United States Environmental Protection Agency

REVIEW OF THE NATIONAL AMBIENT AIR QUALITY STANDARDS FOR PARTICULATE MATTER

OVERVIEW OF THE DRAFT POLICY ASSESSMENT

Presentation to the Clean Air Scientific Advisory Committee

October 24, 2019

United States Environmental Protection Agency

Outline of Presentation

- Background information and statutory requirements
- Overview of process and schedule
- Purpose and focus of the Policy Assessment
- Emissions and air quality trends
- Consideration of the primary $PM_{2.5}$ standards
- Consideration of the primary PM_{10} standard
- Consideration of the secondary standards

Background and Statutory Requirements

- EPA sets National Ambient Air Quality Standards (NAAQS) for six criteria pollutants, including particulate matter (PM)
- Primary (health-based) standards are those that, in the "judgment of the Administrator" are "requisite" to protect public health with an "adequate margin of safety"
  - The term "requisite" means sufficient, but not more than necessary
  - By requiring an "adequate margin of safety", Congress was directing EPA to build a buffer to protect against uncertain and unknown dangers to human health
- Secondary (welfare-based) standards are those that "…specify a level of air quality the attainment and maintenance of which" in the "judgment of the Administrator" are "requisite to protect the public welfare from any known or anticipated adverse effects"
  - Welfare effects include "effects on soils, water, crops, vegetation, man-made materials, animals, wildlife, weather, visibility and climate . . ."
- In setting NAAQS, EPA is barred from considering the cost of implementing the standards or adjusting a requisite standard solely on the basis of attainability in light of background concentrations of the pollutant

Process and Schedule for This Review of the PM NAAQS

Time

Planning: Identified new scientific information, policy-relevant issues

Call for Information

Workshop

Integrated Review Plan – final in Dec 2016

Assessment: Scientific evidence, risk information, potential policy implications for standards (indicator, averaging time, form, level)

Integrated Science Assessment – final in Dec 2019

Policy Assessment – final in Jan 2020

Rulemaking: Agency decision making, interagency review and public comments process

Proposed Decision – Spring 2020

Final Decision – Dec 2020

Public comments

Clean Air Scientific Advisory Committee (CASAC) review

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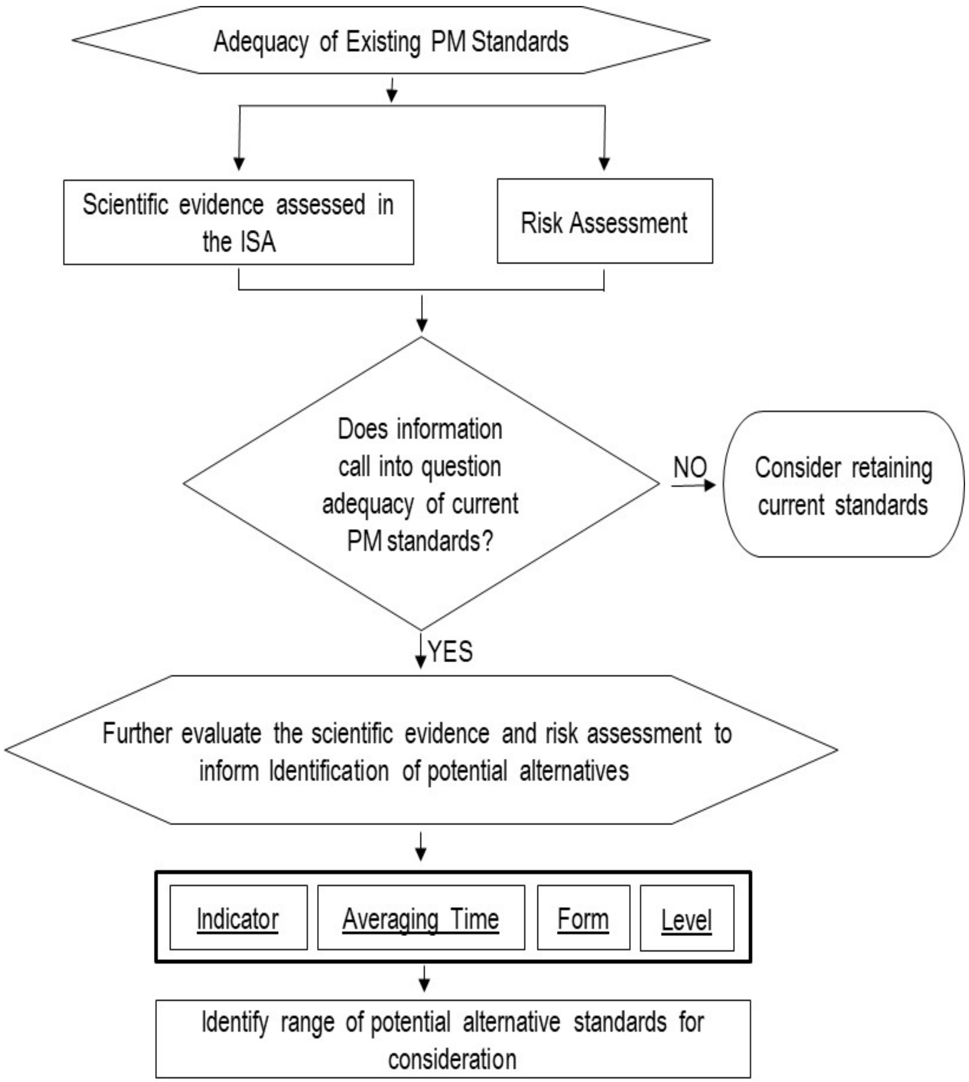
Policy Assessment: Purpose and Focus

- The Policy Assessment (PA) is meant to bridge the gap between the Agency's scientific assessments and the judgments required of the Administrator in determining whether it is appropriate to retain or revise the NAAQS
- The final PA will seek to provide as broad an array of policy options as is supportable by the science, recognizing that final decisions will reflect the Administrator's judgments as to what weight to place on the various types of information
- The draft PA is also intended to facilitate the CASAC's advice regarding the adequacy of the existing standards and revisions that may be appropriate to consider



Current PM Standards Under Review

Current Standards – Last Review Completed in 2012*					Decisions in 2012 Review
Indicator	Averaging Time	Primary/Secondary	Level	Form	
$PM_{2.5}$	Annual	Primary	12.0 µg/m^3	Annual arithmetic mean, averaged over 3 years	Revised level from 15.0 to 12.0 µg/m^3**
		Secondary	15.0 µg/m^3		Retained**
	24-hour	Primary and Secondary	35 µg/m^3	98th percentile, averaged over 3 years	Retained
PM_{10}	24-hour	Primary and Secondary	150 µg/m^3	Not to be exceeded more than once per year on average over a 3-year period	Retained

