AGENDA: 4

BAY AREA AIR QUALITY MANAGEMENT DISTRICT

Fine Particulate Matter Local Risk Methodology Update

Advisory Council Meeting
January 30, 2023

David Holstius, PhD
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Overview

1. Recap of progress during 2022
2. Response to Council re: infiltration
3. Public comments

Recap of Progress During 2022

February	Regulatory toolbox Broadly scoped whitepaper
April	Gaps in the regulatory framework Envisioned applications
July	Focus on maximal risk Extend to multi-year exposure Expand to include asthma
September	Conceptual links between methodologies
November	Draft released for public comment

Infiltration

Concept

- Buildings offer some protection, but situations vary
- For a given pollutant, $\boldsymbol{F_{inf}}$ is the "infiltration factor"—the ratio of its concentration indoors *vs.* outdoors, under steady-state conditions

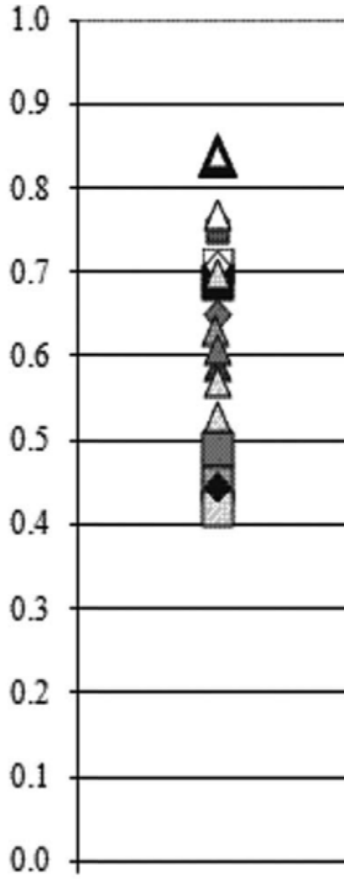
Recommendation

- Adjust calculations such that F_{inf} = 1
- Consistent with cancer-risk framework, where F_{inf} = 1 is implicit
- Consistent with situations where receptor is especially at risk: poor quality housing; no housing; outdoor job site, etc.

Recommendation

Typical F_{inf} estimates for $PM_{2.5}$ are clustered around 2/3

- Epidemiological results effectively include this
- Use ratio to back it out: $\frac{1}{2/3} \approx$ **1.5x adjustment**



Diapouli et al. / J. Air & Waste Mgmt Assoc 63 (2013) 1113–1129

- Ozkaynak et al., 1996 (CA, U.S.A.)
- Long et al., 2001a (MA, U.S.A.)
- Meng et al., 2005b (U.S.A.)
- Diapouli, 2008 (Athens, Greece)
- Polidori et al., 2007 (CA, U.S.A.)
- Hanninen et al., 2004 (Basle, Switzerland)
- Hanninen et al., 2004 (Helsinki, Finland)
- Diapouli, 2008 (Athens, Greece)
- Noullett et al., 2010 (Canada)
- Koutrakis et al., 1992 (NY, U.S.A.)
- Williams et al., 2003 (NC, U.S.A.)
- Wichmann et al., 2010 (Stockholm, Sweden)
- Allen et al. 2003 (WA, U.S.A.)
- Samat et al., 2002 (MA, U.S.A.)

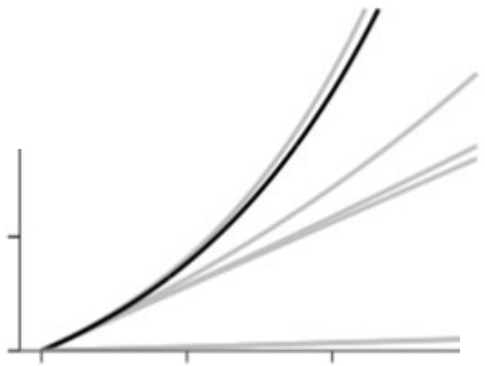
Revised Net Adjustments

		Previous	**Revised**
Mortality	Residential	5x	**7x**
	Worker	11x	**17x**
Asthma	Daycare	12x	**19x**
	Student	10x	**15x**
	Residential	5x	**7x**

Ratios of final results (with vs without adjustments) for a +0.1 ug/m^3 incremental concentration

Methodological Considerations

- Consider a **+0.3 µg/m³** annual average $PM_{2.5}$ increment (ΔC)
- Given a 20x adjustment, the Δx term would be **+6 µg/m³**
- Compare to ranges of data in supporting studies
- Model form is exponential (curves upward)



Public Comments: Overview

1: Methodology

- Strength of the science
  - Epidemiology & causation
  - Below current NAAQS
  - For asthma
- Risk magnitude
- Accuracy
- Uncertainty
- Completeness
- Adjustments for vulnerable groups

2: Policy / Implementation

- Authority & precedent
- Ramifications
- Efficiency
- Context

3: Minor

- Technical details
- Clarifications

Public Comments: Methodology

1(a): Foundation

- Select 2 health endpoints: asthma & mortality
- Take emission data for single source and model its impact on air quality at most-impacted receptors
- For each endpoint, apply an epi-derived equation to predict annual excess risk (EPA approach)
- Extend to multi-year exposure window

1(b): Extensions

- Account for higher potential risk by adjusting foundational results
- Assume relationship between concentration, exposure, and dose is linear
- Follow OEHHA guidance doc re: key parameters & values (e.g. breath rate)
- Also adjust for vulnerability
  - Reduce estimation problem to choice between 1x, 3x, or 10x—focus on fitness for purpose; avoid “precision paralysis”
  - For senior mortality: 3x (epi data)
  - If no data: default to 3x (precautionary)

Effect Size

***Standardization formula**: RR per 1 µg/m³ = (RR per U µg/m³) ^ (1 / U)*

		Relative Risk (RR)	
Endpoint	**Study**	**Reported As**	**Standardized**
Asthma	Tetréault et al (2016)	1.33 (1.31, 1.34) per 6.53 µg/m³	1.045 per 1 µg/m³
Mortality	Di et al (2017) [a]	1.136 (1.131, 1.141) per 10 µg/m³	1.013 per 1 µg/m³
	Di et al (2017) [b]	1.11 (1.08, 1.15) per 10 µg/m³	1.010 per 1 µg/m³
	Vodonos et al (2018) [c]	1.0129 (1.0109, 1.0150) per 1 µg/m³	1.013 per 1 µg/m³

[a] For exposures less than 12 µg/m³

[b] Pooled random-effects summary of recent studies

[c] Evaluated at 10 ug/m³ baseline

Note: additional studies (e.g. Yazdi et al 2021) cited and discussed in FAQ section of public white paper (v1.1)

Thank You

Questions and Comments

California Council for Environmental and Economic Balance

AGENDA: 5

RISK MANAGEMENT AND REGULATORY CONTEXT

Modeling Local Sources of Fine Particulate Matter (PM2.5) for Risk Management

Bay Area Air Quality Management District 2022

CCEEB Presentation to BAAQMD Advisory Council

January 30, 2023

California Council for Environmental and Economic Balance

The California Council for Environmental and Economic Balance (CCEEB) is a nonpartisan, nonprofit coalition of labor, business, and public policy leaders that advances strategies for a healthy environment and sound economy.

CCEEB represents many facilities that operate in BAAQMD.

GUIDING PRINCIPLES

Recommendations should:

- Be based on best available, peer-reviewed science
- Consider input and lessons learned from other agencies
- Consider $PM_{2.5}$ speciation and source apportionment
- Address regional vs local impacts and control strategies
- Include an economic evaluation
- Prioritize strategies by greatest amount of near-term, cost-effective reductions

California Council for Environmental and Economic Balance

SIMPLICITY VS COMPLEXITY

QUESTION:

IS THE PROPOSED METHODOLOGY INTENDED TO SUPPORT ONE SPECIFIC APPLICATION, OR IS IT INTENDED TO UNDERLIE MULTIPLE, DISTINCT REGULATORY PROGRAMS?

- Project applicants must understand how regulatory frameworks apply to their projects and application must be consistent
- Best available data should be used, even where it adds "complexity"

California Council for Environmental and Economic Balance

FACTORS OF CONSERVATISM

Table 13: Protective approaches applied to key dimensions of the methodology.

Component	Protective Aspect(s)
Exposure duration	For residential receptors, the length of the exposure window (30 years) is based on the 90th percentile of residency times.
Dose	For breathing rates, 95th percentiles are used. For workers and children, moderate exertion levels are assumed.
Effect size	The starting points are central estimates of population-average effect size. These are scaled by factors of 3 to account for individual variation.

QUESTIONS:

IN WHICH CONTEXTS IS A MAXIMUM RISK FRAMEWORK MOST APPROPRIATE?

DOES THE MODEL REDUCE DUPLICATION AND FACILITATE USE IN REGULATORY CONTEXTS?

BAAQMD 2022 v1.1, p. 25

California Council for Environmental and Economic Balance

RISK COMMUNICATION

QUESTIONS:

HOW BEST TO CONTEXTUALIZE AND COMMUNICATE RISK VS. INCIDENCE?

DOES THE PROPOSED METHODOLOGY'S DESIGN SUPPORT EASY TO UNDERSTAND, TRANSPARENT APPLICATION?

