STATE PERSPECTIVES ON REGULATING BACKGROUND OZONE

HEARING

BEFORE THE

SUBCOMMITTEE ON ENVIRONMENT

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

HOUSE OF REPRESENTATIVES

ONE HUNDRED FIFTEENTH CONGRESS

SECOND SESSION

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June 21, 2018

STATE PERSPECTIVES ON REGULATING BACKGROUND OZONE

THURSDAY, JUNE 21, 2018

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON ENVIRONMENT
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
Washington, D.C.

The Subcommittee met, pursuant to call, at 10:04 a.m., in Room 2318 of the Rayburn House Office Building, Hon. Andy Biggs [Chairman of the Subcommittee] presiding.

LAMAR S. SMITH, Texas
CHAIRMAN

EDDIE BERNICE JOHNSON, Texas
RANKING MEMBER

Congress of the United States
House of Representatives

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
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Subcommittee on Environment

State Perspectives on Regulating Background Ozone

Thursday, June 21, 2018
10:00 a.m.
2318 Rayburn House Office Building

Witnesses

Ms. Diane Rath, Executive Director, Alamo Area Council of Governments

Mr. Timothy Franquist, Air Quality Division Director, Arizona Department of Environmental Quality

Dr. Elena Craft, Senior Health Scientist, Environmental Defense Fund

Mr. Gregory Stella, Senior Scientist, Alpine Geophysics, LLC.

U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

HEARING CHARTER

Thursday, June 21, 2018

TO: Members, Subcommittee on Environment

FROM: Majority Staff, Committee on Science, Space, and Technology

SUBJECT: Subcommittee hearing: "State Perspectives on Regulating Background Ozone"

The Subcommittee on Environment will hold a hearing titled *State Perspectives on Regulating Background Ozone* on Thursday, June 21, 2018, at 10:00 a.m. in Room 2318 of the Rayburn House Office Building.

Hearing Purpose:

The purpose of this hearing is to examine the ozone National Ambient Air Quality Standards (NAAQS). This hearing will also explore the policy and available remedies to address natural and international background ozone under the Clean Air Act.

Witness List

- **Ms. Diane Rath**, Executive Director, Alamo Area Council of Governments
- **Mr. Timothy Franquist**, Air Quality Division Director, Arizona Department of Environmental Quality
- **Dr. Elena Craft**, Senior Health Scientist, Environmental Defense Fund
- **Mr. Gregory Stella**, Senior Scientist, Alpine Geophysics

Staff Contact

For questions related to the hearing, please contact Majority Staff at 202-225-6371.

Chairman BIGGS. The Subcommittee on Environment will come to order. Without objection, the Chair is authorized to declare recess of the Subcommittee at any time.

Welcome to today's hearing entitled "State Perspectives on Regulating Background Ozone." Before we get started, I want to take a moment to recognize the new Vice Chairman of the Subcommittee, Mr. Norman from South Carolina. I look forward to continuing our work together and the success of the Environment Committee.

I now recognize myself for five minutes for an opening statement.

In 2015, the Obama EPA lowered the National Ambient Air Quality Standard (NAAQS) from 75 parts per billion to 70 parts per billion. Meeting this new, unreasonable standard has placed an excessive economic burden on States across the country, and especially those in the Southwest. In my own State of Arizona, naturally-occurring background ozone, over which we have virtually no control, has created a compliance nightmare.

The solution to this problem is simple: the EPA should take local geographic factors into account when determining ozone standards. Simply slapping a "nonattainment" designation on areas where ozone emissions are not even originating is both unfair and devastating to business in the state. Background ozone can come from both domestic and international sources. For instance, a large amount of Arizona emissions originate in Mexico. However, the way the NAAQS are set, these emissions from outside the country are used against U.S. states.

The tragic result is that the Clean Air Act ends up burdening the very Americans it seeks to help—more often than not, hard-working people living in rural areas. Cutting emissions has become synonymous with cutting jobs.

Instead of enforcing unreasonable mandates, the states and EPA should instead work together to determine the amount of manmade emissions versus natural and international emissions in any given area. It makes absolutely no sense to force an area within the United States to try to compensate for emissions caused by other countries.

At first glance, Section 179B of the Clean Air Act seems to offer relief from emissions from international sources. However, when put into practice, it does not go far enough. A successful 179B demonstration does not allow an area to avoid a "nonattainment" designation; it just relieves it of some potential sanctions.

We cannot continue to punish states for emissions it cannot control. A nonattainment designation in turn triggers a nonattainment New Source Review, which then applies to all new major sources or major modifications to existing sources of pollutants. So, if a new business wants to open up or an old business wants to make certain changes, it has to go through the NSR process.

One of the requirements in this process is for a company to offset emissions. But in agricultural communities, where big business is the exception not the rule, offsets are almost impossible. There are simply not enough businesses to offset against. This is why businesses would be reluctant to set up shop in a rural area that is in nonattainment, and I don't blame them. In a situation where sanctions are costly and offsets are impossible, businesses are not given much of a choice. Job opportunities disappear and environmental regulations end up institutionalizing poverty.

We need to find a better system, and I look forward to this hearing as a way to explore these issues and foster a true discussion on the impacts of background ozone.

[The prepared statement of Chairman Biggs follows:]

COMMITTEE ON
SCIENCE, SPACE, & TECHNOLOGY
Lamar Smith, Chairman

For Immediate Release
June 21, 2018

Media Contact: Bridget Dunn
(202) 225-6371

Statement by Chairman Andy Biggs (R-Ariz.)

State Perspectives on Regulating Background Ozone

Chairman Biggs: In 2015, the Obama EPA lowered the National Ambient Air Quality Standard (NAAQS) from 75 parts per billion to 70 parts per billion. Meeting this new, unreasonable standard has placed an excessive economic burden on states across the country, and especially those in the Southwest. In my own state of Arizona, naturally-occurring background ozone—over which we have virtually no control—has created a compliance nightmare.

The solution to this problem is simple: the EPA should take local geographic factors into account when determining ozone standards. Simply slapping a "nonattainment" designation on areas where ozone emissions are not even originating is both unfair and devastating to business in the state. Background ozone can come from both domestic and international sources. For instance, a large amount of Arizona emissions originate in Mexico. However, the way the NAAQS are set, these emissions from outside the country are used against U.S. states.

The tragic result is that the Clean Air Act ends up burdening the very Americans it seeks to help—more often than not, hard-working people living in rural areas. Cutting emissions has become synonymous with cutting jobs.

Instead of enforcing unreasonable mandates, the states and EPA should instead work together to determine the amount of man-made emissions versus natural and international emissions in any given area. It makes absolutely no sense to force an area within the U.S. to try to compensate for emissions caused by other countries.

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This is why businesses would be reluctant to set up shop in a rural area that is in nonattainment—and I don't blame them. In a situation where sanctions are costly and offsets are impossible, businesses aren't given much of a choice. Job opportunities disappear and environmental regulations end up institutionalizing poverty.

We need to find a better system, and I look forward to this hearing as a way to explore these issues and foster a true discussion on the impacts of background ozone.

###

Chairman BIGGS. I now recognize the Ranking Member of the Subcommittee, the gentlewoman from Oregon, Ms. Bonamici, for an opening statement.

Ms. BONAMICI. Thank you, Mr. Chairman.

The Clean Air Act is one of the most successful pieces of public health legislation enacted by Congress. According to the EPA, the protections helped avoid more than 200,000 premature deaths in its first 20 years alone. A clean environment is essential to a high quality of life for every American. It is important to consider the health effects of weakened air standards, particularly for children, the elderly and those suffering from asthma.

The National Ambient Air Quality Standards, or NAAQS, were established under the Clean Air Act to regulate criteria pollutants that have significant negative effects on human health. Congress made sure that public health was the driving factor in setting the NAAQS by requiring the standards to be based on exclusively on scientific, health-based evidence.

Since 2008, The Environmental Protection Agency's Clean Air Scientific Advisory Committee has recommended setting the ozone standard between 60 and 70 parts per billion. In 2015, the ozone NAAQS were strengthened to 70 parts per billion. Public health groups were concerned that the new level was still not as protective as it could have been, but acknowledged the positive health outcomes the new standard would have for all Americans.

Some states and localities argue that meeting the 2015 ozone NAAQS levels is impossible because of background or naturally occurring ozone levels, but that is simply not true. The EPA determined that background ozone levels remain relatively constant, and contribute only fractionally to ozone concentrations above the 70 parts per billion level on high ozone days. The EPA also recently revised their Exceptional Events Rule and Guidance to more clearly define the scope of the rule to help states and localities identify air quality monitoring data that may be affected by exceptional events.