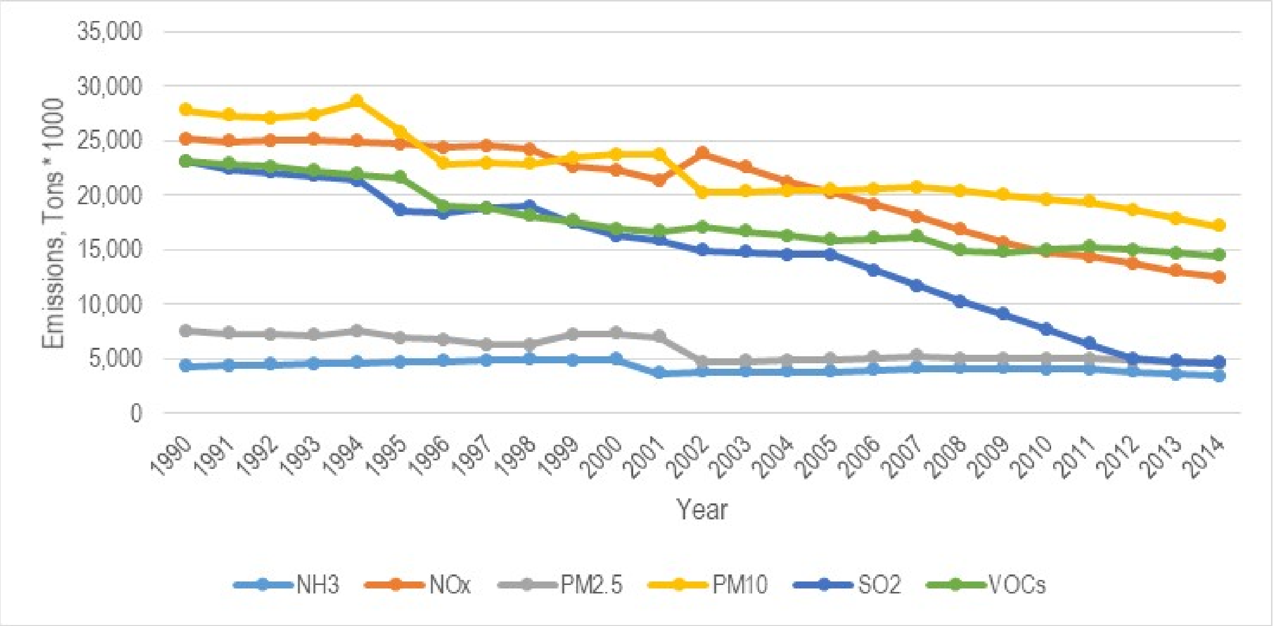
*Prior to 2012, PM NAAQS were reviewed and revised several times – established in 1971 (total suspended particulate – TSP) and revised in 1987 (set PM_{10}), 1997 (set $PM_{2.5}$), 2006 (revised $PM_{2.5}$, PM_{10})

**EPA eliminated spatial averaging for the annual standards

National Emissions Trends

Since 1990, the largest declines in precursor emissions have been for SO_2 (by about 80%)

National trends in emissions of $PM_{2.5}$, PM_{10}, and precursor gases

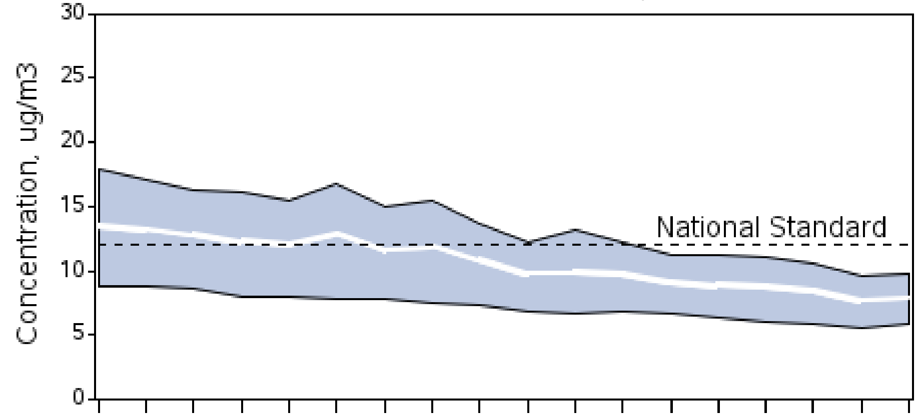


Pollutant	Major Sources
NH_3	Agricultural Sources (Fertilizer and Livestock Waste), Fires
NO_X	EGUs, Mobile Sources
SO_2	EGUs, other Stationary Sources
VOCs	Solvents, Fires, Mobile Sources
$PM_{2.5}$	Dust, Fires
PM_{10}	Dust, Fires

National Air Quality Trends

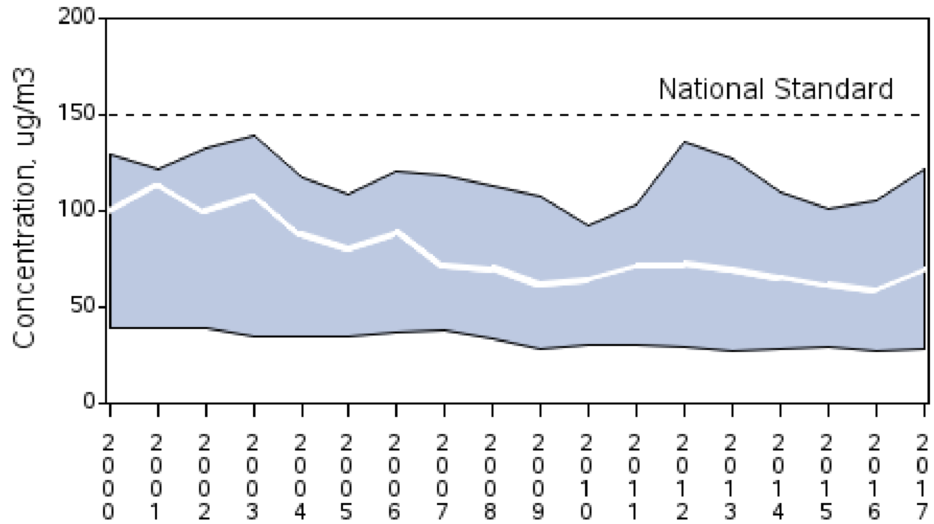
From 2000 to 2017, national annual average $PM_{2.5}$ concentrations have declined by 41%

Annual Average $PM_{2.5}$



From 2000 to 2017, 2nd highest 24-hour PM_{10} concentrations have declined by about 30%

Annual 2nd Highest 24-Hour PM_{10}



Primary $PM_{2.5}$: Summary of Approach

- The draft PA considers what the available scientific evidence and quantitative risk information may indicate regarding the annual and 24-hour $PM_{2.5}$ standards – focus is on "causal" or "likely to be causal" $PM_{2.5}$-related health outcomes

Annual $PM_{2.5}$ standard

- Generally viewed as the principle means of providing public health protection against "typical" daily and annual $PM_{2.5}$ exposures
- In previous reviews, conclusions on the annual $PM_{2.5}$ standard have been largely informed by consideration of the $PM_{2.5}$ air quality distributions associated with mortality or morbidity in epidemiologic studies
  - The current level of 12.0 $\mu g/m^3$ was set below the overall means of the long- and short-term $PM_{2.5}$ exposure estimates in key epidemiologic studies reporting health effect associations
- In this review, the draft PA characterizes the $PM_{2.5}$ air quality distributions in key studies (i.e., overall means, lower quartiles) and identifies study-area $PM_{2.5}$ metrics similar to design values (pseudo-design values)
- Similar to previous reviews, the PA also provides quantitative estimates of health risks that would be allowed by the current and various alternative standards

Primary $PM_{2.5}$: Summary of Approach (cont)

