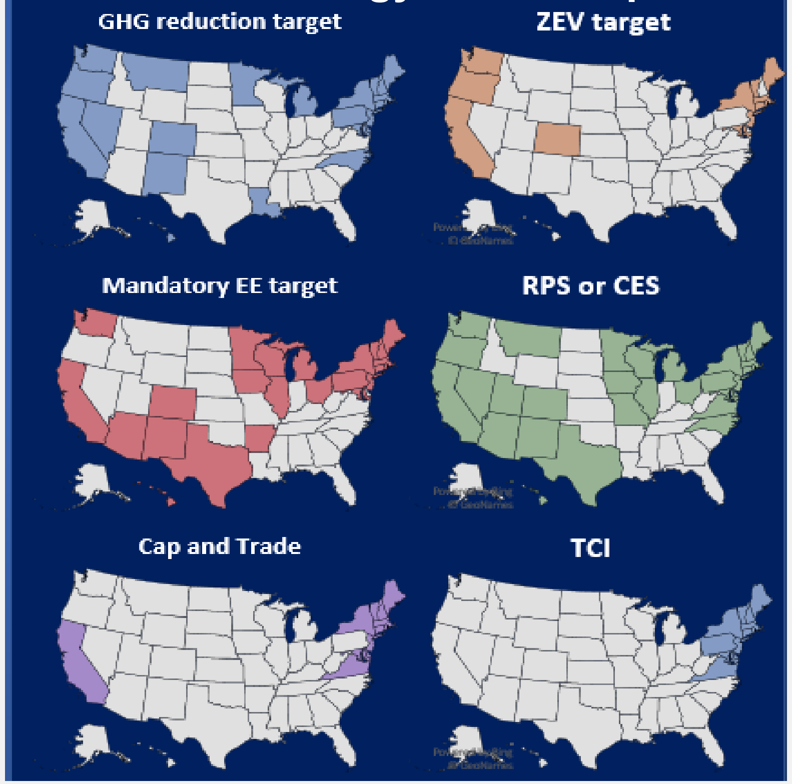
EPA United States Environmental Protection Agency

Non-attainment areas



- 130 million people live in non-attainment areas
- States with nonattainment areas must develop attainment strategies
- In many, limited traditional control options remain

State energy and GHG policies



- Many states have implemented energy and climate policies
- These typically have air pollutant co-benefits

Role of Energy System Modeling

ORD is using the TIMES, COMET, and GCAM-USA energy system models to answer questions such as:

- How are state energy and climate policies expected to affect attainment into the future?
- What additional measures area available and what are the benefits?
    - Energy efficiency
    - Renewable electricity
    - Electric vehicles

We are demonstrating these capabilities for NYC, CT, and several Mid-Atlantic states.

MEASUREMENT RESEARCH TO INFORM THE NAAQS

Lara Phelps, Director

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

A-E BOSC Subcommittee Meeting

February 17 – 19, 2021

Outline

- Air Methods and Characterization Division
- Measurement Programs
  - Regulatory Program
  - Sensor Program
  - Application Programs
- Measurement Tools
- Summary

Air Methods and Characterization Division (AMCD)

- AMCD develops, evaluates and applies advanced laboratory and field methods to measure, characterize, and analyze concentrations of pollutants in the air and at a diverse array of emission sources. AMCD scientists also:
  - Develop fundamental methods required to support the implementation of the Clean Air Act (CAA), including federal reference methods (FRMs) and federal equivalent methods (FEMs) to measure criteria pollutants that are required to determine compliance with National Ambient Air Quality Standards (NAAQS).
  - Develop analytical methods for the collection and analysis of air toxics and related species to meet regulatory requirements and inform analyses of exposure and health effects.
  - Develop, evaluate, and apply advanced monitoring technologies and methods to characterize and predict emissions from a variety of sources, provide solutions to manage air pollutant sources, and to minimize environmental impact.
- AMCD interfaces with all ORD centers in addition to EPA Program and Regional offices, state/local agencies, academia, industry, communities, and other federal and nonfederal organizations relative to Division programs and services.