I would like to thank our witnesses for being here today. I'm glad to see Dr. Elena Craft back at the witness table to provide us with a scientific perspective not only on issues related to ozone, but also to discuss how the anti-science actions this Administration has taken at the EPA will undermine public health protections if left unchallenged.

I would also like to draw attention to the fact that it has been one year and 4 months since Scott Pruitt was confirmed as the EPA Administrator. In that time, Democratic members of this Committee have sent multiple letters to Chairman Smith requesting the Administrator's presence at the witness table. The Ranking Member of the Full Committee and I have both requested, on the record, during Committee hearings that Administrator Pruitt be asked to testify in front of the Science Committee, only to be told that we could invite him ourselves. So we did. In fact, I invited Administrator Pruitt to participate in today's hearing as the Minority witness, but he rejected our request.

This Committee is doing a disservice to the American people by not having the EPA Administrator testify to explain his anti-science agenda and explain the actions he's taking that will undermine public health and the environment. This is especially egregious considering that this Committee has jurisdiction over the EPA, and Administrator Pruitt has found the time to testify in front of other congressional committees multiple times.

The EPA Administrator and Committee Chairman are touting the need for more transparency in science at the EPA. It seems that Administrator Pruitt's testimony in front of this Committee would be a key part of fulfilling that goal. It is our job to monitor Agency activities and to make sure they are consistent with congressional intent. We should not abdicate our responsibility to hold this Administration accountable.

So I sincerely hope this Committee will fulfill its duty to conduct congressional oversight of the EPA's science programs to make sure the Agency meets its mandate to protect public health and the environment.

And Mr. Chairman, I have a letter from nine public health, medical, and nursing organizations that support the full implementation and enforcement of the ozone NAAQS under the Clean Air Act. This letter also lays out concerns with the May 2018 memo on updating the NAAQS review process written by EPA Administrator Scott Pruitt that is inconsistent with the statutory requirements in the Clean Air Act. This letter highlights the importance of maintaining the NAAQS as a health-based standard built on scientific evidence and not allowing additional considerations such as cost or technically feasibility—technical feasibility to play a role in setting the standards. I ask unanimous consent that this letter be entered into the record.

Chairman BIGGS. Without objection.

[The information appears in Appendix I]

Ms. BONAMICI. Thank you, and Mr. Chairman, I also have a poll conducted in April of 2018 by the American Lung Association that found that 75 percent of voters support the enforcement of the 2015 Ozone Standard. This included a plurality of Republicans. Mr. Chairman, I would like to add the results of the American Lung Association's poll into the record.

Chairman BIGGS. Without objection.

[The information appears in Appendix I]

Ms. BONAMICI. Thank you, Mr. Chairman, and I yield back.

[The prepared statement of Ms. Bonamici follows:]

OPENING STATEMENT

Ranking Member Suzanne Bonamici (D-OR)
of the Subcommittee on Environment

House Committee on Science, Space, and Technology
Subcommittee on Environment
"State Perspectives on Regulating Background Ozone"
June 21, 2018

Thank you, Mr. Chairman. The Clean Air Act is one of the most successful pieces of public health legislation enacted by Congress. The protections helped avoid more than 200,000 premature deaths in its first 20 years alone. A clean environment is essential to a high quality of life for every American. It is important to consider the health effects of weakened air standards, particularly for children, the elderly and those suffering from asthma.

The National Ambient Air Quality Standards, or NAAQS, were established under the Clean Air Act to regulate criteria pollutants that have significant negative effects on human health. Congress made sure that public health was the driving factor in setting the NAAQS by requiring the standards to be based on exclusively on scientific, health-based evidence.

Since 2008, The Environmental Protection Agency's Clean Air Scientific Advisory Committee has recommended setting the ozone standard between 60 and 70 parts per billion. In 2015, the ozone NAAQS were strengthened to 70 parts per billion. Public health groups were concerned that the new level was not as protective as it could have been, but acknowledged the positive health outcomes the new standard would have for all Americans.

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I would like to thank our witnesses for being here today. I am glad to see Dr. Elena Craft back at the witness table to provide us with a scientific perspective not only on issues related to ozone, but also to discuss how the anti-science actions this Administration has taken at the EPA will undermine public health protections if left unchallenged.

I would also like to draw attention to the fact that it has been one year and four months since Scott Pruitt was confirmed as the EPA Administrator. In that time, the Democratic members of this Committee have sent multiple letters to Chairman Smith requesting the Administrator's presence at the witness table. The Ranking Member of the full Committee and I have both requested, on the record, during Committee hearings that Administrator Pruitt be asked to testify in front of the Science Committee, only to be told that we could invite him ourselves. We did; in fact I invited Administrator Pruitt to participate in today's hearing as the Minority witness, but he rejected our request.

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The EPA Administrator and Committee Chairman are touting the need for more transparency in science at the EPA. It seems that Administrator Pruitt's testimony in front of this Committee would be a key part of fulfilling that goal. It is our job to monitor Agency activities to make sure they are consistent with congressional intent, and we should not abdicate our responsibility to hold this Administration accountable.

I sincerely hope this Committee decides to fulfill its duty to conduct congressional oversight of the EPA's science programs to make sure the Agency meets its mandate to protect public health and the environment. Thank you, Mr. Chairman, and with that I yield back.

Chairman BIGGS. The gentlelady yields back.

I now recognize the Chairman of the Full Committee, Chairman Smith, for his opening statement.

Chairman SMITH. Thank you, Mr. Chairman, and thanks to our witnesses for being here today as well. And before we begin, I'd like to congratulate the gentleman from South Carolina to my right, Mr. Norman, for being the new Vice Chairman of the Subcommittee. We look forward to his contributions to the Committee. We've already seen examples of that in the last few months.

The Science Committee—I'm sorry I'm so hoarse today. It's better than having lost my voice, which I did yesterday, and Suzanne, you can't comment on my losing my voice and wishing that were the case today.

Ms. BONAMICI. Duly noted, Mr. Chairman.

Chairman SMITH. The Science Committee has held a number of hearings on the regulatory overreach of the previous Administration's Environmental Protection Agency. Today's hearing is a timely discussion on the National Ambient Air Quality Standards, or NAAQS.

The air in the U.S. is cleaner than it has ever been before. Yet in 2015 the previous Administration tightened the NAAQS for ground-level ozone.

The fastest way to hurt our local economy is to implement far reaching regulations that stunt business growth and development. The 2015 NAAQS often places heavy burdens on the American people, with few actual benefits.

Ensuring we have clean air and water, now and in the future, is important and should be a priority for everyone. However, regulations that stifle business and innovation, while doing little to actually meet these goals, are counterproductive.

Instead of using an unachievable, one-size-fits-all approach, the EPA should collaborate with the States and come up with plans that actually work. Background ozone includes both natural and international ozone. Natural ozone comes from many sources including wildfires, lightning and vegetation. International ozone refers to emissions coming from other countries like China and Mexico.

In some areas of the country, even background ozone levels exceed 70 parts per billion. In these areas, no matter how much a State controls its own emissions, it will never be able to comply with the 2015 NAAQS level.

We simply cannot beat mother nature and we cannot force other countries to stop their emissions. Geologic areas should not be held accountable for emissions they cannot control.

Many areas that receive a nonattainment designation suffer economically. This designation discourages businesses from moving into the State because they would have to deal with permitting and compliance obligations. This in turn limits employment opportunities for hardworking Americans living in our rural communities.

Let me say, it's good to have a personal friend from San Antonio, Diane Rath, who happens to live in my district, and is here to comment on background ozone issues facing Texas. San Antonio, for example, is directly and adversely affected by the international ozone from Mexico.

Less than a quarter of ozone emissions detected in San Antonio actually originated in the city. Yet to comply with the NAAQS, San Antonio must implement a burdensome regulatory agenda that adversely affects businesses and citizens alike.

Being a good steward of the environment and promoting a healthy economy are not mutually exclusive. Hard working Americans are hit the hardest by these expensive regulations. Regulatory overreach costs billions of dollars, kills jobs and hurts the economy. For example, expensive permitting regulations discourage employers from establishing businesses and creating jobs.

Because states have no control over international and natural emissions, even a state's greatest efforts to reduce emissions often fall short of the benefits envisioned by the Clean Air Act.

I remain hopeful that the EPA will review the current NAAQS standards and evaluate the science and process behind setting future NAAQS. Recently, Administrator Pruitt laid out five principles that will be implemented in future NAAQS reviews. This "back-to-basics" process will ensure that sound science is the foundation of the NAAQS standards and that all relevant data is considered in implementation, including naturally occurring and international ozone.

Thank you, Mr. Chairman, and I'll yield back the balance of my time.