3×10^{-1} µg/m³	1.3×10^{-2}	7.5×10^{-3}	1.1×10^{-2}	2.9×10^{-3}	4.5×10^{-3}
1×10^{-1} µg/m³	4.3×10^{-3}	2.4×10^{-3}	3.6×10^{-3}	9.6×10^{-4}	1.5×10^{-3}
3×10^{-2} µg/m³	1.3×10^{-3}	7.2×10^{-4}	1.1×10^{-3}	2.9×10^{-4}	4.5×10^{-4}
1×10^{-2} µg/m³	4.2×10^{-4}	2.4×10^{-4}	3.5×10^{-4}	9.6×10^{-5}	1.5×10^{-4}
3×10^{-3} µg/m³	1.3×10^{-4}	7.2×10^{-5}	1.1×10^{-4}	2.9×10^{-5}	4.5×10^{-5}
1×10^{-3} µg/m³	4.2×10^{-5}	2.4×10^{-5}	3.5×10^{-5}	9.6×10^{-6}	1.5×10^{-5}

RECOMMENDATIONS

- Prioritize potential regulatory applications and **revise methodology to fit priorities**
- Summarize existing policies and programs (regional, statewide, and federal) intended to control PM2.5 and **assess alignments and conflicts** posed by the proposed methodology
- **Conduct a third-party independent validation** of all equations supporting the proposed methodology by working a "test case" or "case study" to show how the tool should be used
- Describe how the methodology would be **continuously updated and assessed for efficacy and accuracy**
- **Conduct full regulatory analysis** of any application of the proposed methodology

OTHER ISSUES

- District authority
- Potential conflicts with ongoing BAAQMD efforts related to PM2.5
- Implications for District's regulatory, permitting, and CEQA programs
- Impacts to regional economy and infrastructure development

California Council for Environmental and Economic Balance

THANK YOU

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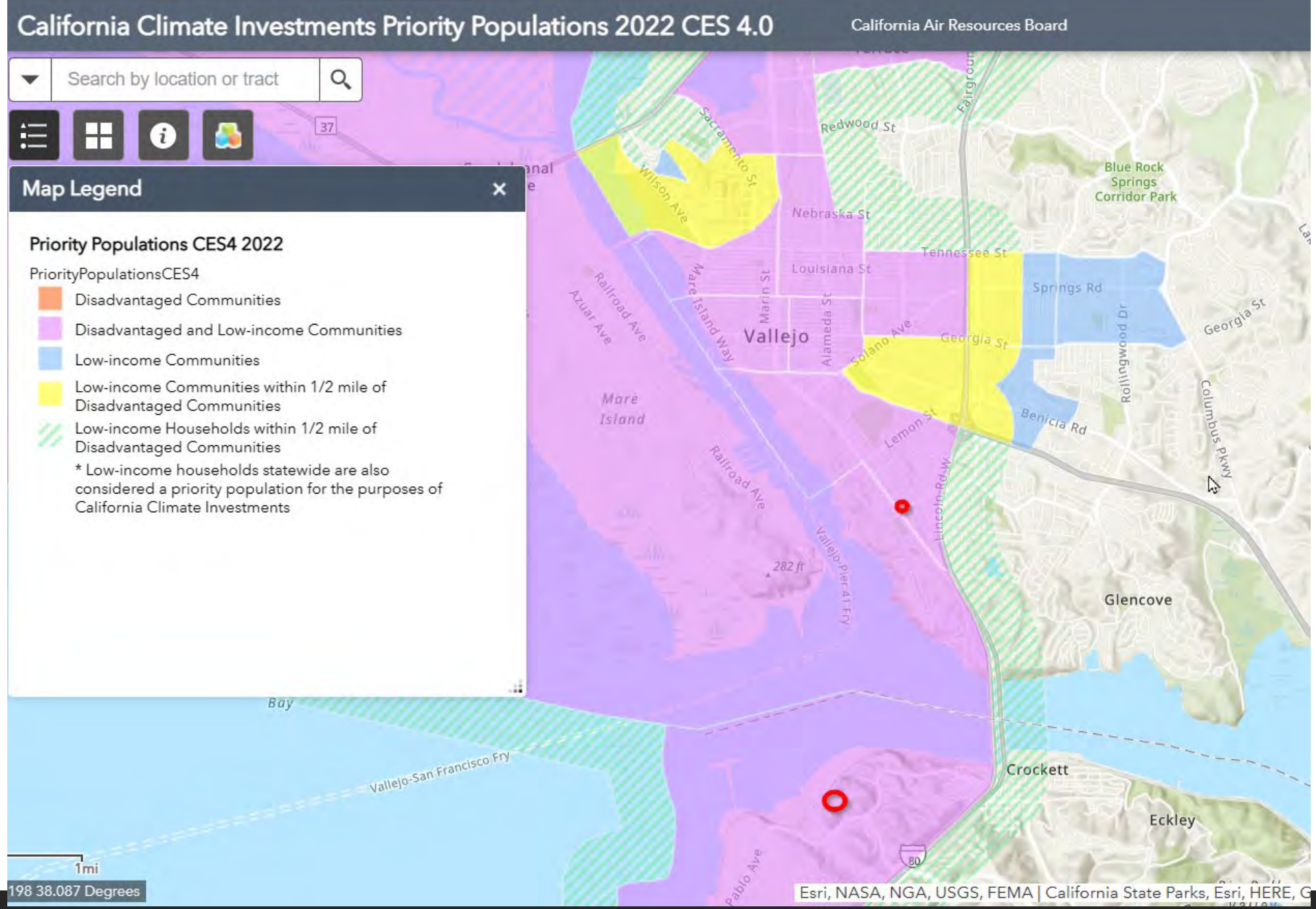
Citizen Air Monitoring Network

KEN SZUTU


2019-10-15 3:45 pm


California Climate Investments Priority Populations 2022 CES 4.0
California Air Resources Board
Search by location or tract
Map Legend
Priority Populations CES4 2022
PriorityPopulationsCES4
Disadvantaged Communities
Disadvantaged and Low-income Communities
Low-income Communities
Low-income Communities within 1/2 mile of Disadvantaged Communities
Low-income Households within 1/2 mile of Disadvantaged Communities
* Low-income households statewide are also considered a priority population for the purposes of California Climate Investments
Vallejo
Mare Island
Glencove
Crockett
Eckley
Blue Rock Springs Corridor Park
Redwood St
Nebraska St
Tennessee St
Louisiana St
Georgia St
Springs Rd
Benicia Rd
Lemon St
Solano Ave
Wilson Ave
Sacramento St
Mare Island Way
Railroad Ave
Azuar Ave
Marin St
Alameda St
Rollingwood Dr
Columbus Pkwy
Lincoln Rd W
Vallejo-Pier 41 Fry
Vallejo-San Francisco Fry
282 ft
Bay
37
80
1mi
198 38.087 Degrees
Esri, NASA, NGA, USGS, FEMA | California State Parks, Esri, HERE, G

Sonoma x Magazine

Vallejo


ASTHMA Emergency Dept Visits & Hospitalization (per 10,000 Population), May 2016 CHNA
Vallejo 94590 - 470
State - 148
ED Visits & Hospitalization
276.21
102.22
375.27
120.07
470.83
131.67
291.99
100.54
333.64
116.9
256.24
137.64
254.32
120.87
148.86
70.55
Solano County
94589
So Vallejo 94590
94591
Rio Vista 94533
Fairfield 94571
Vacaville 95688
California State
COMMUNITIES OF CONCERN
Source: CHNA - Solano County, May 2016
ED Visits
Hospitalization

Please make sure that **Model Reflects Reality**

Redefining Refinery Community – Vallejo is a refinery community without a refinery.

AGENDA: 5

GRADIENT

Modeling Local Sources of Fine Particulate Matter ($PM_{2.5}$) for Risk Management

Julie E. Goodman, Ph.D., DABT, FACE, ATS
Gradient

Bay Area Air Quality Management District

Advisory Council Meeting
January 30, 2023

BAAQMD Model

- Inputs
  - Concentration-response functions from epidemiology studies
  - Modeled $PM_{2.5}$ concentrations
- Outputs
  - Increases in mortality in older adults and workers
  - Asthma onset in children associated with a local source
- Model highly overestimates incremental increases in risk associated with $PM_{2.5}$ increments of 0.001-0.3 $\mu g/m^3$

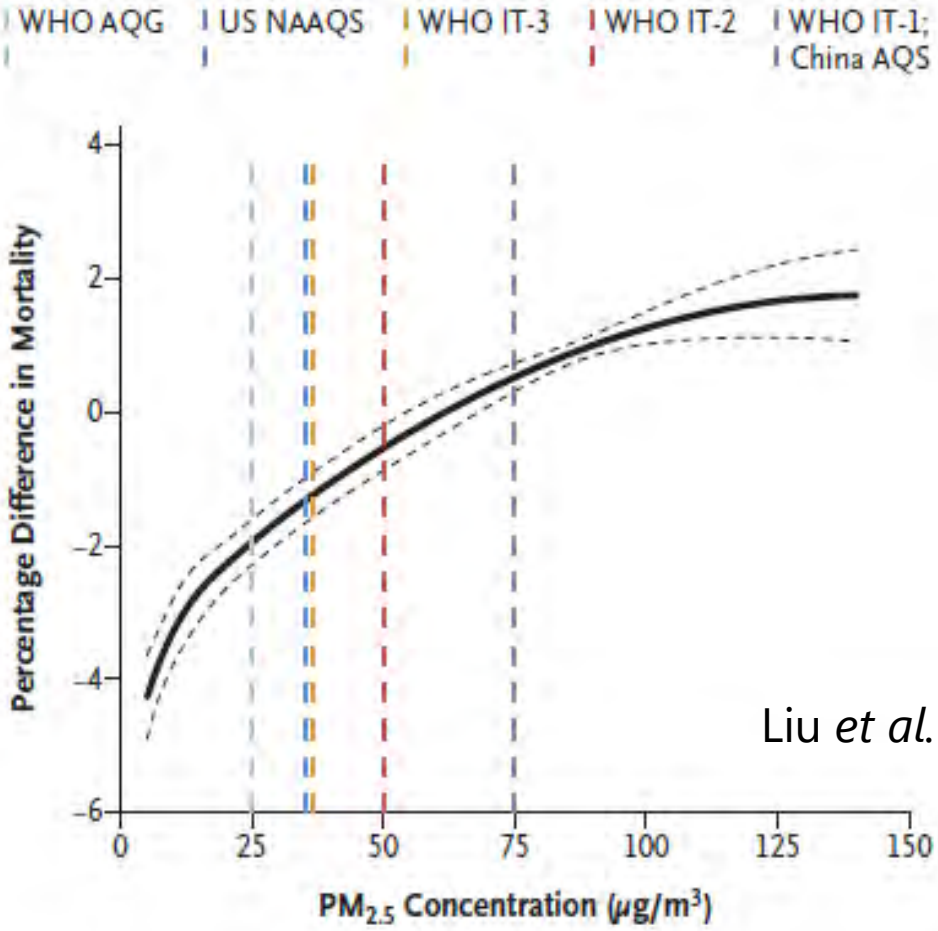
PM Associations vs. Causation

- PM is associated with morbidity and mortality in many traditional epidemiology studies
- Associations, particularly at low concentrations, are small in magnitude
- Association does not always mean causation
- Most likely explanation
  - Bias (*e.g.*, exposure measurement error)
  - Confounding
  - Chance
  - Inappropriate statistical model

The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 AUGUST 22, 2019 VOL. 381 NO. 8