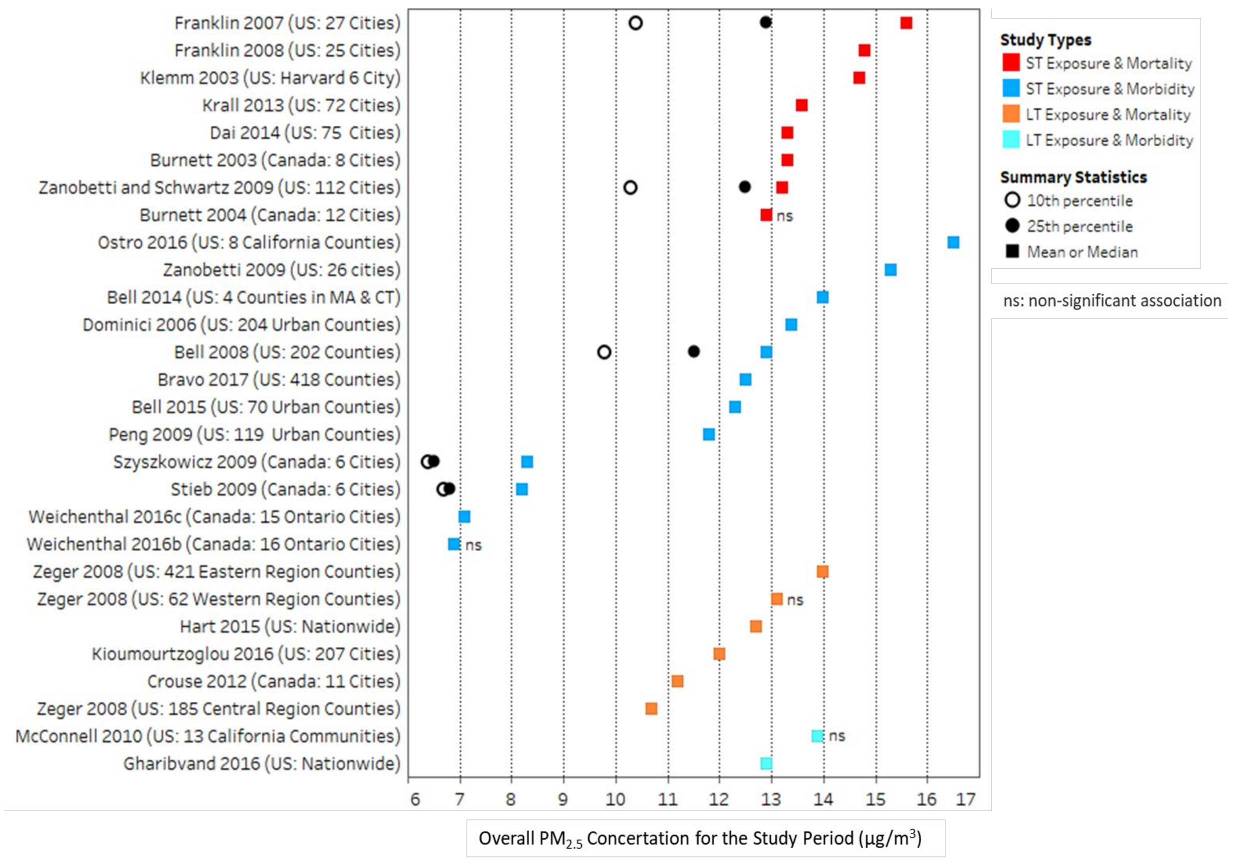
24-hour $PM_{2.5}$ standard (98^{th} percentile form)

- Generally viewed as a means of providing protection against the short-term exposures to "peak" $PM_{2.5}$ concentrations, such as can occur in areas with strong contributions from local or seasonal sources, even when annual average $PM_{2.5}$ concentrations remain relatively low
- Focus is on controlled human exposure studies, which provide evidence for health effects following single, short-term exposures (e.g., 2 hours) to $PM_{2.5}$ concentrations corresponding to the peak of the air quality distribution (e.g., at or above 120 ug/m^3)
- The $PM_{2.5}$ epidemiologic evidence is less informative regarding the health effects that can result following exposures to atypical, peak $PM_{2.5}$ concentrations
- Air quality and risk assessment analyses can inform the relationship between the annual and 24-hr standards

$PM_{2.5}$ Concentrations in Epidemiologic Studies

- Overall mean concentrations reflect study averages of daily or annual $PM_{2.5}$ exposure estimates – bulk of data generally occurs around overall means
- Key studies that consistently report positive and statistically significant associations have overall mean $PM_{2.5}$ concentrations > 8.0 μg/m³
- In studies with data available, 75% of health events occurred in areas with mean $PM_{2.5}$ concentrations ≥ 11.5 μg/m³ (U.S. studies) or 6.5 μg/m³ (Canadian studies)

Monitored $PM_{2.5}$ concentrations*

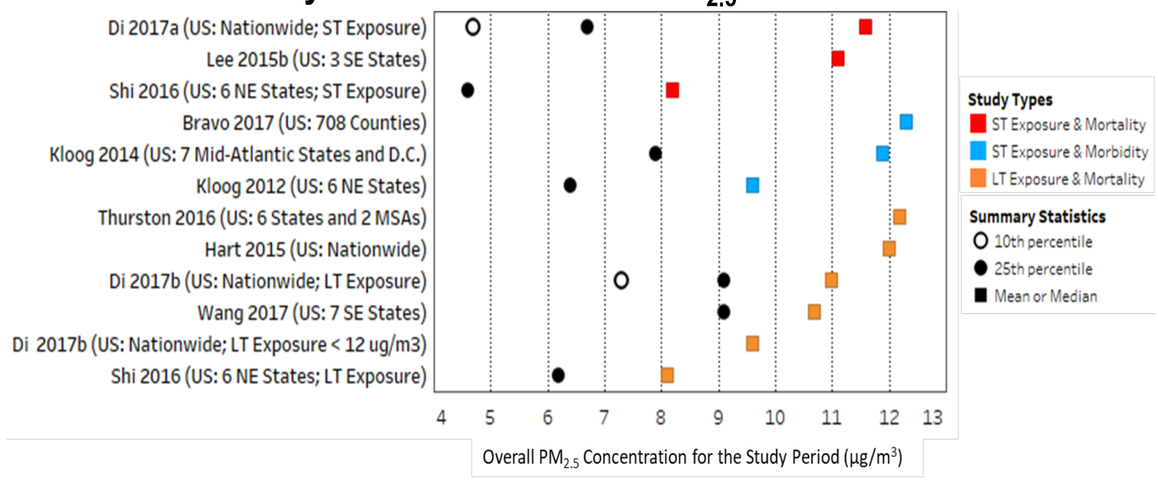


*Colored squares reflect overall study-reported mean (or median) $PM_{2.5}$ concentrations. Circles reflect the mean $PM_{2.5}$ concentrations corresponding to the 25[th] (filled) and 10[th] (open) percentiles of health events.

$PM_{2.5}$ Concentrations in Epidemiologic Studies (Continued)

- Many new studies have used hybrid approaches to estimate $PM_{2.5}$ exposures in monitored and unmonitored locations
- All of these key studies report positive and statistically significant associations and have overall mean $PM_{2.5}$ concentrations > 8.0 μg/m³
- In most studies with data available, 75% of exposures (or deaths) are at predicted ambient $PM_{2.5}$ concentrations > 6.0 μg/m³

Hybrid Model-Predicted $PM_{2.5}$ Concentrations



Uncertainties in using this information to inform conclusions on standards include:

- Study concentrations are not the same as those used by the EPA to compare with standard levels
- Studies have not identified a threshold concentration below which associations do not occur
- Performance of hybrid approaches varies by location, with factors contributing to poorer performance (e.g., lack of monitors) often coinciding with relatively low ambient $PM_{2.5}$ concentrations

Design Value-Like $PM_{2.5}$ Metrics

The draft PA also identifies monitor-based metrics – similar to design values – in study locations (pseudo-design values)

- Annual values: 3-year average of annual $PM_{2.5}$
- 24-hour values: 3-year average of 98th percentile 24-hour hour $PM_{2.5}$

Approach

–Identify study areas (counties/cities) with sufficient monitoring data to calculate pseudo-design values