EPA

FRM / FEM Samplers and Analyzers

Output 2.2 and Related Products

Federal Reference Methods (FRMs)

- Designed to provide the most fundamentally sound and scientifically defensible concentration measurement
- FRM measurement principles for each criteria pollutant are published in 40 Code of Federal Regulations (CFR) Part 50
- FRMs serve as the basis of comparison upon which to judge other measurement methods

Federal Equivalency Methods (FEMs)

- Intended to provide a comparable level of compliance decision making quality as provided by FRMs
- May include newer, innovative technologies to reduce overall operating cost and to achieve multiple monitoring objectives (e.g., real-time reporting for health studies and for issuing timely public health advisories)

Methods Designation Program

- FRM/FEM monitoring methods are domestically and internationally recognized as the gold standard of air monitors by:
  - Government regulatory programs,
  - Instrument manufacturers,
  - Air quality researchers,
  - Health scientists, and
  - The public

- During the last 5 years, 116 FRM/FEM designations decisions were made – https://www.epa.gov/amtic/air-monitoring-methods-criteria-pollutants

Complementary Role of Air Sensors

Outputs 7.1, 7.2, and 7.3 and Related Products

- Goal of the nationwide regulatory monitoring network is to provide high quality data to help assess the public's exposure to the criteria pollutants and for evaluating the effectiveness of pollutant control strategies
- There is a desire for community level monitoring and mobile measurements that may be filled by a new class of complementary technology, air sensors

Regulatory Monitoring Site

More local measurements and temporary sites

Educational exploration

Mobile measurements carried by individuals

Mobile measurements using vehicles

Key Differences

FRMs/FEMs and Sensors Provide Complementary Approaches for Measuring Ambient Air Quality

- Measurements for regulatory use
- Data used for compliance decisions
- Provide high confidence in the data
- Adhere to established data quality control and assurance methods

- 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
- Offer smaller and/or more portable devices at a lower cost

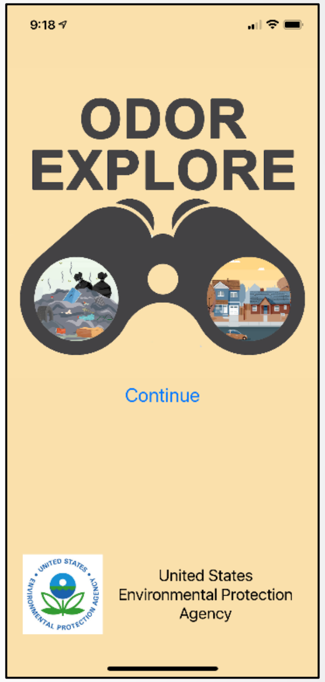
Key Differences

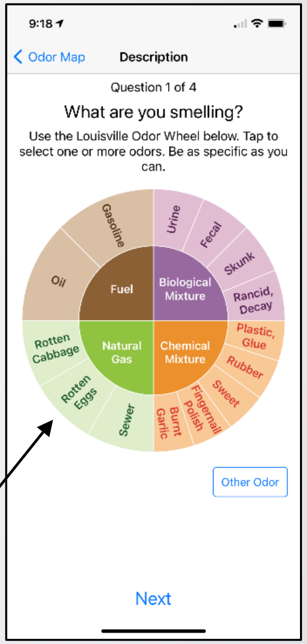
	Reference Monitors	Air Sensors
Typical Purchase Cost	$15,000 to $40,000 (USD)	$200 to $5,000 (USD)
Formal Designation/ Testing Program	Yes	No
Staff Training	Highly trained technical staff	Little or no training to operate; May need more training to interpret data
Operating Expense	Expensive – shelter, technical staff, maintenance, repair, quality assurance, data management	May be less expensive but costs due to replacement, data streaming, data management
Siting Location	Fixed Location (climate-controlled building/trailer needed)	More portable. May require weather shielding. Siting can be easier due to lower flow but trickier because of data streaming
Data Quality	Known and consistent quality in a variety of conditions	Unknown. Can vary from sensor to sensor, in different weather conditions, and in different pollution environments
Operating Lifetime	10+ Years (calibrated and operated to maintain accuracy)	Short (1 year) or Unknown (may become less sensitive over time)
Regulatory Monitoring?	Yes	No