Ambient Particulate Air Pollution and Daily Mortality in 652 Cities

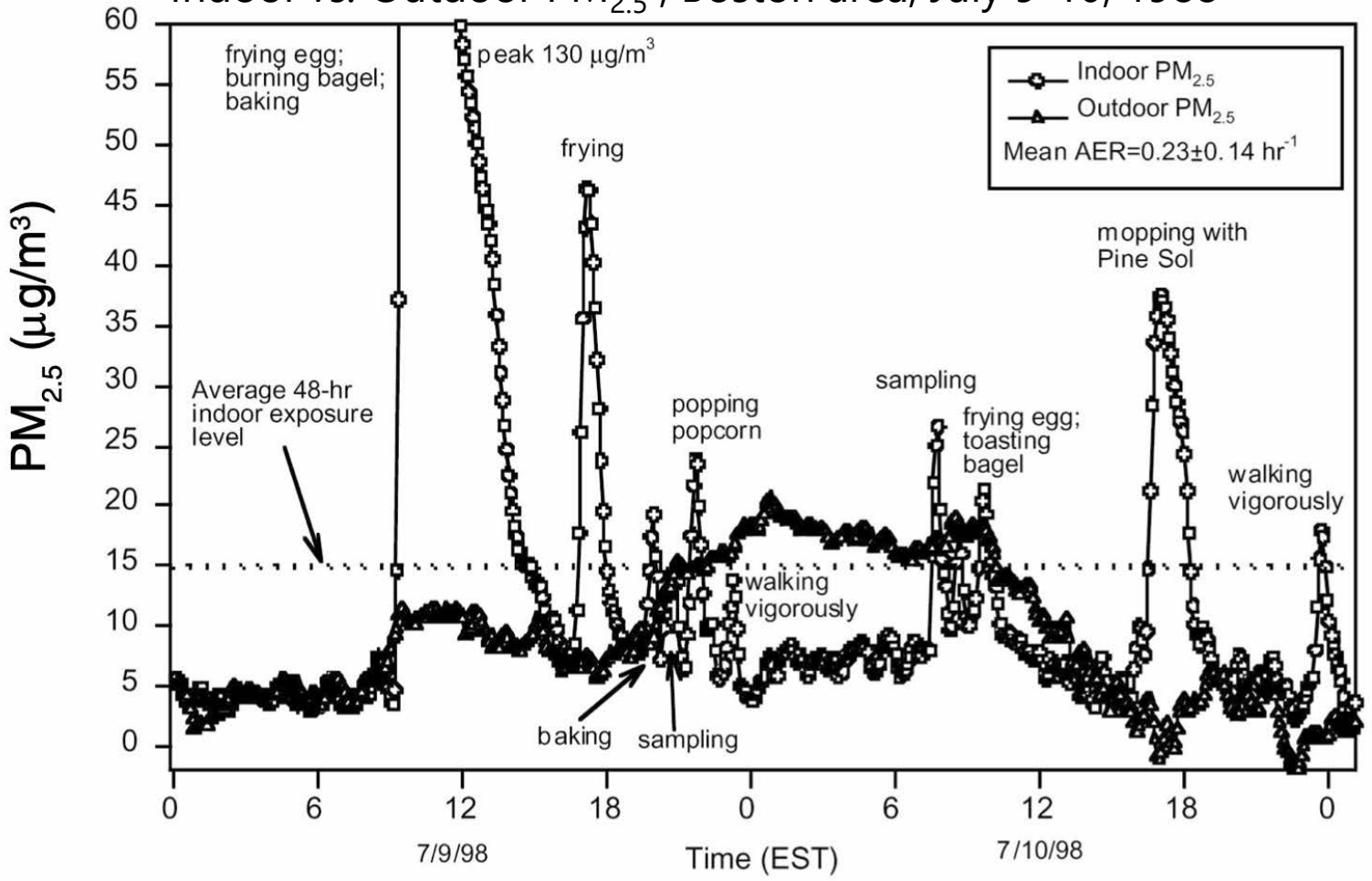


Liu *et al.* (2019)

Exposure Measurement Error – Ambient Air Monitors

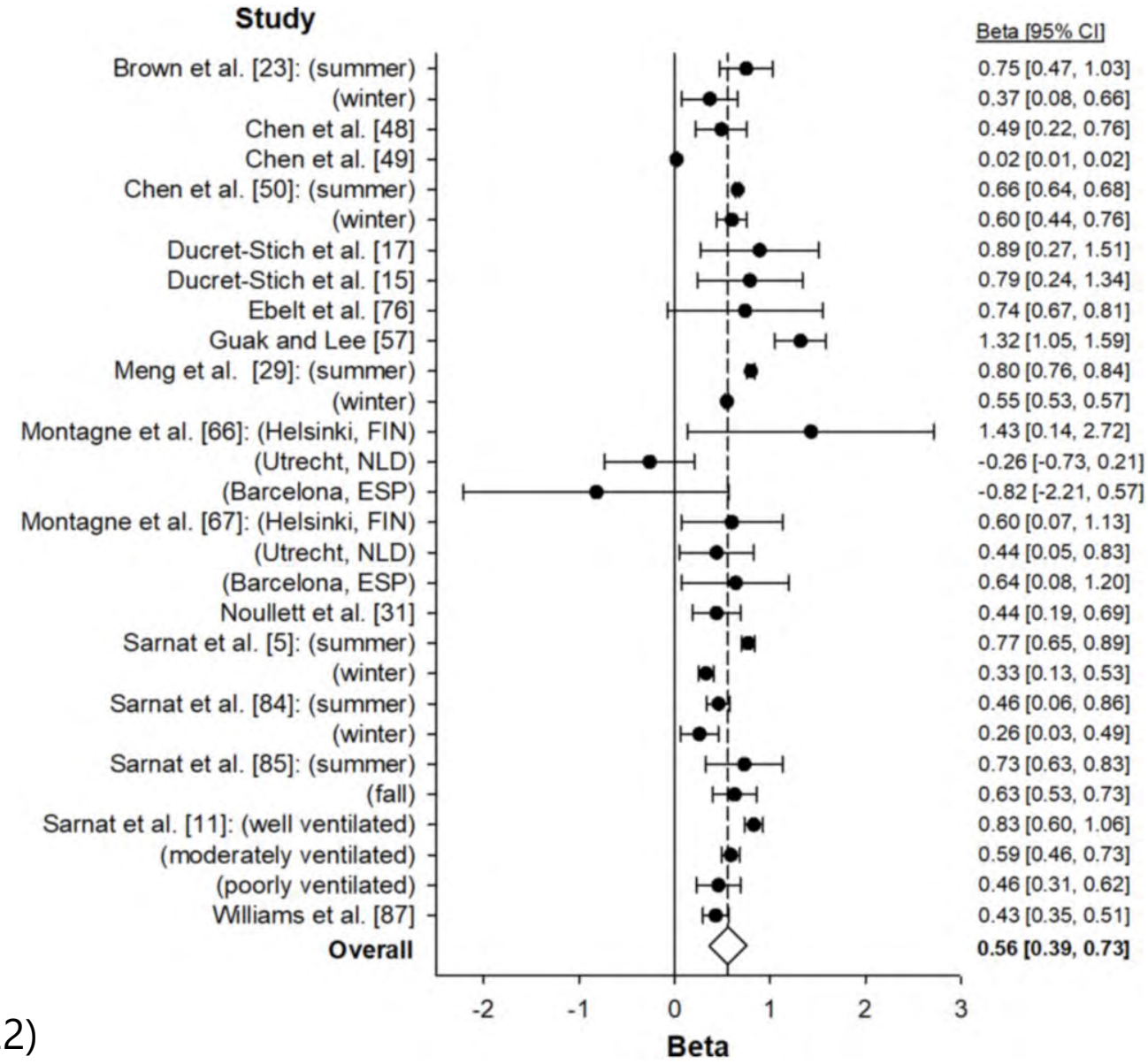
- Most studies use ambient air monitors
- People often spend a lot of time away from home or move
- People spend most time indoors
- Average PM exposures can be higher indoors

Indoor *vs.* Outdoor $PM_{2.5}$, Boston area, July 9-10, 1988



Long *et al.* (2000)
Harvard School of Public Health

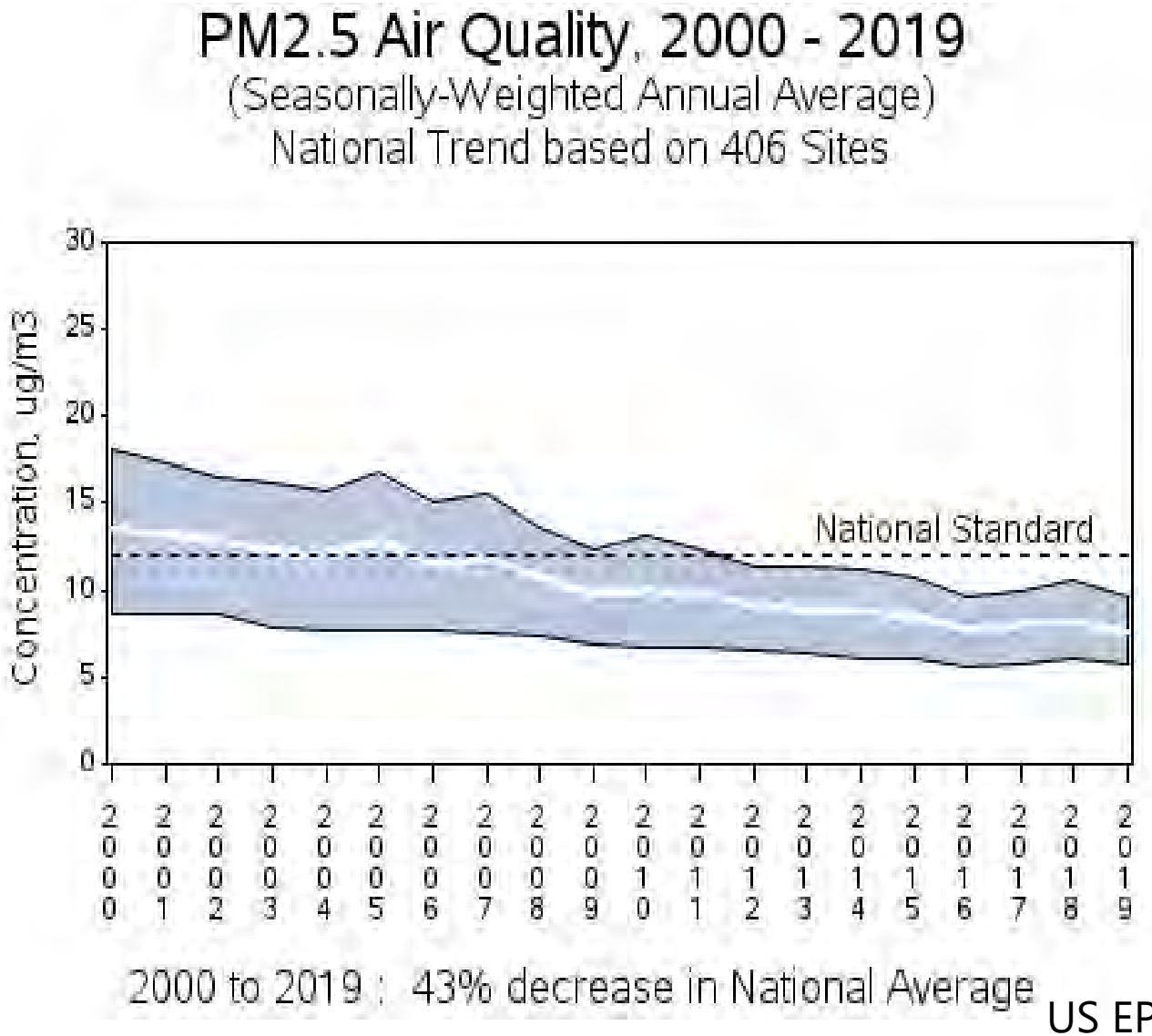
Exposure Measurement Error – Personal vs. Ambient $PM_{2.5}$ Associations Vary