–For each monitored area and each 3-yr period of the study, identify the highest monitored $PM_{2.5}$ value

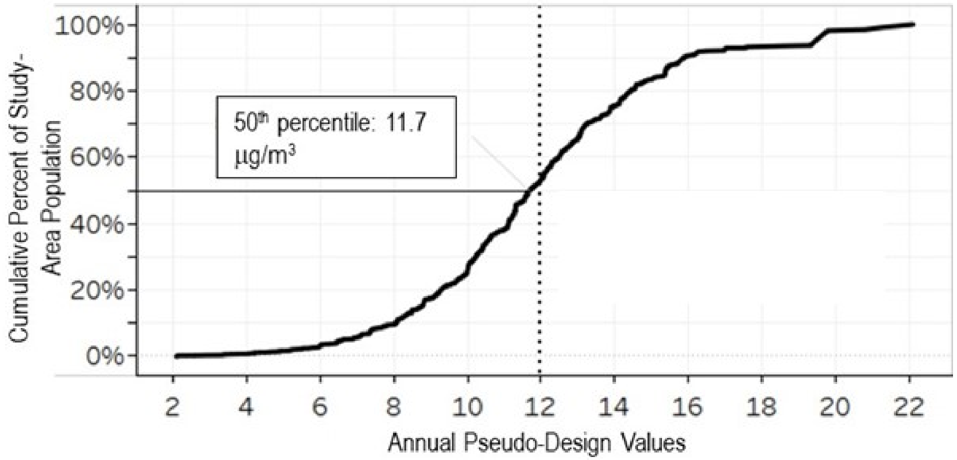
–For each monitored area, calculate the study-period average of these highest values

–Link values to study area populations or health events

–Arrange study locations by ascending pseudo-design values

–Identify the cumulative percent of population or health events at or below various pseudo-design values

Example for Di et al. (2017)



Linking pseudo-design values to the number of health events or population size in study areas can provide insight into the degree to which reported associations reflect air quality likely to have met/violated the current (or alternative) standards during study periods

$PM_{2.5}$ Annual Pseudo-Design Values in Locations of Key Studies

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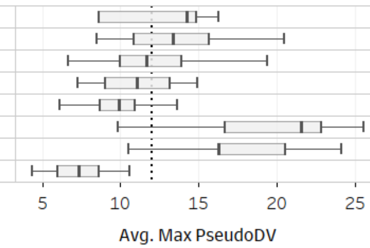
- For most key studies, about 25% or more of study area health events/populations were in locations that generally would have met both standards during study periods
- For 9 key studies (of the 29 evaluated), more than 50% of study area health events/populations were in such locations
- For 4 key studies, more than 75% of study area health events/populations were in such locations
- Uncertainties include:
  - Many studies examine a mix of locations and time periods meeting and violating standards
  - Values are not available in unmonitored areas
  - Values do not reflect data from currently required near-road monitors

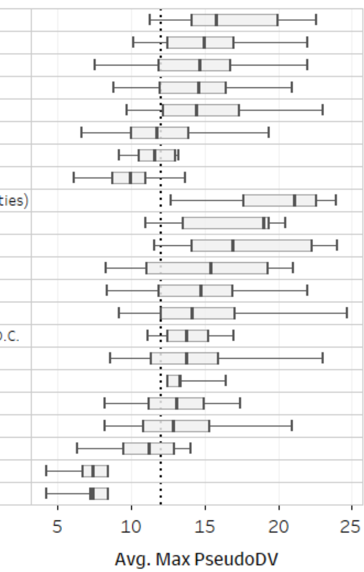
Long-term exposure studies

Country	Endpoint Group	Citation	Study Years	Geographic Areas
U.S.	Mortality	Lepeule et al., 2012*	2001-2009	6 U.S. Cities
		Kioumourtzoglou et al., 2016*	2000-2010	207 U.S. Cities
		Di et al., 2017b*	2000-2012	U.S. Nationwide
		Wang et al., 2017*	2000-2013	7 SE U.S. States
		Shi et al., 2016*	2003-2008	6 NE U.S. States
	Morbidity	Urman et al., 2014*	2002-2007	8 CA Counties
		Mcconnell et al., 2010	2003-2005	13 CA Communities
Canada	Mortality	Pinault et al., 2016*	2000-2011	Multicity



Short-term exposure studies

Coun..	Endpoint Group	Citation	Study Years	Geographic Areas
U.S.	Mortality	Franklin et al., 2008*	2000-2005	25 U.S. Cities
		Dai et al., 2014*	2000-2006	75 U.S. Cities
		Baxter et al., 2017*	2001-2005	77 U.S. Cities
		Zanobetti et al., 2014*	1999-2010	121 U.S. Cities
		Zanobetti and Schwartz, 2009*	1999-2005	112 U.S. Cities
		Di et al., 2017a*	2000-2012	U.S. Nationwide
		Lee et al., 2015b*	2007-2011	3 SE U.S. States
		Shi et al., 2016*	2003-2008	6 NE U.S. States
	Morbidity	Yap et al, 2013*	2000-2005	CA (Central & Southern Counties)
		Ostro et al., 2016*	2005-2009	8 CA Counties
		Zanobetti et al., 2009*	2000-2003	26 U.S. Cities
		Malig et al., 2013*	2005-2008	35 CA Counties
		Peng et al., 2009*	2000-2006	119 U.S. Urban Counties
		Dominici et al., 2006*	1999-2002	204 U.S. Urban Counties
		Kloog et al., 2014*	2000-2006	7 U.S. Mid-Atlantic States & D.C.
		Bell et al., 2008*	1999-2005	202 U.S. Urban Counties
		Bell et al., 2014*	2000-2004	4 U.S. Counties, MA & CT
		Bravo et al., 2017*	2002-2006	708 U.S. Counties
		Bell et al., 2015*	1999-2010	213 U.S. Urban Counties
		Kloog et al., 2012*	2000-2006	6 NE U.S. States
Canada	Morbidity	Weichenthal et al., 2016b	2004–2011	16 Ontario Cities
		Weichenthal et al., 2016c*	2004-2011	15 Ontario Cities

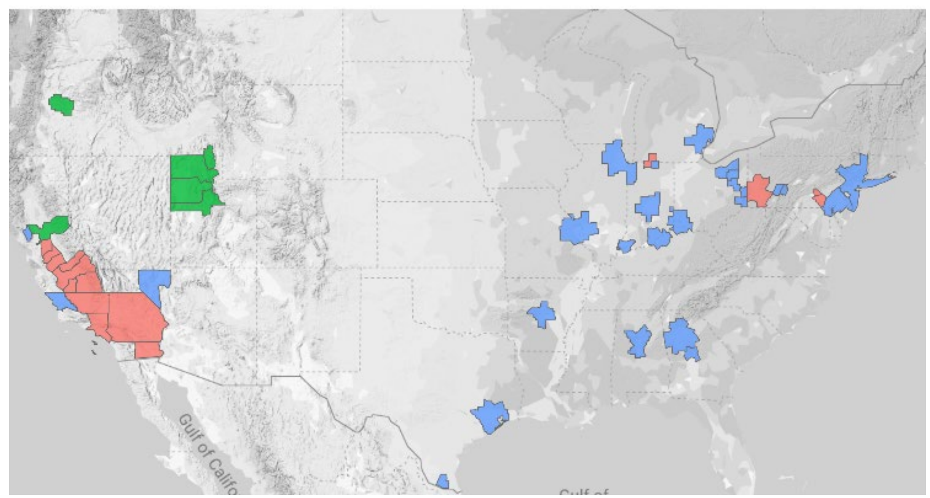


* Whiskers correspond to 5th and 95th percentiles, boxes correspond to 25th and 75th percentiles, central vertical lines correspond to 50th percentiles