[The prepared statement of Chairman Smith follows:]

COMMITTEE ON
SCIENCE, SPACE, & TECHNOLOGY
Lamar Smith, Chairman

For Immediate Release
June 21, 2018

Media Contact: Bridget Dunn
(202) 225-6371

Statement by Chairman Lamar Smith (R-Texas)

State Perspectives on Regulating Background Ozone

Chairman Smith: Thank you, Mr. Chairman, and thanks to our witnesses for being here today. Before we begin, I'd like to congratulate the gentleman from South Carolina, Mr. Norman, who is the new vice chairman of the Environment Subcommittee. We look forward to his contributions to the subcommittee.

The Science Committee has held a number of hearings on the regulatory overreach of the previous administration's Environmental Protection Agency (EPA). Today's hearing is a timely discussion on the National Ambient Air Quality Standards (NAAQS).

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Less than a quarter of ozone emissions detected in San Antonio actually originated in that city. Yet to comply with the NAAQS, San Antonio must implement a burdensome regulatory agenda that adversely affects businesses and citizens alike.

Being a good steward of the environment and promoting a healthy economy are not mutually exclusive. Hard working Americans are hit the hardest by these expensive regulations. Regulatory overreach costs billions of dollars, kills jobs and hurts the economy.

For example, expensive permitting regulations discourage employers from establishing businesses and creating jobs.

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This "back-to-basics" process will ensure that sound science is the foundation of the NAAQS standards and that all relevant data is considered in implementation, including naturally occurring and international ozone.

###

Mr. BIGGS. The gentleman yields, and I now recognize the Ranking Member of the Full Committee, Ms. Johnson, for an opening statement.

Ms. JOHNSON. Thank you very much, Mr. Biggs, and I want to thank all of our witnesses for being here to discuss their perspectives on air pollution regulations.

For the past several years, whenever the Majority has held a hearing on air pollution there has been one common thread. Virtually every hearing has highlighted one or more excuses as to why air pollution shouldn't be regulated. Today, we will hear about another excuse: background ozone. This isn't even a novel excuse. We held a hearing on this same topic just a few years ago.

One thing the Committee never seems to address is the public health effects of Americans breathing in air pollution. I'm a nurse. I've done some studies. And those health effects are devastating. Disease, misery, and death. In addition to the severe bodily toll that air pollution takes on Americans, it is also—it also imposes a serious monetary cost. It is estimated that the EPA's 2015 Ozone regulations, which were only slightly more stringent than the previous standards, would result in hundreds of thousands dollars—of fewer asthma attacks in children every year. They continue, however, to go up. That would, in turn, result in over 100,000 less missed school days, which, in turn, would result in significantly increased productivity for the parents of those children. And just—that just deals with asthma. These regulations would also reduce COPD, cardiovascular disease, and other negative health effects.

The total health care savings from regulating ozone even slightly more stringently than before runs well into the billions of dollars every year. That should really come as no surprise to the Members of Congress. Healthcare is very expensive. Rising healthcare costs are one of the primary drivers of our increasing national debt. As we work to address these issues, I think it makes more sense to cut the pollution that is helping to drive those healthcare costs higher, rather than cutting the healthcare treatments people need to survive.

I hope that the Minority witness, Dr. Craft, can help us highlight some of the reasons why it is so important to regulate air pollution in the first place. And I'm sure that she can also address the rationale being offered today by our Majority for why we shouldn't be regulating pollution.

I am from Texas, and we get plenty of cross border air pollution coming from our neighbors to the South. Not just Mexico, but Louisiana sits over there, too. Quite frankly, we probably also send a little air pollution to our neighbors in the east. Every state has its own unique issues related to reducing air pollution. But I don't think that is an excuse to let people in Dallas, Houston or San Antonio get sick and suffer. I hope we can keep that in mind today as we talk about these compliance issues. I look forward to hearing from our witnesses, and I yield back.

[The prepared statement of Ms. Johnson follows:]

OPENING STATEMENT
Ranking Member Eddie Bernice Johnson (D-TX)

House Committee on Science, Space, and Technology
Subcommittee on Environment
"State Perspectives on Regulating Background Ozone"
June 21, 2018

Thank you, Chairman Biggs. I also want to thank all of our witnesses for being here today to discuss their perspectives on air pollution regulations.

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I look forward to hearing from our witnesses today, and I yield back.

Chairman BIGGS. The gentlelady yields back. Thank you.

I now recognize Chairman Smith to introduce our first witness.

Chairman SMITH. Thank you, Mr. Chairman. I'm glad to be able to introduce Diane Rath, the Executive Director of the Alamo Area Council of Governments, which serves much of my home district back in Texas.

Ms. Rath began work in public service when then-Governor George Bush appointed her Chair of the Texas Workforce Commission. She was then nominated by President Bush to be Assistant Secretary of Administration for Children and Families at the U.S. Department of Health and Human Services. During this time, she became recognized as a national leader in workforce development.

Prior to her current position, Ms. Rath served as Senior Vice President at ResCare Workforce Services with oversight responsibility for operations at over 300 locations in 28 States.

As Executive Director of AACOG, she oversees 300 employees and 11 program areas with a budget of $50 million. Ms. Rath attended Texas Christian University and graduated from the University of Texas Medical Branch at Galveston.

We are pleased to have her here. I yield back.

Chairman BIGGS. Thank you, Chairman Smith. Indeed, we are pleased to have Ms. Rath and all of our wonderful witnesses here today. We are grateful that you are here.

Our next witness today will be from my home State of Arizona, Mr. Timothy Franquist. He is the Arizona Department of Environmental Quality's Air Quality Director. He previously served as the Air Quality Division Deputy Director and has been with ADEQ for more than 14 years.

Prior to State service, Mr. Franquist worked in a variety of environmental positions, including private sector consulting, county government, and environmental non-government organizations.

As Director of Air Quality, Mr. Franquist has led the division's effort to become nationally recognized for the agency's work on international transport of ozone, exceptional event demonstrations, permitting, and air quality meteorology.

Mr. Franquist received his bachelor's degree in environmental science and policy from the University of Maryland and his master's in environmental management from ASU. Welcome, Dr. Franquist.

Our third witness is Dr. Elena Craft, a senior health scientist at Environmental Defense Fund. For a decade, Dr. Craft has strategized to identify, monitor, and mitigate risks from environmental pollution from the industrial sector, as well as from within the transportation sector, most specifically around port areas and freight corridors.

In addition, she has facilitated development of initiatives to support public health research, including helping to establish the Hurricane Harvey Environmental Health and Housing Registry in Houston, the first registry established after a major flood event.

Dr. Craft's other scientific research focuses on understanding health disparities associated with living in pollution hotspots.

She holds a bachelor's of science in biology from UNC Chapel Hill, a master's of science and toxicology from North Carolina State University, and a Ph.D. from Duke University. Dr. Craft also holds an adjunct assistant professorship at the University of Texas Health Science Center, and is a Kinder Fellow at Rice University. Thank you for being here, Dr. Craft.

Our final witness today is Mr. Gregory Stella, a senior scientist at Alpine Geophysics, LLC. For over 25 years, Mr. Stella has coordinated with both public and private workgroups, modeling centers, and stakeholders to develop, evaluate, and apply control measures and program designs in support of emissions and air quality policy decisions.

Prior to joining Alpine Geophysics in 2003, Mr. Stella was on staff at EPA's Office of Air Quality, Planning, and Standards, where he managed and prepared the emission inventories, control strategies, and associated temporal, spatial, and speciation data from multiple projects. He is internationally recognized as a technical authority in the modeling and policy application of emission inventories for ozone, and particulate matter, pollutants, and precursors.

Mr. Stella received his bachelor's of science in chemical engineering from the Johns Hopkins University in Baltimore, Maryland.

I now recognize Ms. Rath for five minutes to present her testimony.

TESTIMONY OF MS. DIANE RATH, EXECUTIVE DIRECTOR, ALAMO AREA COUNCIL OF GOVERNMENTS

Ms. RATH. Thank you, Mr. Chairman, and thank you for inviting me. I am Diane Rath, Executive Director of the Alamo Area Council of Governments. I'd also like to introduce my Board Chair who is with us today, Judge Chris Schuchart, who is a county judge in Medina County.

I am very pleased to appear today to provide information on the history of public and private partnerships that have helped reduced ozone concentrations in the San Antonio MSA, and how background ozone, international emissions, and ozone transport contribute to San Antonio's ozone levels. Slide, please.

[Slide.]

Ms. RATH. The San Antonio-New Braunfels MSA has experienced significant improvement in its ozone levels in the past several years, with a 20 percent decline from 2004 to 2016. These improvements occurred despite a population increase of nearly 600,000 folks across the region.