Boomhower *et al.* (2022)

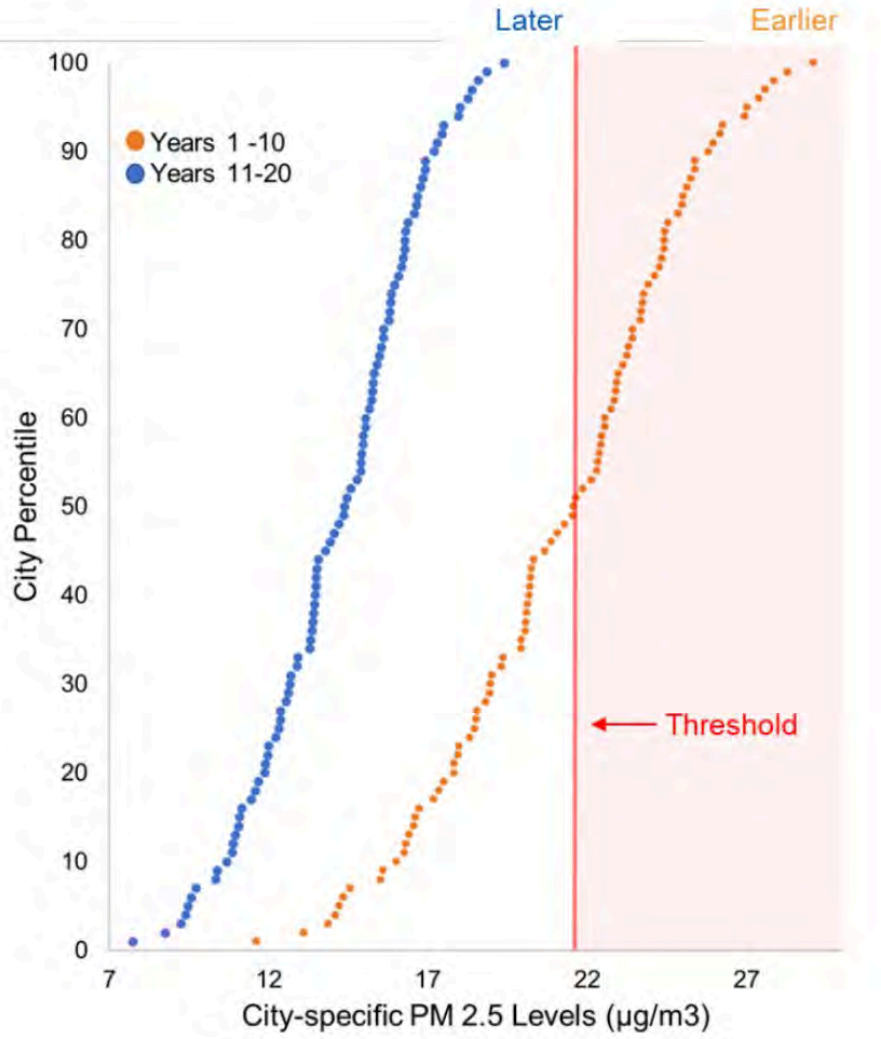
GRADIENT

Exposure Measurement Error – Many Studies Evaluate the Wrong Exposure Window and Overestimate Associations



US EPA, 2020

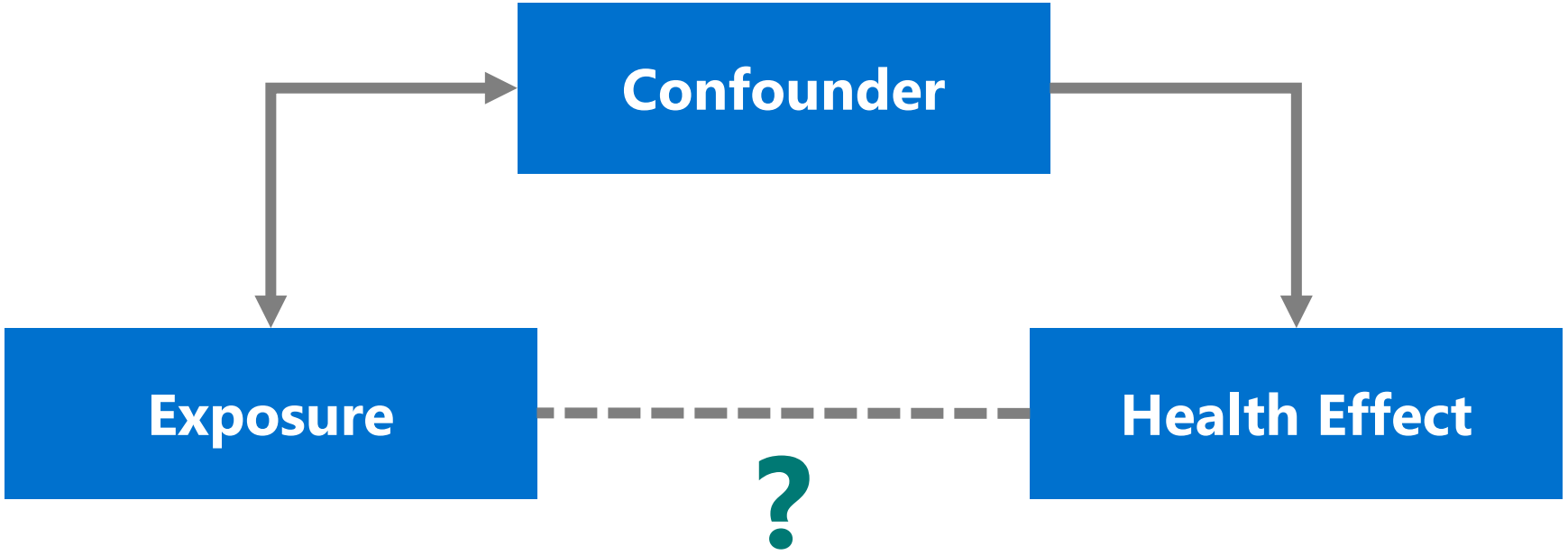
Figure 1. $PM_{2.5}$ Distributions in Illustrative Example



Smith and Chang, 2020

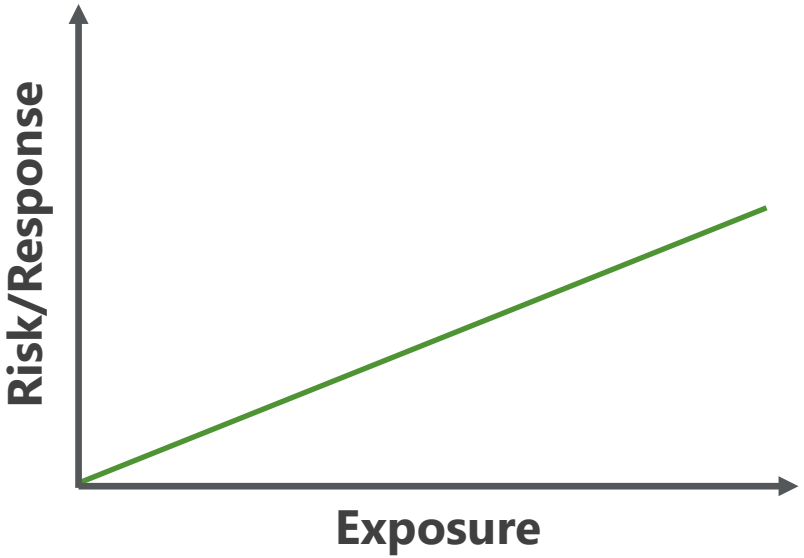
Confounding

- Other exposure window
- Atmospheric conditions
- Other copollutants, allergens
- Socioeconomic status (SES)
- Lifestyle factors (*e.g.*, smoking)
- Access to health care
- Genetics

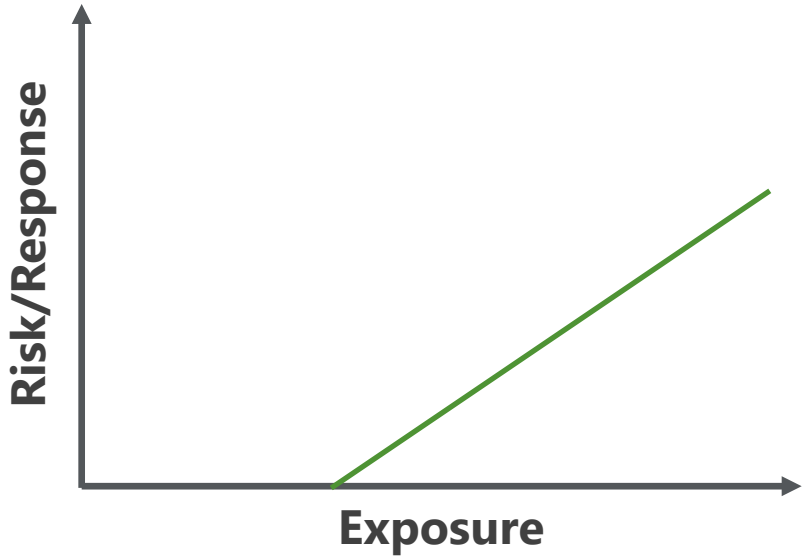


Model Choice and Measurement Error Linearizes Exposure-response Curve

No Threshold



Threshold



Causal Methods Example – Burns *et al.* (2017)
Health Effects Institute Review of 42 Studies of 38 Interventions