$PM_{2.5}$ Risk Assessment – Background and Approach

- To inform conclusions regarding the primary $PM_{2.5}$ standards that are “requisite” to protect the public health, it is important to consider the health risks that would be allowed under those standards
- The risk assessment combines concentration-response functions with $PM_{2.5}$ air quality scenarios of interest, baseline health incidence data, and population demographic information
- The risk assessment evaluates air quality adjusted to simulate “just meeting” the current standards; alternative annual standards with levels of 11.0, 10.0, and 9.0 µg/m^3; and alternative 24-hour standard with a level of 30 µg/m^3 (analysis year is 2015)

In **selecting study areas**, the draft PA focuses on areas with relatively dense ambient monitoring networks; areas that represent a variety of U.S. regions and that include a substantial portion of the U.S. population; and areas for which downward air quality adjustments, or relatively small upward adjustments, are required



47 urban study areas (population ≥ 30 years: ~60M)
- 30 annual-controlling (population ≥ 30 years: ~50M)
- 11 daily-controlling (population ≥ 30 years: ~4M)
- 6 mixed (population ≥ 30 years: ~5M)

Above 10 annual and 30 daily
Above 30 daily
Above 10 annual

$PM_{2.5}$ Risk Assessment – Background and Approach (Continued)

- Concentration-response functions are from U.S. multicity studies examining total mortality (all-cause and non-accidental), ischemic heart disease mortality, and lung cancer mortality associated with long-term $PM_{2.5}$ exposures and total mortality associated with short-term $PM_{2.5}$ exposures
- Model-based approach to adjusting $PM_{2.5}$ air quality combines CMAQ-modeled surfaces with ambient monitoring data to generate ambient $PM_{2.5}$ estimates for 2015 on a grid with 12-km horizontal resolution
- Two strategies are used to adjusting air quality to the current standards and to potential alternatives with levels of 10.0 $\mu g/m^3$ (annual) and 30 $\mu g/m^3$ (24-hour)
  - Focus on adjusting direct emissions (pri-PM)
  - Focus on adjusting precursor emissions to simulate changes in secondarily formed $PM_{2.5}$ (sec-PM)
- Linear interpolation and extrapolation were used to simulate just meeting additional alternative annual standard levels (9.0 and 11.0 $\mu g/m^3$)

Summary of $PM_{2.5}$ Risk Estimates

Estimates of $PM_{2.5}$-associated deaths in the full set of 47 study areas

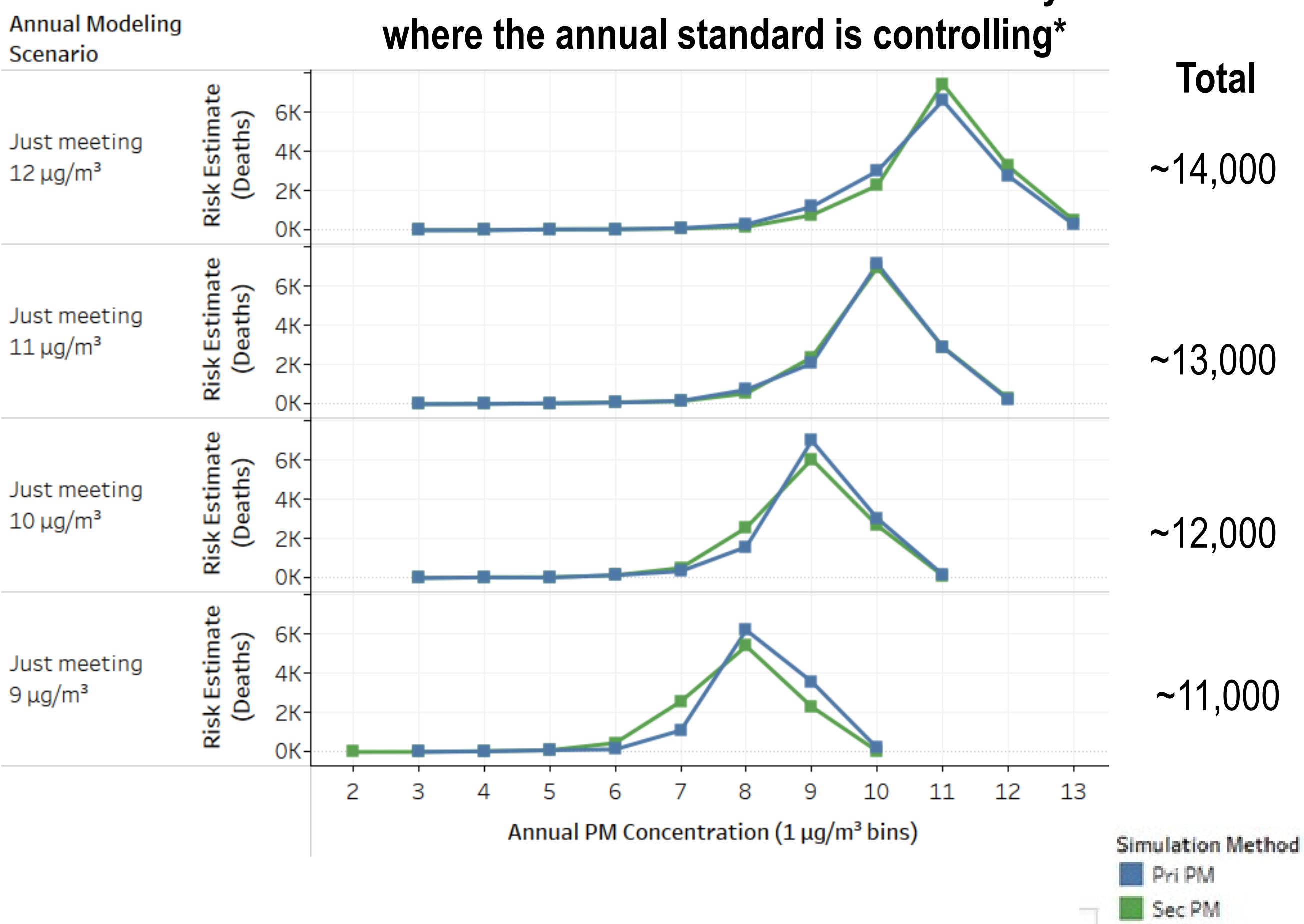
Endpoint	Study	Air quality simulation approach*	Current Standad Absolute Risk (12/35 µg/m^3)	CS (12/35) % of baseline**	Alternative Standard Absolute Risk: Alternative Annual (10 µg/m^3)	Alternative Standard Absolute Risk: Alternative 24-hr (30 µg/m^3)
Long-term exposure related mortality						
Ischemic Heart Disease	Jerrett 2016	Pri-PM	16,500 (12,600-20,300)	14.1	14,400 (11,000-17,700)	16,400 (12,500-20,000)
		Sec-PM	16,800 (12,800-20,500)	14.3	14,200 (10,900-17,500)	16,500 (12,600-20,200)
	Pope 2015	Pri-PM	15,600 (11,600-19,400)	13.3	13,600 (10,100-17,000)	15,400 (11,500-19,200)
		Sec-PM	15,800 (11,800-19,600)	13.4	13,400 (9,970-16,700)	15,600 (11,600-19,400)
All-cause	Di 2017	Pri-PM	46,200 (45,000-47,500)	8.4	40,300 (39,200-41,400)	45,700 (44,500-47,000)
		Sec-PM	46,900 (45,600-48,200)	8.5	39,700 (38,600-40,800)	46,200 (44,900-47,500)
	Pope 2015	Pri-PM	51,300 (41,000-61,400)	7.1	44,700 (35,700-53,500)	50,700 (40,500-60,700)
		Sec-PM	52,100 (41,600-62,300)	7.2	44,000 (35,100-52,700)	51,300 (41,000-61,400)
	Thurston 2015	Pri-PM	13,500 (2,360-24,200)	3.2	11,700 (2,050-21,100)	13,300 (2,330-24,000)
		Sec-PM	13,700 (2,400-24,600)	3.2	11,500 (2,010-20,700)	13,500 (2,360-24,200)
Lung cancer	Turner 2016	Pri-PM	3,890 (1,240-6,360)	8.9	3,390 (1,080-5,560)	3,850 (1,230-6,300)
		Sec-PM	3,950 (1,260-6,460)	9.1	3,330 (1,060-5,470)	3,890 (1,240-6,370)
Short-term exposure related mortality						
All cause	Baxter 2017	Pri-PM	2,490 (983-4,000)	0.4	2,160 (850-3,460)	2,460 (970-3,950)
		Sec-PM	2,530 (998-4,060)	0.4	2,120 (837-3,400)	2,490 (982-3,990)
	Ito 2013	Pri-PM	1,180 (-16-2,370)	0.2	1,020 (-14-2,050)	1,160 (-16-2,340)
		Sec-PM	1,200 (-16-2,400)	0.2	1,000 (-14-2,020)	1,180 (-16-2,370)
	Zanobetti 2014	Pri-PM	3,810 (2,530-5,080)	0.7	3,300 (2,190-4,400)	3,760 (2,500-5,020)
		Sec-PM	3,870 (2,570-5,160)	0.7	3,250 (2,160-4,330)	3,810 (2,530-5,070)