San Antonio is currently the largest city in the country with attainment with ozone national ambient air quality standards. The city of San Antonio added the most people of any city in the country between 2016 and 2017, and high population growth is expected to continue.

Another example of the improvement in ozone levels is the number of days when any monitor exceeded an 8-hour average over 70 parts per billion. In 2017, there were only five such days at regulatory monitors, compared to an average of 12. The region's success in improving ozone levels is due, in large part, to local voluntary public and private initiatives to reduce ozone precursor emissions. Several examples are included in my written testimony. Slide, please.

[Slide.]

Ms. RATH. Photochemical modeling can be used to estimate the contribution from other geographic areas to ozone levels at a given location using the Anthropogenic Precursor Culpability Assessment. APCA analysis suggests that in 2017, the maximum local contribution to San Antonio's ozone at Camp Bullis C58 was 12.86 parts per billion, or 20.5 percent. This means that 79.5 percent of San Antonio's ozone is caused by emissions and transport from outside the San Antonio region; that is, outside of local control. Slide, please.

[Slide.]

Ms. RATH. A further breakdown of San Antonio ozone contribution reveals that 24.05 parts per billion, or 38.4 percent of San Antonio's ozone, originates from international sources. Other Texas cities contribute 16.1 percent. It's estimated that areas outside Texas contribute 25 percent to San Antonio's ozone.

The San Antonio-New Braunfels MSA has proven to be a leader when it comes to reducing ozone levels through its numerous public and private initiatives that limit ozone precursor emissions. These voluntary efforts have helped reduced San Antonio's ozone design value, and is predicted to continue falling through 2023. These ozone reductions are all the more impressive, given the unique ozone transport situation that San Antonio faces with over 38 percent of ozone contribution coming from international sources.

We urge EPA to take advantage of the flexibility in the Clean Air Act to recognize the impact of background ozone levels and all foreign transport on a region. It is important to acknowledge the amount of ozone that is produced locally and able to be impacted by local actions. The regulatory burden and economic consequences of a nonattainment designation can be devastating to a region when the region is not able to impact the ozone levels by its own actions.

So Mr. Chairman and Committee members, I thank you for this opportunity to discuss the unique impact of background ozone and foreign transport on our region, and share the great progress we have made as a result of voluntary public and private initiatives over the concern for the health of the residents of our region.

Thank you.

[The prepared statement of Ms. Rath follows:]

Written Testimony of
Diane D. Rath
Executive Director
Alamo Area Council of Governments

Before the United States House of Representatives
Committee on Science, Space, and Technology
Subcommittee on Environment

"San Antonio Ozone Levels and the Impact of International Emissions and Transport"
June 21, 2018
10:00 a.m.

2321 Rayburn House Office Building

I am Diane Rath, Executive Director of the Alamo Area Council of Governments. I am pleased to appear today to provide the Committee information on the history of public and private partnerships that have helped reduce ozone concentrations in the San Antonio-New Braunfels Metropolitan Statistical Area (MSA) over the years, and how background ozone, international emissions, and ozone transport contributes to San Antonio's ozone levels.

The San Antonio-New Braunfels MSA has experienced significant improvement in its ozone levels in the last several years, with nearly a 20% decline in design value from 91 parts per billion (ppb) in 2004 to 73 ppb in 2016.[1] These improvements occurred despite a population increase of over 568,000 across the 8-county MSA during that period.[2,3] The MSA consists of Atascosa, Bandera, Bexar, Comal, Guadalupe, Kendall, Medina, and Wilson Counties. San Antonio is currently the largest city in the country with an attainment designation. The City of San Antonio, located in Bexar County, added the most people of any city in the United States (US) between 2016 and 2017,[4] and high population growth is expected to continue in the region for the foreseeable future.

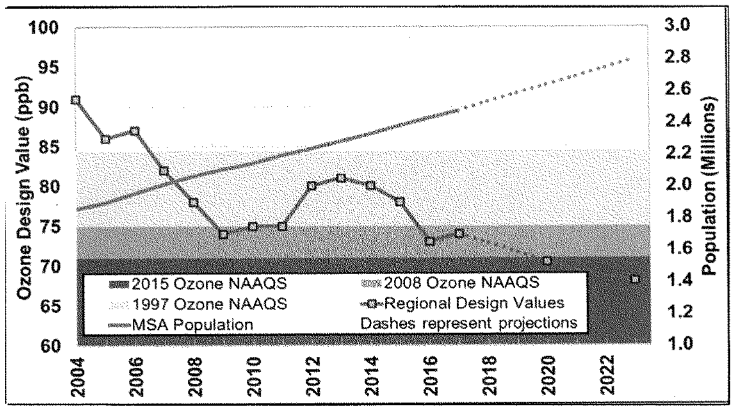

Figure 1: Design Value and Population Trend and Projections for San Antonio, 2004-2023[5,6]

[1] TCEQ. "Compliance with Eight-Hour Ozone Standard." Austin, TX. Available online: https://www.tceq.texas.gov/cgi-bin/compliance/monops/8hr_attainment.pl. Accessed June 7, 2018.

[2] U.S. Census Bureau, April 2017. "County Intercensal Tables: 2000-2010." Available online: https://www2.census.gov/programs-surveys/popest/tables/2000-2010/intercensal/county/co-est00int-01-48.xls. Accessed June 7, 2018.

[3] U.S. Census Bureau. American Fact Finder, March 2018. "Annual Estimates of the Resident Population: April 1, 2010 to July 1, 2017 - United States -- Metropolitan Statistical Area; and for Puerto Rico 2017 Population Estimates." Available online: https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk. Accessed June 7, 2018.

[4] O'Hare, Peggy. (2018) 'City's population growth largest in nation, census data shows', *San Antonio Express-News*, May 23. Available online: https://www.expressnews.com/news/local/article/City-s-population-growth-largest-in-nation-12939249.php. Accessed June 7, 2018.

[5] Texas Demographic Center. "2014 Texas Population Projections by Migration Scenario Data Tool." Available online: http://txsdc.utsa.edu/Data/TPEPP/Projections/Tool?fid=59C8EB01DC924235BC194ED95001697F. Accessed June 11, 2018.

[6] Assumes population change due to migration at a rate equal to the 2000-2010 migration rate

Another testament to the improvement of ozone levels in San Antonio is in the number of days when any monitor exceeded an 8-hr average over 70 ppb in 2017 compared to the 2010-2017 annual average. These are days classified by the Air Quality Index (AQI) as "Unhealthy for Sensitive Groups." In 2017, there were only five such days at regulatory monitors, compared to a 2010-2017 average of twelve. There were 49 days with moderate ozone as classified by the AQI (8-hr average ozone above 54 ppb) in 2017, while the 2010-2017 average is 64 days per year.

The region's success in improving ozone levels is due in large part to local voluntary public and private partnerships to reduce ozone precursor emissions. Some of these efforts include:

- Bexar County and Cities of San Antonio, Leon Valley, and Seguin Anti-Idling Ordinances;
- CPS Energy's Save For Tomorrow Energy Plan (STEP) to reduce demand for electricity generated by coal-fired power plants, equal to shutting down a medium-sized coal plant;
- CPS Energy met its goal of 1,500 megawatts (MW) of renewable energy capacity two years ahead of schedule through the management and expansion of a diverse energy generation portfolio, including wind, rooftop solar, and utility-scale solar; the 1,500 MW amounts to 20% of CPS Energy's total generation capacity;
- Participating in the Texas Emission Reduction Program (TERP) to facilitate turnover of older and dirtier diesel engines; engage in community outreach to spread awareness of TERP among local industry and business leaders;
- Installing selective non-catalytic reduction at cement kilns in Bexar and Comal Counties;
- Equipment and lighting retrofits by San Antonio Water System (SAWS) using incentives from CPS Energy's Commercial Energy Efficiency Program; SAWS biogas capture from new Dos Rios water treatment facility;
- City of San Antonio ban on coal tar sealants; San Antonio is the largest city in the country with such an ordinance;
- VIA Metropolitan Transit (VIA) began converting its diesel bus fleet to compressed natural gas (CNG) in April 2017; VIA's new CNG fueling facility is the largest in North America; and
- Investments in the latest technology by both the energy industry in the Eagle Ford shale and the cement industry to reduce emissions.