Interventions

- Industrial
- Residential
- Vehicular
- Multiple

Comparison: *No restrictions*

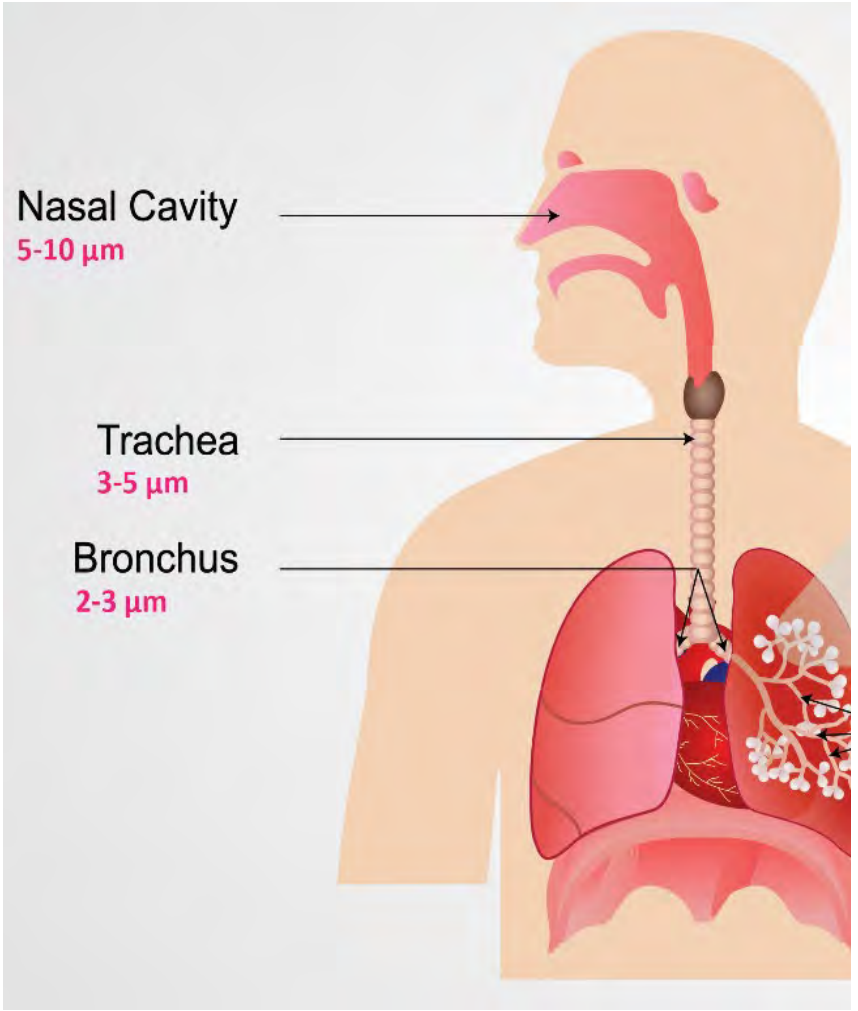
Primary Outcomes

- All cause mortality
- Cardiovascular Mortality
- Respiratory Mortality
- PM_{10}
- $PM_{2.5}$
- Coarse PM
- Soot
- Black carbon (BC)
- Black smoke (BS)
- Elemental carbon (EC)

Results: "Evidence for effectiveness was mixed. Most included studies observed either no significant association or an association favoring the intervention, with little evidence that the assessed interventions might be harmful."

Toxicity Studies – There is a threshold below which people can be exposed to PM and not experience health impacts

- If exposures are sufficiently low, PM will not cause adverse health effects because it won't overwhelm the body's natural defenses.
- This is supported by experimental studies in humans and animals.
- CARB relies on this principle for all other non-carcinogenic agents.
- There is no justification for assuming one particle will impact health.



BAAQMD Model Limitations

- Very small risk estimates more likely due to large numbers and bias than causation

Endpoint	Risk Estimate
Mortality in older adults	1.01
Asthma in children	1.045

- Estimated risks associated with 0.001-0.3 µg/m^3 $PM_{2.5}$ increments are not reliable
- Model uses cancer-based equation, not valid for non-cancer endpoints, which have thresholds
- Incremental differences of 0.001-0.3 µg/m^3 $PM_{2.5}$ are negligible compared to $PM_{2.5}$ concentrations and fluctuations in $PM_{2.5}$ in the Bay Area

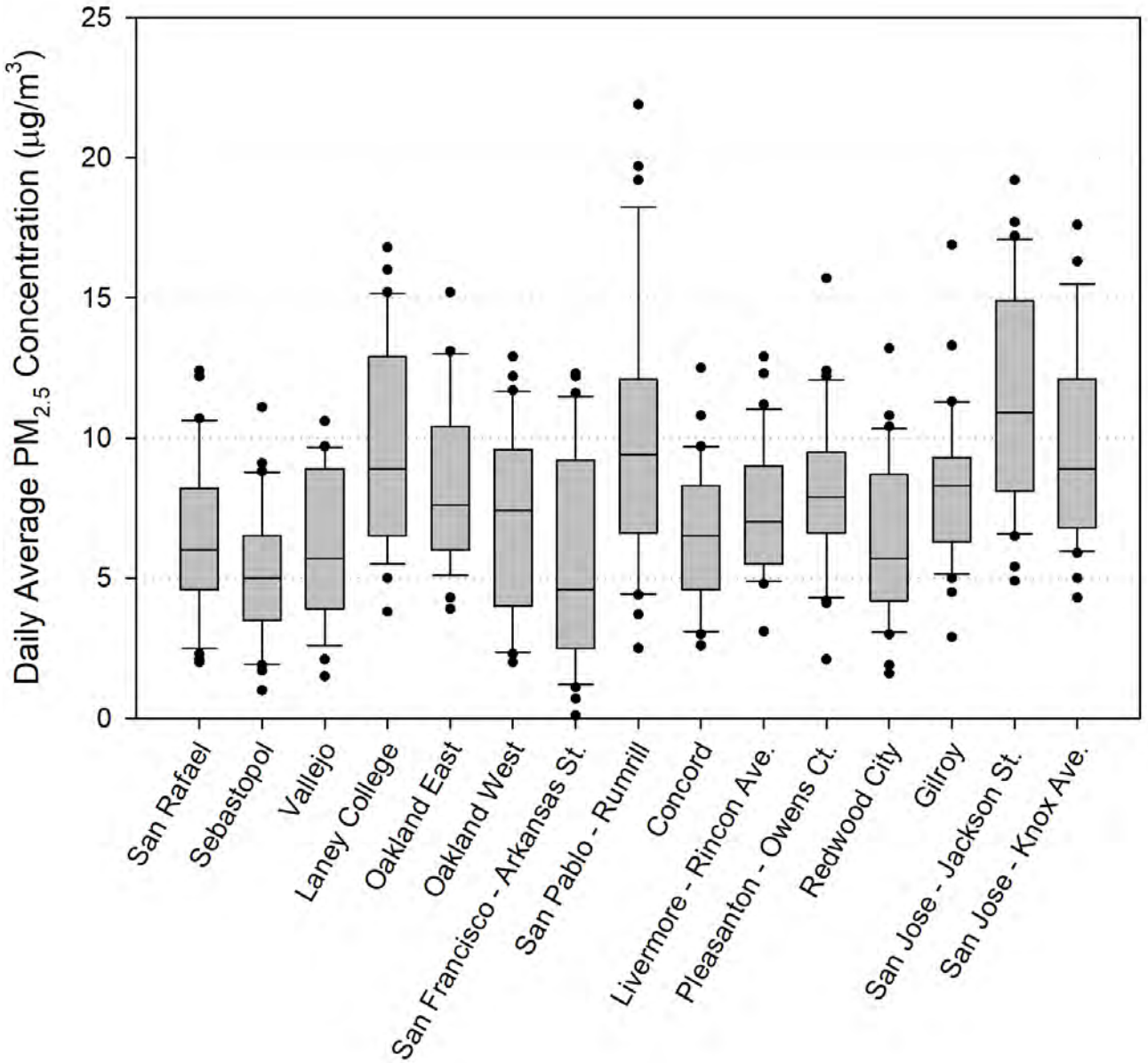
BenMAP-CE

- Used to estimate asthma risk in children
- Emphasizes statistical uncertainty in model, not uncertainties in underlying epidemiology studies on which it relies
- Range of mortality risk estimates supported by the literature is much wider than BenMAP-CE allows the user to model
- Cannot determine the case for childhood asthma, but not likely accurate or reliable