* Pri-PM (primary PM-based modeling approach), Sec-PM (secondary PM-based modeling approach)

** CS denotes the current standard.

Summary of $PM_{2.5}$ Risk Estimates (Continued)

Distributions of estimated risks in the 30 study areas where the annual standard is controlling*



Uncertainty in risk estimates results from uncertainties in the underlying epidemiologic studies, in the air quality adjustments, and in the application of study and air quality information to develop quantitative estimates of $PM_{2.5}$-associated mortality risks

*Estimates of ischemic heart disease deaths associated with long-term $PM_{2.5}$ exposures for air quality adjusted to simulate "just meeting" the current and alternative primary standards (based on Jerrett et al., 2016)

Preliminary Conclusions on the Current Primary $PM_{2.5}$ Standards

- The available scientific information can reasonably be viewed as calling into question the adequacy of the public health protection afforded by the current primary $PM_{2.5}$ standards
- Basis for this preliminary conclusion:
  - Long-standing body of health evidence, strengthened in this review, supporting relationships between short- and long-term $PM_{2.5}$ exposures and various outcomes, including mortality and serious morbidity effects
  - Recent U.S. and Canadian epidemiologic studies reporting positive and statistically significant health effect associations for $PM_{2.5}$ air quality likely to be allowed by the current standards
  - Analyses of pseudo-design values indicating substantial portions of study area health events/populations in locations with air quality likely to have met the current $PM_{2.5}$ standards
  - Risk assessment estimates that the current primary standards could allow thousands of $PM_{2.5}$-associated deaths per year – most at annual average $PM_{2.5}$ concentrations from 10 to 12 $\mu g/m^3$ (well within the range of overall mean concentrations in key epidemiologic studies)

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Preliminary Conclusions on the Current Primary $PM_{2.5}$ Standards (Continued)

- In contrast, a conclusion that the current primary $PM_{2.5}$ standards do provide adequate health protection would place little weight on the epidemiologic evidence or the risk assessment
- Such a conclusion would place greater weight on uncertainties and limitations, including:
  - Uncertainty in the biological pathways through which $PM_{2.5}$ exposures could cause serious health effects at typical ambient concentrations, given that experimental studies showing effects generally examine exposures to much higher $PM_{2.5}$ concentrations
  - Increasing uncertainty in the potential public health impacts of air quality improvements as the ambient concentrations being considered fall farther below those present in accountability studies that document improving health with declining $PM_{2.5}$
    - Accountability studies evaluate air quality improvements with “starting” mean $PM_{2.5}$ concentrations (i.e., prior to the reductions evaluated) from ~13 to > 20 $\mu g/m^3$
  - Uncertainty in the risk assessment results from uncertainties in the underlying epidemiologic studies, in the air quality adjustments, and in the application of study and air quality information to develop quantitative estimates of $PM_{2.5}$-associated mortality risks

Preliminary Conclusions on the Level of the Annual $PM_{2.5}$ Standard

- If consideration is given to revising the primary $PM_{2.5}$ standards to increase public health protection, it would be appropriate to focus on lowering the level of the annual standard
- Support for particular levels depends on the weight placed on various aspects of the science and uncertainties
- For example, a level as low as 10.0 $\mu g/m^3$ could be considered if weight is placed on:
  - Setting a standard to maintain mean $PM_{2.5}$ concentrations below those in most key U.S. epidemiologic studies
  - Setting the standard level at or below the pseudo-design values corresponding to about the 50th percentiles of study area health event/populations in key U.S. studies
  - Setting a standard estimated to reduce $PM_{2.5}$-associated health risks, such that a substantial portion of the risk reduction is estimated at annual average $PM_{2.5}$ concentrations $\geq$ ~8 $\mu g/m^3$

Preliminary Conclusions on the Level of the Annual $PM_{2.5}$ Standard (Continued)

- A level below 10.0 $\mu g/m^3$, potentially as low as 8.0 $\mu g/m^3$, could be supported to the extent greater weight is placed on the importance of $PM_{2.5}$ health effect associations and estimated risks at lower concentrations, as indicated by the following:
  - The few key studies with overall mean $PM_{2.5}$ concentrations below 8.0 $\mu g/m^3$
  - The ambient $PM_{2.5}$ concentrations somewhat below overall means (e.g., corresponding the lower quartiles) in the broader body of key studies
  - Annual pseudo-design values for the smaller number of key studies conducted in Canada, which tend to be somewhat lower than those in the U.S.
  - Annual pseudo-design values corresponding to 25^{th} percentiles of study area populations or health events for the broader body of key studies
  - The potential public health importance of the additional reductions in $PM_{2.5}$-associated health risks estimated for a level of 9.0 $\mu g/m^3$ and the potential for continued reductions at lower standard levels
- A decision to set the level below 10.0 $\mu g/m^3$ would place less weight on the limitations in the evidence that contribute to greater uncertainty at lower concentrations

Preliminary Conclusions on the Level of the 24-Hour $PM_{2.5}$ Standard

- The evidence provides little support for the need to provide additional protection against short-term peak concentrations in areas meeting the current standards
  - The currently available epidemiologic evidence does not indicate that $PM_{2.5}$ health effect associations are driven disproportionately by peak concentrations
  - Human clinical studies report effects following single short-term $PM_{2.5}$ exposures, but most examine concentrations well-above those typically measured in areas meeting the current standards
- Lowering the level of the 24-hour standard (in conjunction with its current 98th percentile form) could be considered in order to reduce the "typical" short- and long-term $PM_{2.5}$ exposures corresponding to the middle portion of the air quality distribution
- However, compared to lowering the level of the annual standard, there would be greater uncertainty in the effectiveness of using the 24-hour standard to achieve national-scale reductions in typical $PM_{2.5}$ exposures