One example of technology employed by the cement industry to reduce emissions is the implementation of SkyMine® technology. Developed at San Antonio's Southwest Research Institute and implemented in September 2015, SkyMine® removes carbon dioxide (CO_2), sulfur oxides (SO_X), and nitrogen oxides (NO_X) from industrial waste streams and transforms them into marketable products like baking soda, bleach, and hydrochloric acid. The Capitol Aggregates cement plant in San Antonio was the first facility in the U.S. to use this technology. SkyMine® requires 30% less energy to operate compared to traditional carbon removal techniques.[7]

Future improvements to local ozone levels will continue to occur as CPS Energy's Deely Units 1 and 2 will be retired in 2018, resulting in over seven tons of NO_X reduced per summer day. Two other large coal-fired plants in central Texas were retired in January 2018. In addition, VIA has committed to convert its entire diesel bus fleet to CNG by 2020.

[7] Capitol Aggregates, Inc. "Capitol Skymine®: Pro-Business, Pro-Environment." Available online: http://www.capitolaggregates.com/s/Sustainability-Skyonic. Accessed June 7, 2018.

Thanks to these united efforts to reduce ozone precursors, photochemical modeling reviewed by the US Environmental Protection Agency (EPA) and the Texas Commission on Environmental Quality (TCEQ) projects that Bexar County monitors will meet the 2015 ozone NAAQS by 2020, which is earlier than would be required under a marginal nonattainment designation. Every regulatory monitor in the area (CAMS 23, CAMS 58, and CAMS 59) is projected to be well below the 2015 standard by 2023.

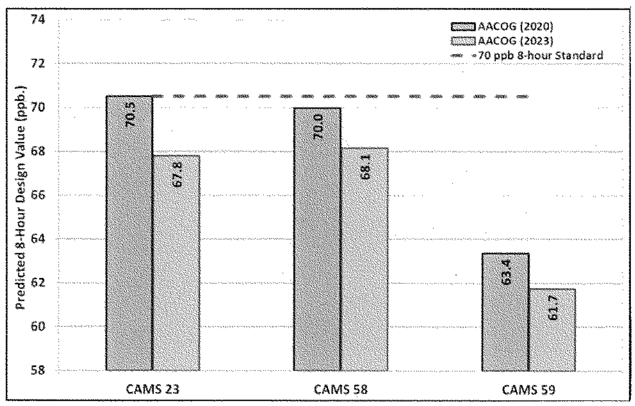

Figure 2: Projected Change in San Antonio-New Braunfels MSA Eight-Hour Design Values with a 2017 Base Line, 2020 and 2023[8]

Photochemical modeling can be used to estimate the contribution from other geographic areas to ozone levels at a given location using the Anthropogenic Precursor Culpability Assessment (APCA). APCA analysis suggest that in 2017, the maximum local contribution to San Antonio's ozone at Camp Bullis C58 on days > 60 ppb was 12.86 ppb, or 20.5%. This means that 79.5% of San Antonio's ozone is caused by emissions and transport from outside the San Antonio-New Braunfels MSA, that is, outside of local control.

[8] AAMPO, November 2017. "Ozone Analysis of the 2012 Ozone Season Photochemical Modeling Episode." P. 8-7. San Antonio, TX.

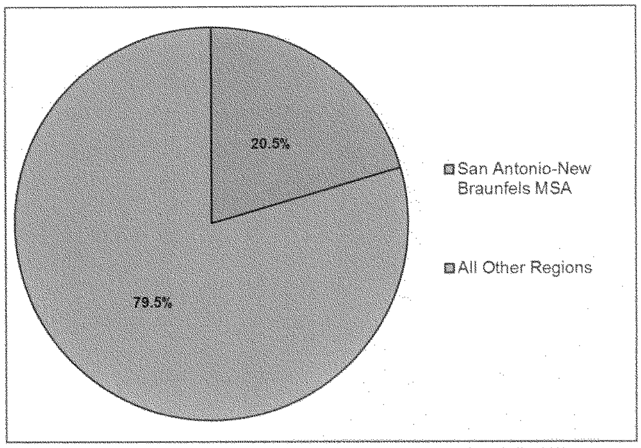

Figure 3: Local vs. Transported Ozone Measured at CAMS 58 Camp Bullis, 2017[9]

A further breakdown of San Antonio ozone contribution reveals that 24.05 ppb, or 38.4% of San Antonio's ozone on days > 60 ppb originates from international sources. Specifically, these are ozone precursors or ozone located outside of the black box labeled "RPO 36 km".

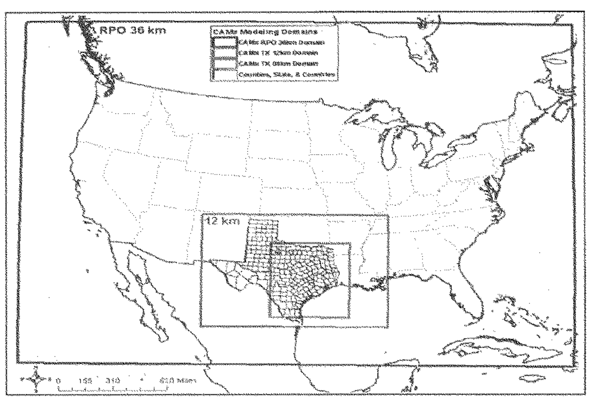

Figure 4: Nested Photochemical Modeling Grids for Ozone Season 2012 Episode[10]

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[9] AACOG. March 2018. "International Contribution to Local Ozone in the San Antonio-New Braunfels MSA, 2017 and 2023." San Antonio, TX. Email correspondence to TCEQ.

[10] TCEQ. "Texas Air Quality Modeling – Domains". Austin, Texas. Available online: http://www.tceq.texas.gov/airquality/airmod/rider8/modeling/domain. Accessed June 7, 2018.

It is estimated that areas within Texas (including the San Antonio-New Braunfels MSA) contribute to 36.6% of San Antonio's ozone. Areas outside Texas but within the modeling domain (including southern Canada, northern Mexico, the northwest Caribbean, and adjacent offshore areas) contribute 25% to San Antonio's ozone. A summary of modeled contribution to San Antonio area ozone by geographic region is provided in Figure 5.

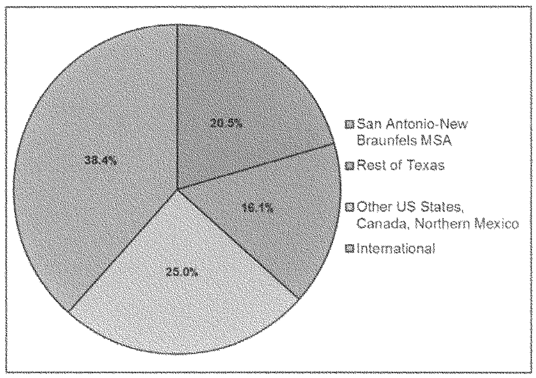


Figure 5: Projected Contribution to San Antonio Maximum Ozone at Camp Bullis CAMS 58 by Geographic Region on Days > 60 ppb, 2017 [11]

Daily local meteorological observations during high ozone events show that elevated ozone levels typically occur in the days following the passage of a frontal boundary. In the absence of large-scale weather features like fronts, southeasterly flow dominates. This flow regime transports relatively clean air (< 55 ppb ozone) from the Gulf of Mexico over the San Antonio region. When a front passes through south Texas, northerly winds transport relatively dirty continental air containing ozone and ozone precursors from major metropolitan areas and heavily-traveled transportation corridors like Interstate 35. Under these conditions, ozone concentrations typically rise to moderate levels (55-70 ppb). As frontal boundaries either dissipate or continue to move south away from the region, high pressure in the southeastern U.S. becomes reestablished, and southeasterly flow begins to return to the San Antonio region. The highest ozone levels coincide with this flow transition from northerly to southeasterly, which is most pronounced at the Camp Bullis CAMS 58 monitor. Wind roses comparing morning and afternoon wind direction and speed at CAMS 58 on high ozone days clearly show this flow reversal (Figure 6). Ozone levels fall back to below moderate levels about a day after southeasterly flow returns.

[11] AACOG, March 2018. "International Contribution to Local Ozone in the San Antonio-New Braunfels MSA, 2017 and 2023." San Antonio, TX. Email correspondence to TCEQ.

Landfalling tropical cyclones in the southeastern U.S. can also cause a spike in local ozone levels by creating a similar flow reversal pattern seen after a frontal passage. When San Antonio is west of a large cyclonic (counterclockwise) circulation, northerly winds are observed locally. As the weakening tropical cyclone moves farther inland and away from San Antonio, its influence on local weather diminishes, and southeasterly flow returns, initiating a high ozone event. The most recent such occurrence was Hurricane Irma in September 2017, whose landfall in Florida on September 10 triggered a high ozone event in San Antonio on September 13. Other meteorological characteristics that are conducive to high ozone in San Antonio are low humidity, weak or variable steering flow, a large diurnal temperature difference, and a rapid rise in mixing height during the day.