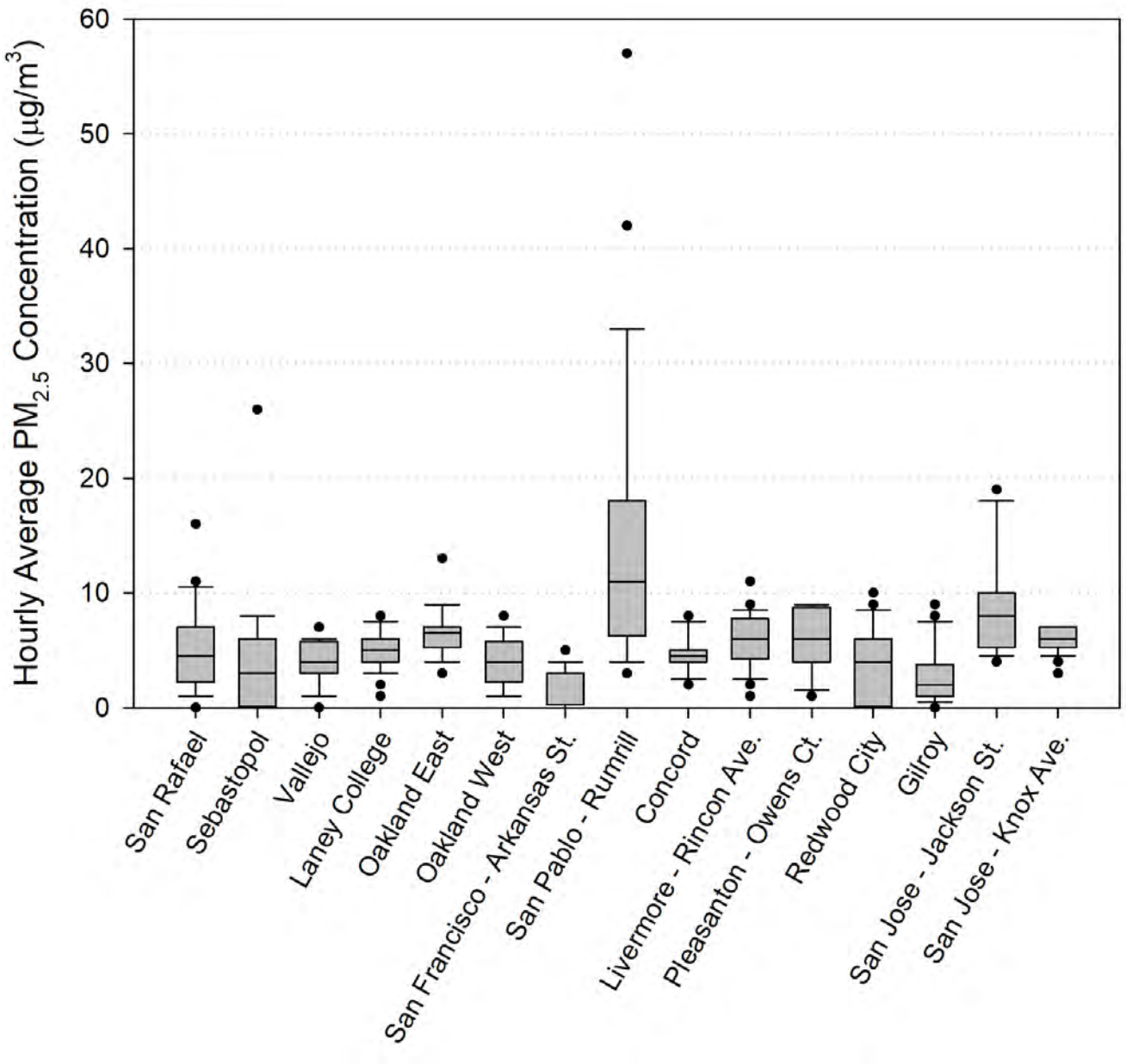
Tetrault *et al.* (2016)

- BAAQMD only uses Tetrault *et al.* (2016) study
- Population is from urban and rural Quebec
- Exposure was not modeled locally
- Single $PM_{2.5}$ value reflected average value estimated from satellites over a 5-year period, applied to 15-year period.
- No adjustments for ozone or nitrogen dioxide
- Individual SES, smoking in the home, and family history of asthma also were not accounted for

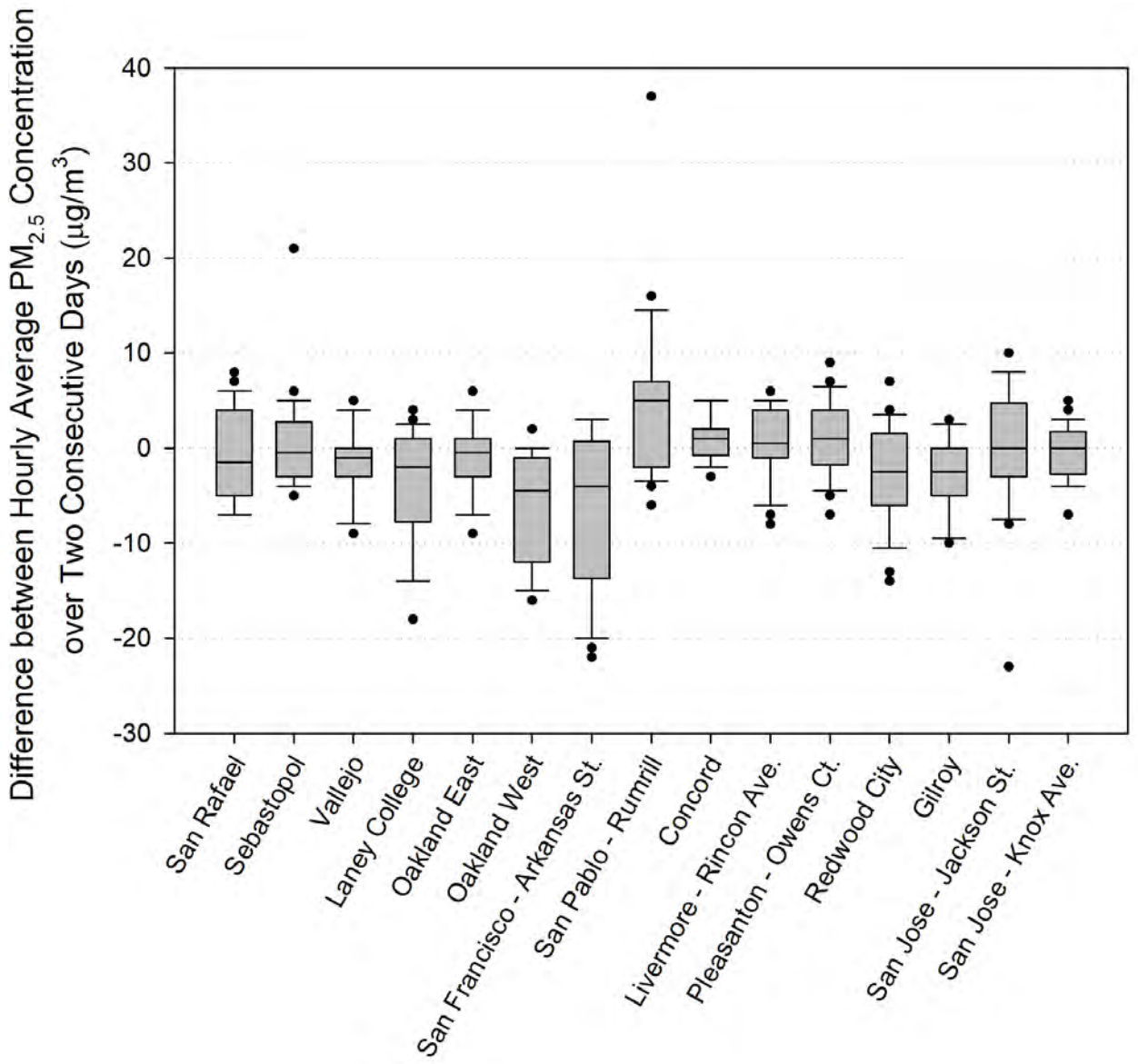
Daily Average $PM_{2.5}$ ($\mu g/m^3$) in BAAQMD – October 2022



Hourly Average $PM_{2.5}$ ($\mu g/m^3$) in BAAQMD – October 1, 2022



Difference Between Average $PM_{2.5}$ ($\mu g/m^3$) in BAAQMD at the Same Hour on October 1 and September 31, 2022



Conclusions

- Several limitations with the BAAQMD model
- $PM_{2.5}$ concentrations in BAAQMD vary considerably
- Model highly overestimates incremental increases in risk associated with $PM_{2.5}$ increments of 0.001-0.3 $\mu g/m^3$
- Recommendation: Use a threshold model and focus on larger increments in $PM_{2.5}$ concentrations

BAY AREA AIR QUALITY MANAGEMENT DISTRICT

AGENDA: 6

Revision of the $PM_{2.5}$ National Ambient Air Quality Standard: The Role of Air Monitoring Data

Advisory Council Meeting
January 30, 2023

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Presentation Outcome

To provide information and context about the recent proposal from U.S. Environmental Protection Agency (EPA), Air District staff will provide an overview of the Particulate Matter (PM) National Ambient Air Quality Standards (NAAQS) and how air monitoring data is compared to the NAAQS.

Presentation Outline

- NAAQS
- Role of air monitoring data
- What is a design value?
- Example: $PM_{2.5}$ trends
- Next steps for PM NAAQS, designations, and planning

Presentation for Information Only

No action required.

National Ambient Air Quality Standards (NAAQS)

- U.S. EPA sets limits for concentrations of six pollutants in ambient (outdoor) air according to the Federal Clean Air Act
  - Carbon monoxide, ozone, lead, oxides of nitrogen, particulate matter (PM), and oxides of sulfur
  - Primary NAAQS: Health-based, to an adequate margin of safety
  - Secondary NAAQS: Welfare-based, e.g. visibility, damage to crops, vegetation, buildings, and animals
- U.S. EPA is required to review NAAQS every five years

PM NAAQS (Primary)

Indicator	Averaging Time	Level	Form	Bay Area Status
$PM_{2.5}$	Annual	12.0 $\mu g/m^3$	**Annual average**, averaged over 3 years	Unclassifiable/ Attainment
$PM_{2.5}$	24-Hours	35 $\mu g/m^3$	**98th percentile**, averaged over 3 years	Nonattainment
PM_{10}	24-Hours	150 $\mu g/m^3$	**Not to be exceeded** more than once per year on average over a 3-year period	Unclassifiable/ Attainment

Revised Annual $PM_{2.5}$ NAAQS Proposal

- On January 6, EPA announced their proposed decision for the reconsideration of the PM NAAQS
- Proposed to revise the level of the annual $PM_{2.5}$ NAAQS to between 9 – 10 µg/m^3
  - Soliciting comment on revising between 8 – 11 µg/m^3
- Proposed to retain the 24-hour $PM_{2.5}$
  - Soliciting comment on revising as low as 25 µg/m^3
  - CASAC did not reach consensus about whether to retain the 24-hour $PM_{2.5}$ NAAQS most suggested 25-30 g/m^3. EPA notes that in **most locations**, a more stringent annual standard also ensures peak concentrations are well controlled
- Propose to retain the PM_{10} NAAQS
- Proposed changes to the monitoring requirements and to the AQI breakpoints
- The proposal also includes a Regulatory Impact Analysis which assess which areas currently are above the proposed range as well as forecasts who would still be not attaining in 2032 after the upcoming rules have been implemented

Commenting on the PM NAAQS Proposal

- EPA taking comment on the proposed NAAQS, and range of annual and 24-hour NAAQS recommended by CASAC, as well as the revisions to the monitoring requirements and AQI breakpoints
- 60-day public comment period after publication – estimated March 17
  (EPA has discretion to extend if petitioned)
- Written comments can be submitted on Regulations.gov (Docket No. EPA-HQ-OAR-2015-0072)
- There will be virtual public hearings between 11am and 7pm Eastern Time (dates tbd). Speakers can pre-register to provide comments after the hearing announcement is published.
- Staff are reviewing proposal and preparing comments - we can share updates about themes and recommendations before public comments are due

What Happens After EPA Revises a NAAQS?