Application Programs

A-E Output 7.1, Product 7.1.2
Summary of Next Gen Methods and Citizen Science to Evaluate Source Emission Impacts

- **Issue**
  - Source emissions can be complex to characterize
  - Many communities (including environmental justice communities) live, work, play, and attend school in and around the vicinity of pollution sources
  - Poor air quality and odors resulting from different emissions can be a nuisance and may cause health concerns and stress for impacted communities
- **Approach**
  - EPA is developing a mobile app (for iOS and Android) that can be used by community members to report odors and view odor reports in their area
  - Data from the app will be paired with data from next generation emissions measurement (NGEM) systems to capture a chemical 'fingerprint' of emissions
- **Anticipated Outcomes**
  - Demonstrate utility of combining a variety of data types (citizen science and NGEM) to help better understand emissions
  - Engage communities and increase transparency
  - Help EPA Regions, state/local agencies, and industries evaluate air pollution and odor control strategies





Odor Wheel
Captures detailed information about odors

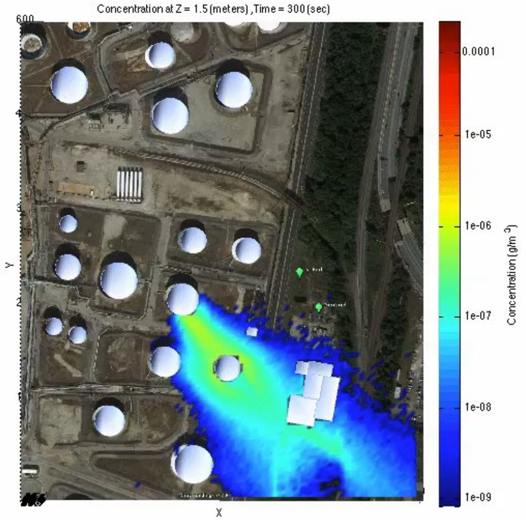
Next Generation Emissions Measurement (NGEM)

- New approaches for difficult sources
- Sensors in facilities and in communities
- Crowdsourcing odor and other observations
- Hybrid measurement/model systems
- Predictive and transparent informetric

Metrology

Facility Sensors

Personal and Community Sensors



Informetrics

Near Source Impacts/ Energy/ Industry Sensors

Metadata

Geospatial

Emission Measurement Tools

Method Modifications

USGS UAS with ORD "Kolibri" Sensor/Sampler

Low-cost PM Sensors

Emission Characterization Tools

- Laboratory and pilot-scale **source** emissions characterization
    - Stationary diesel genset
    - Multi-Pollutant Control Research Facility (MPCRF)
    - EtO sterilizer
- Field studies
    - Rural and urban settings
    - Near-source
    - Fugitive emissions

AMCD's Stationary Diesel Facility (200kW genset)

CESER's Laboratory EtO sterilizer

AMCD's Multi-Pollutant Control Research Facility (MPCRF)

Summary

- With the ability to measure our environment at previously unseen levels of detection, the landscape of science is constantly evolving.
- Emerging environmental issues and contaminants of concern are being investigated to answer the immediate questions of uncertainty with regards to public health and exposure.
- Novel, innovative technology is being unveiled at a rapid pace and evaluated for relevance in measurement and monitoring priority areas.
- The development or application of an innovative approach; improvement in problem solving capacity; and formation of successful alliances with stakeholders are strategic means for advancing our knowledge to the rapidly changing surroundings.