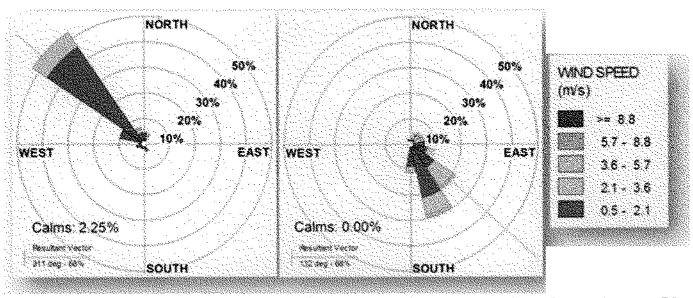
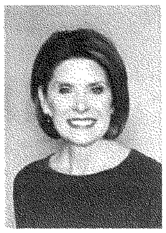


Figure 6: Wind Roses Comparing Morning and Afternoon Winds at CAMS 58 on Ozone Days > 70 ppb, 2010-2017

The San Antonio-New Braunfels MSA has proven to be a leader when it comes to reducing ozone levels through its numerous public and private initiatives that limit ozone precursor emissions. These efforts have helped reduce San Antonio's ozone design value from 91 ppb in 2004 to 73 ppb in 2016, and is predicted to continue falling through 2023. These ozone reductions are all the more impressive given the unique ozone transport situation that San Antonio faces, with over 38% of ozone contribution coming from international sources.

We urge EPA to take advantage of the flexibility in the Clean Air Act to evaluate and actively consider during NAAQS designation the impact of background ozone levels and all foreign transport on a region. It is important to acknowledge the amount of ozone that is produced locally and able to be impacted by local actions. The regulatory burden and economic consequences of a nonattainment designation can be devastating to a region when the region is not able to impact the ozone levels by its own actions.

Thank you for providing this opportunity to discuss the unique impact of background ozone and foreign transport on our region and share the great progress we have made as a result of the voluntary public-private partnerships.



Diane Rath has served as Executive Director of AACOG since December 2014. In this capacity, she oversees 300 employees in 11 program areas with a budget of $50 million. During her tenure, AACOG has been recognized with national awards from NADO recognizing both Innovation and Transportation Partnerships.

Before joining AACOG, Ms. Rath served as Senior Vice President at ResCare Workforce Services, with oversight responsibility for operations in over 300 locations in 28 states with 2200 employees and a budget of $223 million.

In 1996, then Governor George W. Bush appointed her as Chair and Commissioner for the Texas Workforce Commission, where she served until 2008. During her tenure, she oversaw the consolidation of 28 programs from 10 different state agencies to form a $1.2 billion agency with responsibility for services involving federal programs from the U.S Department of Labor, Health and Human Services, and two other federal agencies. In 2007, Rath was nominated by President George W. Bush as Assistant Secretary of Administration for Children and Families at U.S. Health and Human Services. During this time she became recognized as a national leader in workforce development, forging partnerships with economic development and educational entities to meet the workforce needs of Texas businesses.

A physical therapist by background, Ms. Rath attended TCU, and graduated from UTMB-Galveston.

She is active in the San Antonio community and currently serves (or served) on numerous boards and committees which include

- National Association of Regional Councils, Executive Director Council, 2017-
- Frost Bank- San Antonio, Advisory Board Member, 2003-present
- Texas Conservative Coalition Research Institute, Board Member, 2003-present
- Valero Alamo Bowl, Board Member, 1994-present, Chair 2002
- San Antonio Airport Advisory Commission, 2015 – present
- Lone Star Rail District Board, 2015-present
- San Antonio Mobility Coalition (SAMCo) Board Member, 2015 – present, Treasurer 2016-2017
- American Public Human Services Association Policy Council, 2007-2008
- Texas Public Education Reform Foundation, Board Member, 2006-2010
- Bexar County United Way, Board Member 1998-2004
- Greater San Antonio Chamber of Commerce, Board of Directors 1993-96, Vice-Chair 1993
- JPMorganChase - San Antonio, Advisory Board Member, 1992-2003
- Texas Council on Workforce & Economic Competitiveness, 1995-2003, Chair 1995-1996
- Texas Department of Commerce, Board Member 1995-1996
- San Antonio Development Agency, Vice Chair, 1990-94
- San Antonio Water System Board, Vice-Chair 1992-94
- Texas Rehabilitation Commission, Board Member 1989-1992
- Texas Board of Physical Therapy Examiners, 1981-1983

Mr. NORMAN. [Presiding.] Thank you, Ms. Rath, and I too want to take this opportunity to thank each of you for devoting your time and talent to educating us on the issue.

I now recognize Mr. Franquist for five minutes to present his testimony.

TESTIMONY OF MR. TIMOTHY FRANQUIST, AIR QUALITY DIVISION DIRECTOR, ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

Mr. FRANQUIST. Thank you. Mr. Chairman, Members of the Committee, my name is Timothy Franquist, and I am the Air Quality Director at the Arizona Department of Environment Quality, and I appreciate the opportunity to offer testimony today.

The Clean Air Act has done a remarkable job of reducing air pollution across the county for the past 48 years from industry and vehicles. Now, however, we face a new air quality challenge: global air pollution, specifically, air pollution that is transported to the U.S. in such quantities to cause areas of the country to exceed the National Ambient Air Quality Standards. Unfortunately, the Clean Air Act is ill-equipped to address this new air quality problem in terms of protecting public health and our local economies.

The U.S. EPA has conducted ozone modeling for U.S. background, or what is more commonly referred to as international transport, several times over the past three years. The models continue to indicate that ozone concentrations are increasing from international sources and impacting the U.S.

The most recent U.S. model indicates that over 83 percent of ozone in southern Arizona is attributed to international sources. Arizona is not only impacted by Mexican emissions, 65 percent of the ozone in the Southwest is attributed to international transport from Asia, according to a surface ozone study conducted by a team of researchers from NOAA, Princeton University, Columbia University, and the U.S. EPA.

The surface ozone study further indicates that during summertime in the western U.S. "increasing Asian emissions approximately offset the benefits of U.S. emissions reductions."

Beginning in May 2017, the Arizona Department of Environmental Quality installed an ozone monitor in San Luis Rio Colorado, Mexico, to determine the impacts of international transport on Yuma, Arizona, a new ozone nonattainment area proposed by the U.S. EPA as of April 2018. Our preliminary analysis indicates that prevailing winds from the south and increasingly high levels of ozone originating south of the U.S. border are causing Yuma to exceed the federal ozone standard.

Because Yuma exceeds the 2015 Ozone standard, the Clean Air Act will require the State of Arizona to develop a state implementation plan for the area. Yuma will be subject to emission offsets for new large businesses or major expansions to existing businesses and those sources will be required the install extremely expensive emission control equipment before operating. Yuma is not a heavy industrial or urban area and therefore, it does not generate the requisite emission offsets, which ultimately discourages new or expanding business in the area.

The only relief for Yuma under the Clean Air Act is the state to pursue an international transport demonstration, but we can only do that demonstration after three years of an area not meeting the standard. Yuma will remain in perpetual nonattainment until international emissions decrease to the extent that Yuma attains the ozone standard. The international transport demonstration does nothing to better protect Yuma residents from the health impacts of international pollution or lessen the burden on their local economy.

The negative health effects of ozone is well documented; as is poverty's negative effect on public health. The impact of nonattainment on Yuma's public health and economy creates an incredibly dire situation for a primarily agricultural community of 100,000 residents, 19 percent of which live below the poverty line.

The World Bank states in a report entitled "Poverty and Health" that "Poverty is a major cause of ill health and a barrier to accessing health care when needed."

According to a study authored by Michael McCally, MD, and his colleagues, people living in countries with a higher Gross National Product have a longer life expectancy. In short, public health is not just about clean air, it's also about a healthy economy.

Finding state-level solutions for ozone nonattainment areas are made infinitely more complicated when the area is significantly impacted by international transport of air pollution, as we are in Arizona. Therefore, we must look to our federal agencies and representatives for relief to the international air pollution transport problem so that the recipients of pollution are not punished, but protected.

The Clean Air Act has not been significantly revised since 1990. As Arizona and the U.S. confront the growing challenge of global air pollution impacts on the U.S., I urge Congress to seriously consider meaningful revisions to the Clean Air Act to address international transport of air pollution.

Senator Flake has introduced Senate Bill 2825, which helps remove some of the negative economic impacts to areas of the U.S. that do not meet the Ozone standard due to international transport, while maintaining adequate air quality control measures to ensure that public health and the environment are protected. Senate Bill 2825 would be a major step in protecting places like Yuma, Arizona, and the West from international air pollution.

Thank you.