NAAQS Revision → Initial Designations → SIP* Development → SIP Implementation

This process includes a lot of work and decisions we haven't had to make in the Bay Area in a long time

We'll be planning conversations over the next year to outline, update, and bring decisions to the Board

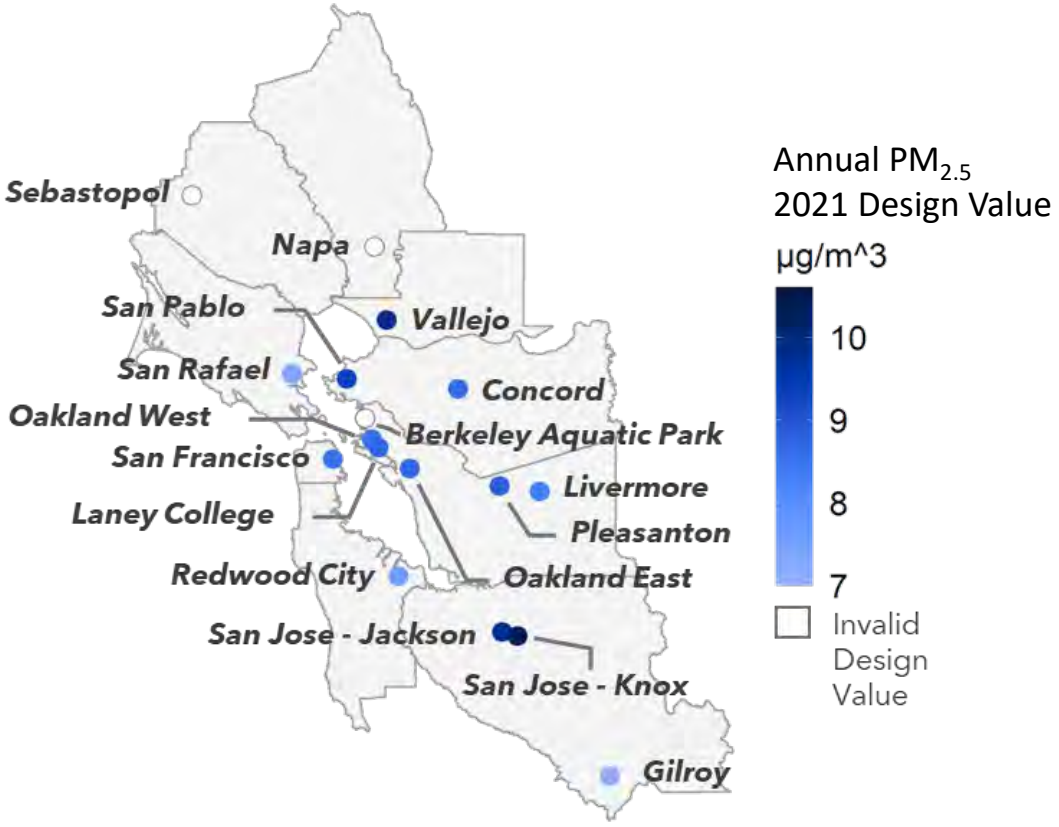
We'll start today with a review of the PM NAAQS and designations, which both are linked to air monitoring data

GOAL & OBJECTIVE → **ATTAINMENT & MAINTENANCE OF THE NAAQS**

*State Implementation Plan (SIP)

Goals for Air Monitoring

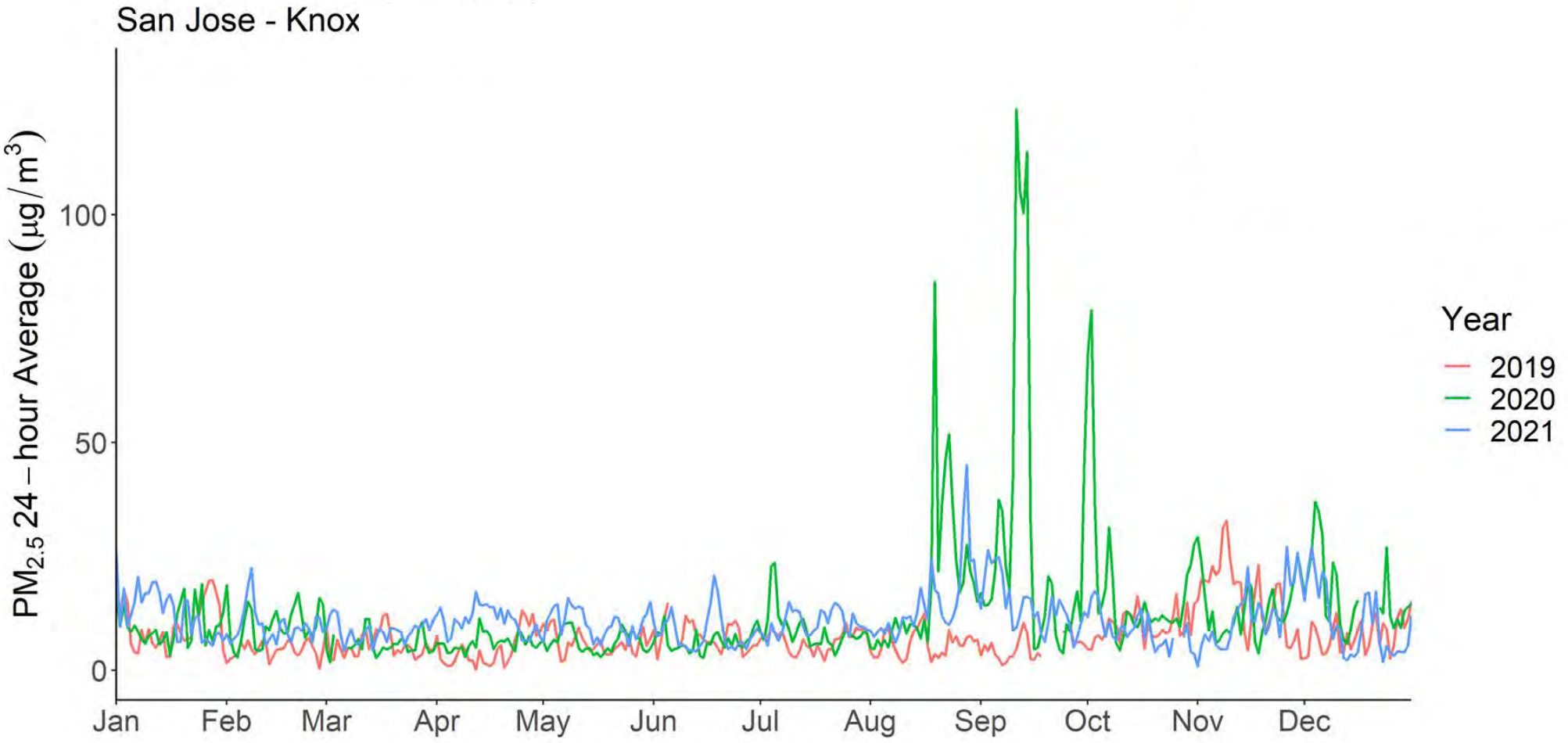
- Timely public information
- **Demonstrate compliance with NAAQS**
- Other supporting technical uses, like developing or assessing emission control strategies (long-term trends)
- Provide information about air quality in overburdened communities, and about impacts from nearby sources (near road)
- Air pollution research studies (atmospheric processes or health effects/exposure)



Bay Area $PM_{2.5}$ Monitoring Stations

How Should We Compare a Highly Variable Dataset (Air Monitoring Data) To One Number (NAAQS)?

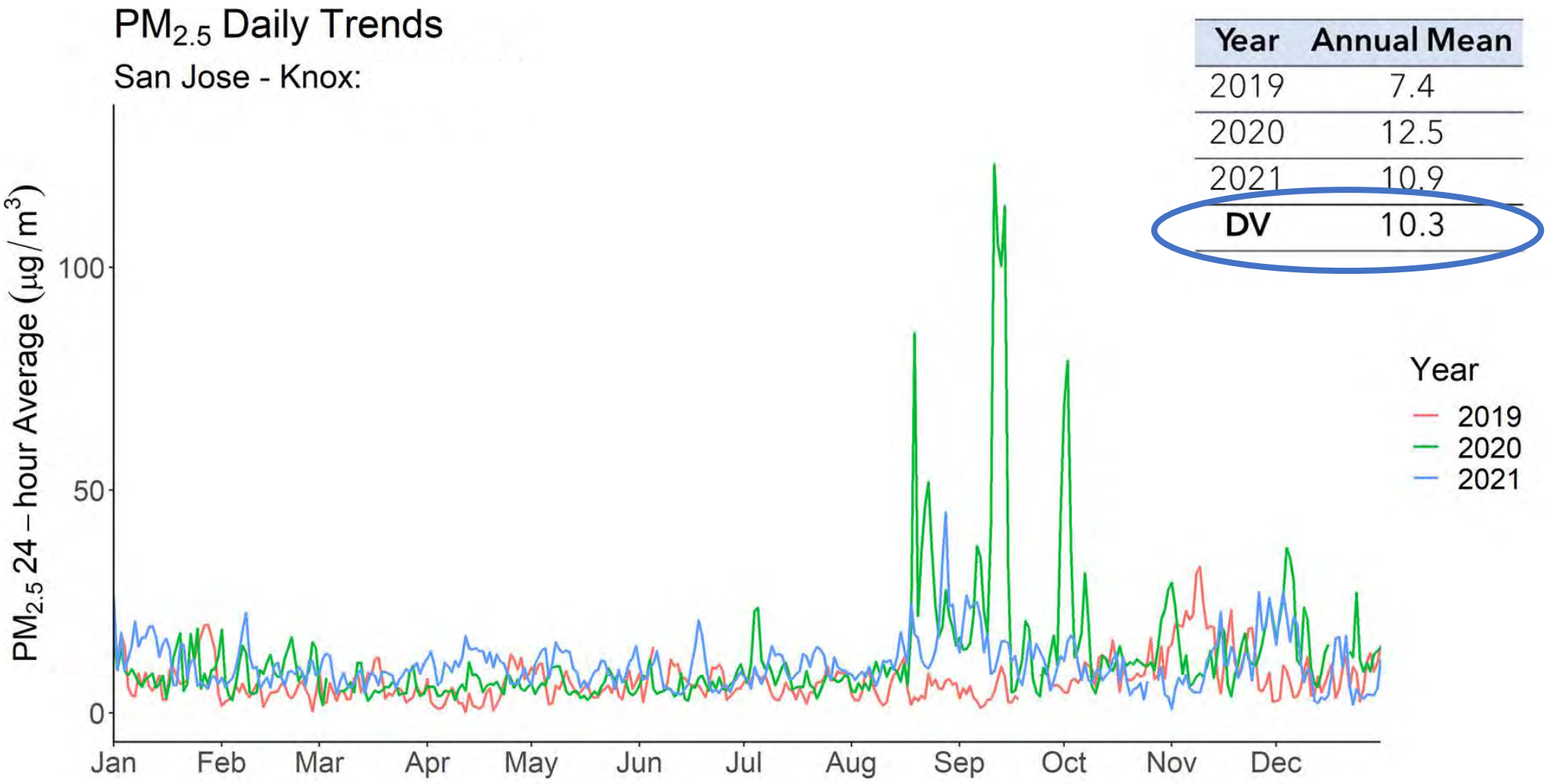
Example: $PM_{2.5}$ Daily Trends



Design Value (DV): A Statistic to Summarize Air Monitoring Data to Compare to NAAQS