Primary PM_{10} Standard

- The purpose of the PM_{10} standard is to protect against $PM_{10-2.5}$ exposures – therefore, the draft PA focuses on the evidence for $PM_{10-2.5}$-related health effects
- Recent epidemiologic studies reporting positive associations between $PM_{10-2.5}$ exposures and mortality or morbidity have expanded and strengthened the evidence for some outcome categories
- However, remaining uncertainties result in the draft ISA conclusions that the strongest evidence for $PM_{10-2.5}$-related effects is “suggestive of, but not sufficient to infer, causal relationships”
  - Lack of systematic evaluation/comparison of exposure estimation methods
  - Limited examination of copollutant models, with some showing attenuation
  - Limited experimental evidence to support biological plausibility
- Drawing from this evidence, the draft PA reaches the preliminary conclusions that:
  - While the available evidence supports maintaining a PM_{10} standard to provide some measure of protection against $PM_{10-2.5}$ exposures, uncertainties lead to questions regarding the potential public health implications of revising the existing PM_{10} standard
  - The available evidence does not call into question the adequacy of the public health protection afforded by the current primary PM_{10} standard, and thus, supports consideration of retaining that standard without revision

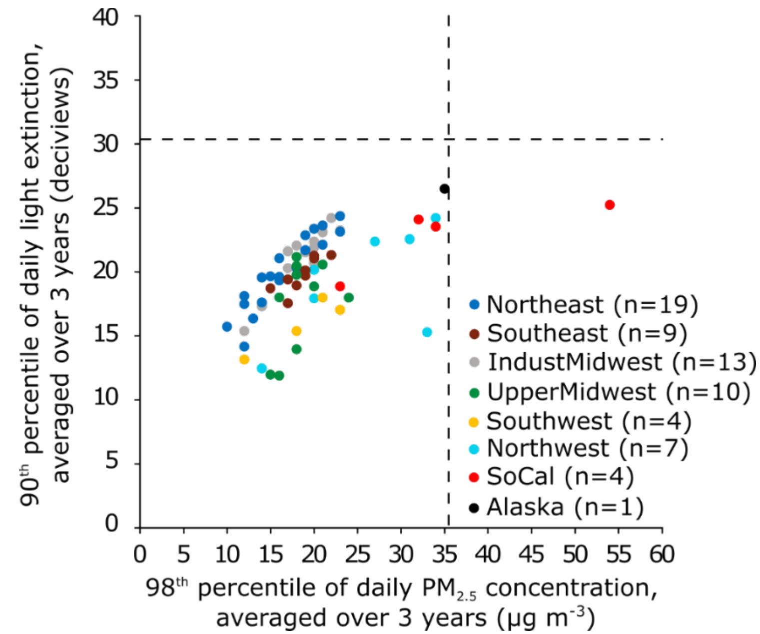
Secondary PM Standards: Summary of Approach and Scientific Evidence

- The secondary PM standards were set to protect against PM-related visibility impairment, climate impacts, materials effects, and ecological effects
  - This review focuses on the endpoints of visibility impairment, climate impacts and materials effects
  - The ongoing review of the NOx/SOx/PM Secondary NAAQS includes assessment of ecological effects
- The scientific evidence for visibility and non-visibility (climate, materials) effects newly available in this review is consistent with evidence base in last review, including its associated uncertainties
- Quantitative analyses for visibility impairment were supported in this review by the availability of some new information addressing uncertainties identified in the last review; quantitative analyses were not supported for climate and materials effects

Secondary PM: Summary of Quantitative Information for Visibility Impairment

EPA United States Environmental Protection Agency

- Consistent with the last review, the draft PA evaluates visual air quality in terms of the 3-year visibility metric, based on recent air quality
  - 30 deciviews (dv) is the target protection level identified in the last review based on studies of public preferences of acceptable levels of visibility impairment; there is no new information available in this review regarding public preferences of acceptable levels of visibility impairment
- New information:
  - Recent air quality data (2015-2017)
  - 67 geographically distributed areas
  - Spatially refined relative humidity data
  - Estimated $PM_{2.5}$ light extinction using three versions of the IMPROVE equation
  - Additional coarse PM monitoring data
- Findings are consistent with the last review, in that the 3-year visibility metric was no higher than 30 dv in areas that meet the current 24-hour $PM_{2.5}$ standard (average of 20 dv across 67 sites)



Note: For the figure above, light extinction was calculated using the original IMPROVE equation, consistent with the methods used in the last review

Secondary PM: Preliminary Conclusions

- Scientific evidence for PM-related visibility impairment, climate effects, and materials effects that is newly available in this review is consistent with evidence base in last review, including uncertainties associated with that evidence
- Quantitative analyses for visibility impairment suggest that those areas meeting the current secondary 24-hour $PM_{2.5}$ standard are also meeting the target level of protection (i.e. 30 dv)
- Drawing from this information, the draft PA reaches the preliminary conclusion that the available evidence and quantitative information, including uncertainties, do not call into question the adequacy of protection provided by the current secondary PM standards, and thus, support consideration of retaining the current secondary standards, without revision

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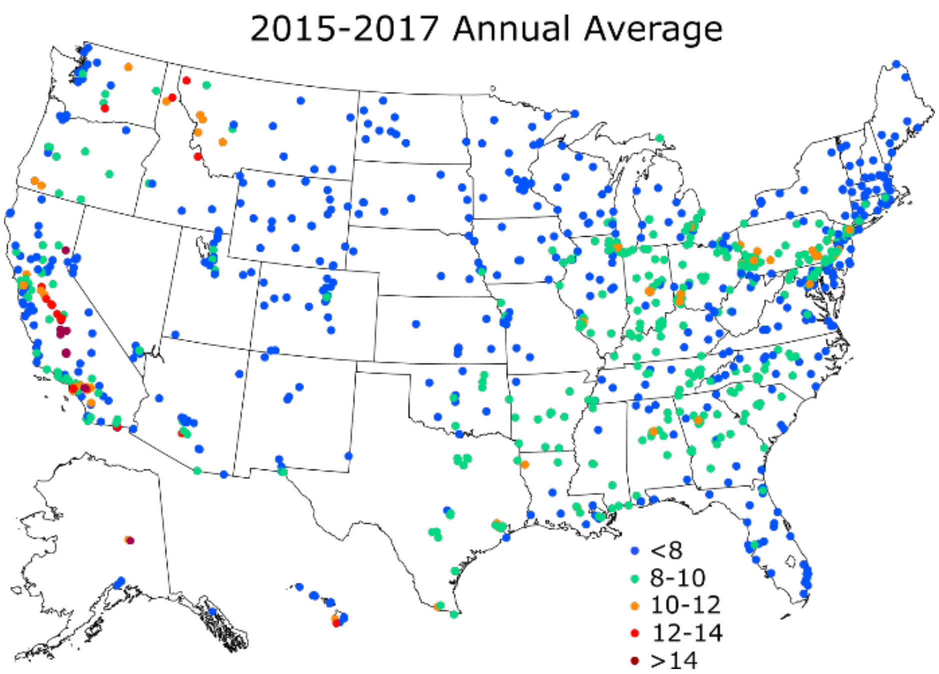
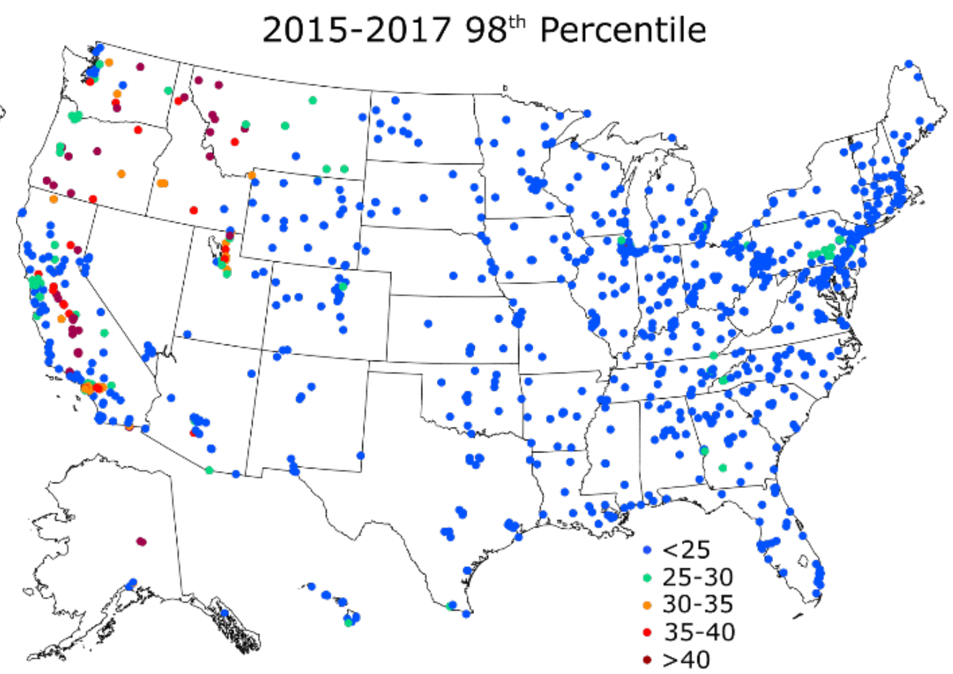
Additional Slides