[The prepared statement of Mr. Franquist follows:]

Testimony

U.S. House of Representative Committee on Science, Space, & Technology

Subcommittee on Environment

Thursday, June 21, 2018

By

Timothy Franquist, Air Quality Director

Mr. Chairman, members of the committee. My name is Timothy Franquist. I am the Air Quality Director at the Arizona Department of Environmental Quality and; I appreciate the opportunity to offer testimony today.

The Clean Air Act has done a remarkable job of reducing air pollution across our county for the past 48 years from industry and vehicles. Now, however, we face a new air quality challenge: global air pollution, specifically, air pollution that is transported to the U.S. in such quantities to cause areas of our country to exceed the National Ambient Air Quality Standards (NAAQS). Unfortunately, the Clean Air Act is ill equipped to address this new air quality problem in terms of protecting public health and our local economies.

The U.S. EPA has conducted ozone modeling for U.S. background, or what is more commonly referred to as international transport, several times over the past three years. The models continue to indicate that ozone concentrations are increasing from international sources and impacting the U.S. The most recent U.S. EPA model indicates that over 83% of ozone in Southern Arizona is attributed to international sources (Attachment A).

Arizona is not only impacted by Mexican emissions, 65 percent of the ozone in the Southwest is attributed to international transport from Asia, according to a surface ozone study conducted by a team of researchers from NOAA, Princeton University, Columbia University, and the U.S. EPA (Attachment B).

The surface ozone study further indicates that during summertime in the Western U.S., "increasing Asian emissions approximately offset the benefits of U.S. emissions reductions."

Beginning in May 2017, the Arizona Department of Environmental Quality installed an ozone monitor in San Luis Rio Colorado, Mexico, to determine the impacts of international transport on Yuma, Arizona, a new ozone nonattainment area proposed by the U.S. EPA as of April 2018. Our preliminary analysis indicates that prevailing winds from the south and increasing high levels of ozone originating south of the U.S. border are causing Yuma to exceed the federal ozone standard (Attachment C).

Because Yuma exceeds the 2015 Ozone standard, the Clean Air Act will require the State of Arizona to develop a state implementation plan for the area. Yuma will be subject to emission offsets for new large businesses or major expansions to existing businesses and those sources will be required the install extremely expensive emission control equipment before operating. Yuma is not a heavy industrial or urban area and therefore, it does not generate the requisite emission offsets, which ultimately discourages new or expanding business in the area.

The only relief for Yuma under the Clean Air Act is for the State to pursue an international transport demonstration, but we can only submit that demonstration after three years of the area not meeting the standard. Yuma will remain in perpetual nonattainment until international emissions decrease to the extent that Yuma attains the ozone standard. The international transport demonstration does nothing to better protect Yuma residents from the health impacts of international pollution or lessen the burden on their local economy.

The negative health effects of ozone is well documented; as is poverty's negative effect on public health. The impact of nonattainment on Yuma's public health and economy creates an incredibly dire situation for a primarily agricultural community of 100,000 residents, 19 percent of which, live below the poverty line[1]. The World Bank states in a report entitled, "Poverty and Health", that "Poverty is a major cause of ill health and a barrier to accessing health care when needed." (Attachment E) According to a study, authored by Michael McCally, MD and his colleagues, people living in countries with a higher Gross National Product have a longer life expectancy (Attachment F). In short, public health is not just about clean air, it's also about a healthy economy.

Finding state-level solutions for ozone nonattainment areas are made infinitely more complicated when the area is significantly impacted by international transport of air pollution, as we are in Arizona. Therefore, we must look to our federal agencies and representatives for relief to the international air pollution transport problem so that the recipients of pollution are not punished, but protected.

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Thank you and I am happy to take any questions at this time.

[1] Source: https://www.census.gov/quickfacts/fact/table/yumacountyarizona/PST045217

Attachment

A

U.S. EPA International Transport Modeling

Summary of Modeling Results for Yuma, AZ

Model	Average DV	AZ	CA	Mex/Can	Biogenics	Boundary	USB (three previous columns combined)
Jan 2015	70.7	6.8%	23.5%	6.8%	5.4%	56.8%	69%
Aug 2015	70.7	6.1%	19.5%	7.2%	3.8%	61.3%	72.3%
Sept 2016	71.5	6.0%	18.2%	7.6%	3.3%	62.8%	73.7%
Dec 2016	68.9	4.9%	8.1%	13.3%	2.8%	68.8%	84.9%
Mar 2018	70.4	5.5%	8.0%	14.1%	3.1%	66.3%	83.5%

Summary Modeling Results of Adjacent Locations to Yuma, AZ (March 2018)

	Average DV	Mex/Can	Biogenics	Boundary	USB (three previous columns combined)
Imperial, CA	79.0	23.7%	2.6%	55.2%	81.5%
San Diego, CA	69.4	20.1%	2.3%	37.9%	60.3%
Dona Ana, NM	67.1	20.3%	4.5%	55.8%	80.6%
El Paso, TX	67.6	27.1%	4.4%	52.2%	83.7%
Brewster, TX	67.9	8.2%	3.6%	75.5%	87.3%

Summary of Modeling Results for Reference

	USB		USB
Maricopa, AZ	55.6%	Chicago, IL	38.6%
San Bernardino, CA	44.5%	Atlanta, GA	31.6%

Long Island, NY	34.2%	Orlando, FL	42.8%
Fairfield, CN	30.8%	Baltimore, MD	30.2%
Sheboygan, WI	35.3%	Denver, CO	52.9%

Modeling Boundary Map

Data Sources of U.S. EPA Modeling:

2008 NAAQS Ozone Transport Modeling

January 2015 – https://www.epa.gov/airmarkets/january-2015-memo-and-information-0

August/November 2015 – https://www.epa.gov/airmarkets/proposed-cross-state-air-pollution-update-rule

September 2016 – https://www.epa.gov/airmarkets/final-cross-state-air-pollution-rule-update

2015 NAAQS Ozone Transport Modeling

December 2016 – https://www.epa.gov/airmarkets/notice-data-availability-preliminary-interstate-ozone-transport-modeling-data-2015-ozone

March 2018 - https://www.epa.gov/airmarkets/march-2018-memo-and-supplemental-information-regarding-interstate-transport-sips-2015

Technical Notes:

- Mex/Can contribution is anthropogenic emissions from the portions of Mexico and Canada inside the boundary
- Boundary contribution is all (anthropogenic and natural sources) emissions for everything outside the boundary, a global model is used to determine this
- EPA's definition of U.S. Background (USB) as ozone formed from any sources other than US manmade emissions (which would include Mexico/Canada, Biogenics, and Boundary)

Attachment

B

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Atmospheric Chemistry and Physics

US surface ozone trends and extremes from 1980 to 2014: quantifying the roles of rising Asian emissions, domestic controls, wildfires, and climate

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Abstract. US surface O_3 responds to varying global-to-regional precursor emissions, climate, and extreme weather, with implications for designing effective air quality control policies. We examine these conjoined processes with observations and global chemistry-climate model (GFDL-AM3) hindcasts over 1980–2014. The model captures the salient features of observed trends in daily maximum 8 h average O_3: (1) increases over East Asia (up to 2 ppb yr^{-1}), (2) springtime increases at western US (WUS) rural sites (0.2–0.5 ppb yr^{-1}) with a baseline sampling approach, and (3) summertime decreases, largest at the 95th percentile, and wintertime increases in the 50th to 5th percentiles over the eastern US (EUS). Asian NO_x emissions have tripled since 1990, contributing as much as 65 % to modeled springtime background O_3 increases (0.3–0.5 ppb yr^{-1}) over the WUS, outpacing O_3 decreases attained via 50 % US NO_x emission controls. Methane increases over this period contribute only 15 % of the WUS background O_3 increase. Springtime O_3 observed in Denver has increased at a rate similar to remote rural sites. During summer, increasing Asian emissions approximately offset the benefits of US emission reductions, leading to weak or insignificant observed O_3 trends at WUS rural sites. Mean springtime WUS O_3 is projected to increase by $\sim$10 ppb from 2010 to 2030 under the RCP8.5 global change scenario. While historical wildfire emissions can enhance summertime monthly mean O_3 at individual sites by 2–8 ppb, high temperatures and the associated buildup of O_3 produced from regional anthropogenic emissions contribute most to elevating observed summertime O_3 throughout the USA. GFDL-AM3 captures the observed interannual variability of summertime EUS O_3. However, O_3 deposition sink to vegetation must be reduced by 35 % for the model to accurately simulate observed high-O_3 anomalies during the severe drought of 1988. Regional NO_x reductions alleviated the O_3 buildup during the recent heat waves of 2011 and 2012 relative to earlier heat waves (e.g., 1988, 1999). The O_3 decreases driven by NO_x controls were more pronounced in the southeastern US, where the seasonal onset of biogenic isoprene emissions and NO_x-sensitive O_3 production occurs earlier than in the northeast. Without emission controls, the 95th percentile summertime O_3 in the EUS would have increased by 0.2–0.4 ppb yr^{-1} over 1988–2014 due to more frequent hot extremes and rising biogenic isoprene emissions.