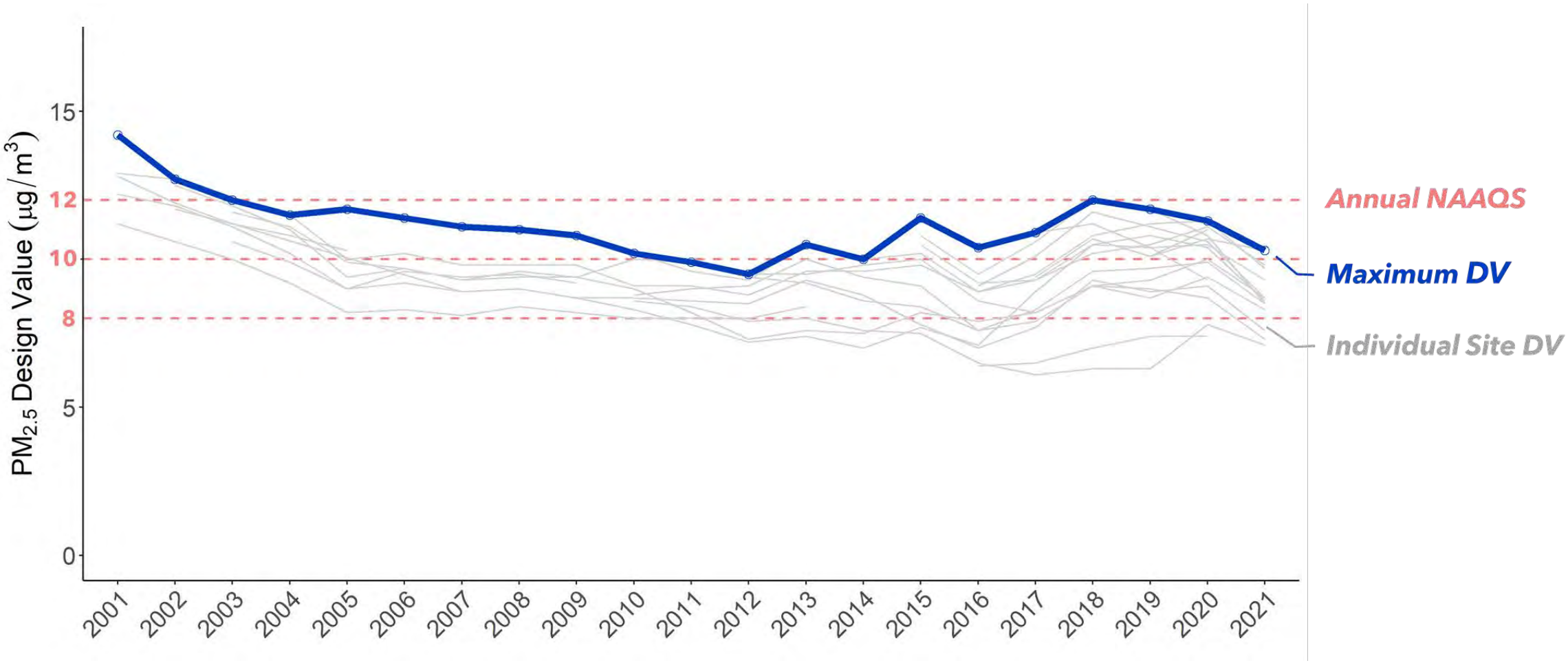
- For each monitoring site for each year, a DV is calculated using data from the past three years (e.g. 2021 DV uses data from 2019, 2020, and 2021).
- The monitoring site with the highest DV determines the DV for the San Francisco Bay Area planning area.
- For our planning area to be attaining the standard, our area DV needs to be below the NAAQS.

Example: DV for a Monitoring Site

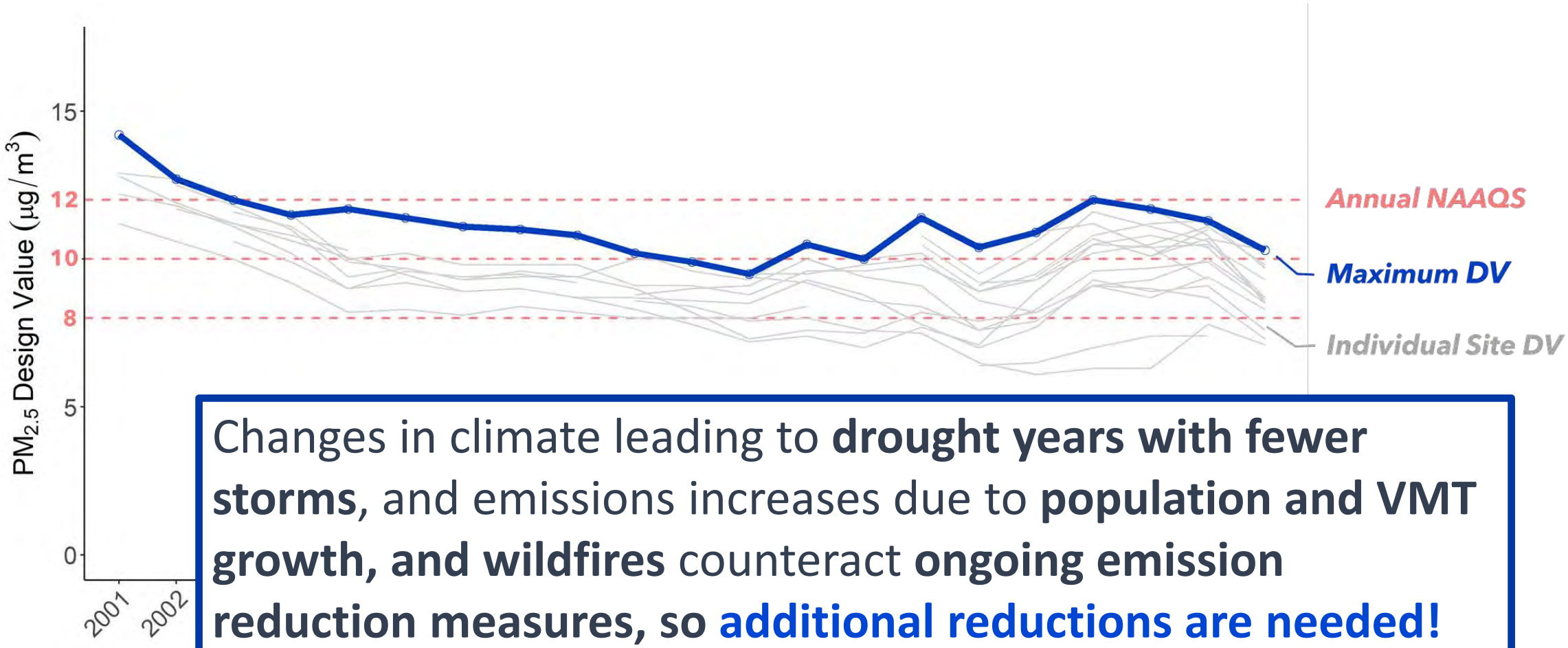


Year	Annual Mean
2019	7.4
2020	12.5
2021	10.9
DV	10.3

Annual $PM_{2.5}$ Design Value Trends



Annual $PM_{2.5}$ Design Value Trends (cont.)



Changes in climate leading to **drought years with fewer storms**, and emissions increases due to **population and VMT growth, and wildfires** counteract **ongoing emission reduction measures, so additional reductions are needed!**

$PM_{2.5}$ Trends: Wildfire Impacts

- Air District can request that EPA remove data from the DV calculations if data are affected by emissions that are not reasonably controllable or preventable.
- Removing smoke days may only change a site's annual DV by 1-2 µg/m^3 at most, which may matter more if the final NAAQS is 10 µg/m^3 and may matter less if the final NAAQS is 9 or 8 µg/m^3

Example: San Jose – Knox

	All data	Without wildfire smoke days (preliminary)
2019	7.4	7.4
2020	12.5	9.9
2021	10.9	10.8
DV	10.3	9.4

NAAQS Designations & Implementation

NAAQS Revision | Initial Designations | SIP Development | SIP Implementation

Where are we now and what does it mean for work over the coming months and years?

Finalizing the NAAQS

Now – late 2023

NAAQS Revision | Initial Designations | SIP Development | SIP Implementation

- EPA announced a revised particulate matter (PM) NAAQS proposal Jan 6
- Agencies and the public review the proposal and submit comments about the proposed NAAQS and associated program changes
- Expect EPA to finalize the NAAQS in late 2023

Initial Area Designations

Now – late 2025

NAAQS Revision | **Initial Designations** | SIP Development | SIP Implementation

- Review data and prepare exceptional events demonstrations if needed
- Work with California Air Resources Board (CARB) to prepare the state recommendation information for the Bay Area
- Work with CARB and EPA on air monitoring data for EPA's technical report

Developing a State Implementation Plan (SIP)

Now – mid 2026

NAAQS Revision | Designations | **SIP Development** | SIP Implementation

- Evaluate inventory, modeling, and monitoring data to assess the combination of emissions we will need to reduce
- Develop a comprehensive strategy to meet the standard and address racial inequities and environmental injustice

EQUITY **Regulatory** **Incentives** **Partnerships** JUSTICE

Next Steps

NAAQS Revision | Initial Designations | SIP Development | SIP Implementation

- Review the NAAQS Rulemaking and submit written comments to EPA
- Continue conversation with the Board about NAAQS designation and implementation
- Share updated technical information about the drivers of $PM_{2.5}$ levels and our path to attainment

Feedback Requested/Questions

- Questions and Comments