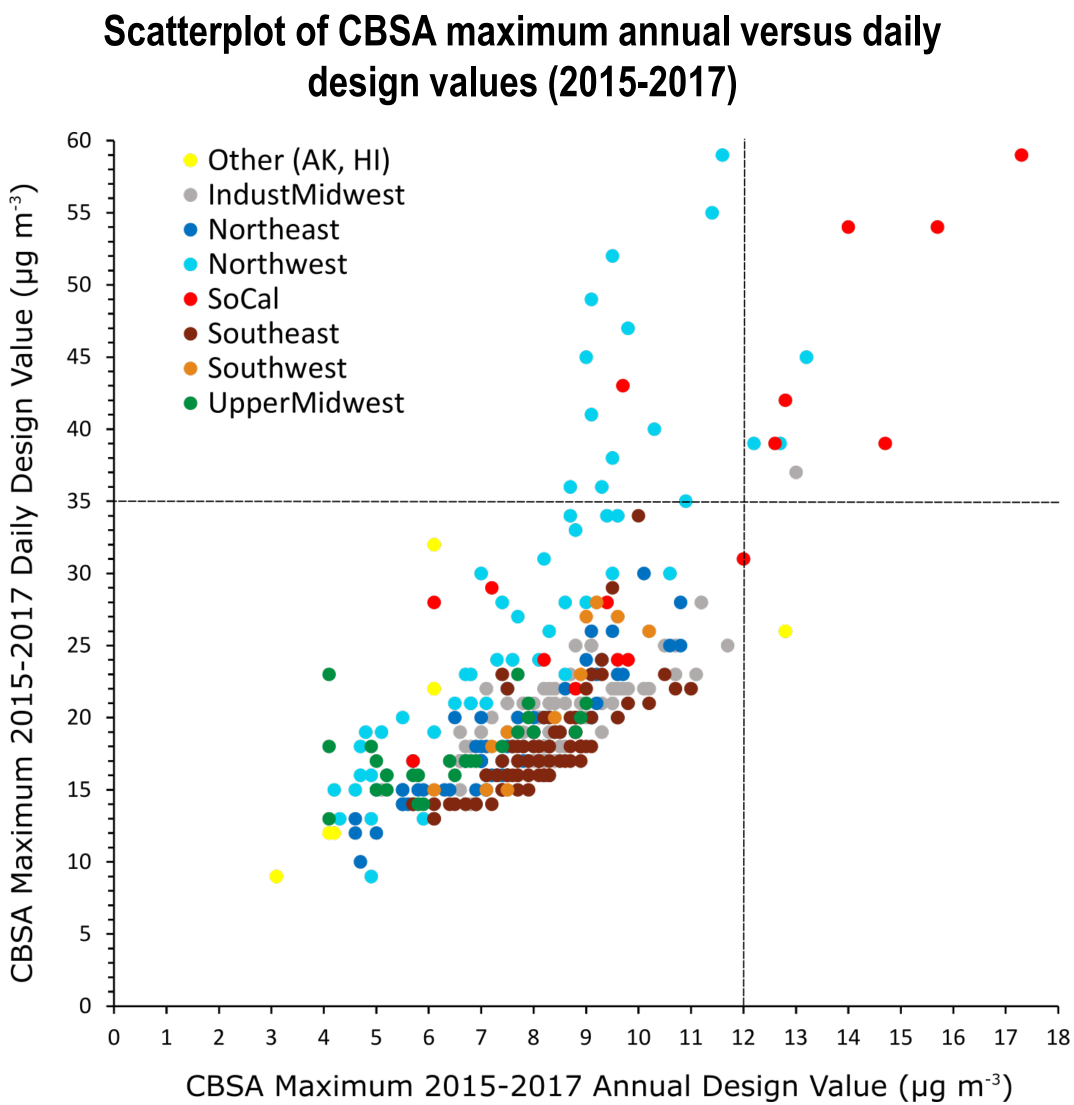
$PM_{2.5}$: Recent Concentrations





- Highest $PM_{2.5}$ concentrations are in the western U.S., particularly California
- Most Eastern sites had annual average and 98th percentiles of 24-hour values at or below 10 and 25 µg m^{-3}, respectively

Annual and Daily $PM_{2.5}$ Design Values



Primary $PM_{2.5}$

Key $PM_{2.5}$-Related Health Outcomes Considered in the Draft PA*

Exposure Duration	Outcome	2009 ISA Conclusion	2018 Draft ISA Conclusion*
Long-Term	Mortality	Causal	Causal
	Cardiovascular	Causal	Causal
	Respiratory	Likely to be causal	Likely to be causal
	Cancer	Suggestive	Likely to be causal
	Nervous System	None	Likely to be causal
Short-Term	Mortality	Causal	Causal
	Cardiovascular	Causal	Causal
	Respiratory	Likely to be causal	Likely to be causal

*Identification of key outcomes draws from the conclusions of the draft ISA. Any updates to those conclusions in the final ISA will be reflected in the final PA.

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Steps in $PM_{2.5}$ Adjustment Approach for the Risk Assessment

1. Characterize baseline concentrations at monitors and on a 12-km gridded spatial field for a recent period
   - Monitoring data was for the 2014-2016 period
   - The spatial field was developed using Downscaler with inputs of CMAQ predictions and monitoring data for 2015
2. Simulate the response of $PM_{2.5}$ relative to the baseline using CMAQ for select changes in emissions of primary $PM_{2.5}$ and NO_x and SO_2
3. Interpolate the $PM_{2.5}$ response at monitors and grid cells across the entire range of emission changes (i.e., -100 to +100%) for each emission case
4. Iteratively adjust the monitored concentrations using the CMAQ-based response factors to identify the emission change where the NAAQS is just met (i.e., the highest DV for the controlling standard equals the NAAQS level)
5. Adjust the gridded concentration field using the $PM_{2.5}$ response factors and the percent emission change needed for monitors to just meet the NAAQS

PM$_{10}$: Recent Concentrations

- 2015-2017 average of 2nd highest 24-hour PM$_{10}$ concentration was 56 μg/m^3 (ranging from 18 to 173 μg/m^3)
- The highest PM$_{10}$ concentrations tend to occur in the western U.S.