1 Introduction

Within the United States, ground-level O_3 has been recognized since the 1940s and 1950s as an air pollutant detrimental to public health. Decreases in summertime O_3 were observed in parts of California and throughout the EUS (e.g., Cooper et al., 2012; Simon et al., 2015), following regional NO_x controls after the lowering of the US National Ambient Air Quality Standard (NAAQS) for O_3 in 1997 to 84 ppb. On the basis of health evidence, the NAAQS level for O_3

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has been further lowered to 75 ppb in 2008 and to 70 ppb in 2015 (Federal Register, 2015). There are concerns that rising Asian emissions and global methane (Jacob et al., 1999; Lin et al., 2015b), more frequent large wildfires in summer (e.g., Jaffe, 2011; Yang et al., 2015; Abatzoglou et al., 2016), and late spring deep stratospheric O_3 intrusions (Lin et al., 2012a, 2015a; Langford et al., 2014) may pose challenges in attaining more stringent O_3 standards in high-elevation WUS regions. A warming climate would also offset some of the air quality improvements gained from regional emission controls (e.g., Fiore et al., 2015). Quantitative understanding of sources of O_3 variability on daily to multi-decadal timescales can provide valuable information to air quality control managers as they develop O_3 abatement strategies under the NAAQS. Here we systemically investigate the response of US surface O_3 means and extremes to changes in Asian and North American anthropogenic emissions, global methane, regional heat waves, and wildfires over the course of 35 years from 1980 to 2014, using observations and chemistry-climate model (GFDL-AM3) hindcasts (Lin et al., 2014, 2015a, b).

Rapid economic growth has led to a tripling of O_3 precursor emissions from Asia in the past 25 years (e.g., Granier et al., 2011; Hilboll et al., 2013). Observed 1 h O_3 mixing ratios can frequently reach 200–400 ppb during regional pollution episodes in eastern China (Wang et al., 2006; Li et al., 2016), with a seasonal peak in the late spring to early summer (Wang et al., 2008; Lin et al., 2009). A synthesis of available observations from the mid-1990s to the 2000s indicates increases of 1–2 $ppb\,yr^{-1}$ in spring to summer O_3 in China (Ding et al., 2008; Ma et al., 2016; Sun et al., 2016). Long-range transport of Asian pollution plumes towards western North America has been identified by aircraft and satellite measurements and in chemical transport models (e.g., Jaffe et al., 1999; Fiore et al., 2009; Brown-Steiner and Hess, 2011; Lin et al., 2012b; Huang et al., 2013; Verstraeten et al., 2015). Systematic comparison of observed and modeled long-term O_3 trends over Asia is lacking in the published literature but is needed to establish confidence in models used to assess the global impacts of rising Asian emissions.

Model simulations indicate that import of Asian pollution enhances mean WUS surface O_3 in spring by ~ 5 ppb (Zhang et al., 2008; Lin et al., 2012b), and occasionally contributes 8–15 ppb during springtime pollution episodes observed at rural sites (Lin et al., 2012b) as supported by in situ aerosol composition analysis (VanCuren and Gustin, 2015). Stratospheric intrusions can episodically increase daily 8 h average surface O_3 by 20–40 ppb, contributing to the highest observed O_3 events at high-elevation WUS sites (Lin et al., 2012a, 2015a), in addition to pollution transport from California (e.g., Langford et al., 2010). In the densely populated EUS, both changes in regional anthropogenic emissions and air pollution meteorology have the greatest impacts on summer surface O_3 during pollution episodes (e.g., Jacob and Winner 2009; Rieder et al., 2015; Porter et al., 2015; Pusede et al., 2015). Discerning directly the effect of climate change on air quality from long-term observation records of O_3 would be ideal, but concurrent trends in precursor emissions and large internal variability in regional climate impede such an effort. It is difficult to separate the impacts of changes in global-to-regional precursor emissions and different meteorological factors on O_3 at given locations without the benefit of multiple sensitivity experiments afforded by models.

On the other hand, process-oriented assessments of the models are needed to build confidence in their utility for assessing pollution control strategies, estimating tropospheric O_3 radiative forcing and projecting pollution extremes under future climate scenarios (e.g., Monks et al., 2015). A number of studies show that global models capture observed decreases in summertime O_3 over the EUS during 1990–2010, but have difficulty simulating O_3 increases measured at remote high-elevation sites that are believed to represent hemispheric-scale conditions with little influence from fresh local pollution (hereafter referred to as "baseline") (e.g., Lamarque et al., 2010; Koumoutsaris and Bey, 2012; Parrish et al., 2014; Brown-Steiner et al., 2015; Strode et al., 2015). Recently, Lin et al. (2015b) examined the representativeness of O_3 trends derived from sparse measurements in the free troposphere over the WUS, originally reported by Cooper et al. (2010) and used in prior model evaluations. They found that discrepancies between observed and simulated O_3 trends reflect measurement sampling biases. Here we seek additional insights into the causes of the model–observation disagreement at the WUS rural sites with continuous, high-frequency measurements. Notably, we reconcile observed and simulated O_3 trends at these sites with a baseline sampling approach in the model.

Our goal in this paper is 2-fold: first, to systematically evaluate how well the GFDL-AM3 model represents trends and variability of surface O_3 observed at rural sites across the US; second, to examine changes in US surface O_3 means and extremes in a suite of multi-decadal hindcast simulations designed to isolate the response of O_3 to increases in Asian anthropogenic emissions, North American emission controls, rising global methane, wildfires, and interannual variability in meteorology. We examine trends across the entire probability distribution of O_3 concentration, which is crucial to assessing the ability of models to simulate the surface O_3 response under different temperature and chemical regimes depending on seasons, geographical location, and regional transport patterns. Specifically, we evaluate the trends separately for the 5th, 50th and 95th percentiles of the O_3 concentration distribution in spring (MAM), summer (JJA), autumn (SON), and winter (DJF).

Section 2 briefly describes the observational records, model experiments, and analysis approach. As a first step towards assessing our understanding of the impacts of rising Asian emissions, we briefly review Asian O_3 trends from observations in recent publications and evaluate modeled trends (Sect. 3). We then focus our analysis on the US, using both observations and models to assess the response of

US surface O_3 to changes in background O_3, regional anthropogenic emissions and meteorology (Sect. 4). In Sect. 5, we further separate the influence of background on WUS O_3 into components driven by rising Asian anthropogenic emissions, global methane, and wildfires. We quantify the contribution of these factors to surface O_3 in both rural areas such as national parks (Sect. 5.1 to 5.3) and in densely populated regions such as the Denver metropolitan area (Sect. 5.4). After evaluating historical trends, we additionally draw upon two simulations following the 21st century RCP4.5 versus RCP8.5 global change scenarios to project WUS O_3 through 2050 (Sect. 5.2). Section 6 examines how the EUS summertime O_3 probability distribution and pollution extremes respond to large-scale heat waves, droughts, and regional NO_x reductions over the past decade, and how well our model simulates the observed features. Finally, we summarize in Sect. 7 the key drivers of US surface O_3 trends and extremes and discuss the implications of this study.

2 Model and observations

2.1 Chemistry-climate model experiments

The GFDL-AM3 model includes interactive stratosphere–troposphere chemistry and aerosols on a cubed sphere grid with a resolution of approximately $200 \times 200\,km^2$ (Donner et al., 2011). Table 1 summarizes the meteorology, radiative forcing agents, and emissions used in each experiment. The hindcast simulations (1979–2014) are nudged to the NCEP/NCAR reanalysis zonal and meridional winds using a height-dependent nudging technique (Lin et al., 2012b). Biogenic isoprene emissions and lightning NO_x are tied to model meteorology (Guenther et al., 2006; Rasmussen et al., 2012) and thus can respond to changes in climate, whereas soil NO_x and chemical dry deposition velocities are set to a monthly climatology (Naik et al., 2013), with a diurnal cycle applied for O_3 dry deposition. To investigate the possible influence of drought on O_3 removal (e.g., Emberson et al., 2013), we additionally conduct a sensitivity simulation for 1988 with reduced O_3 deposition velocity (see Sect. 6). Our BASE simulation and two additional simulations with modified emissions (FIXEMIS and IAVFIRE) were previously used to interpret the causes of increasing autumnal O_3 measured at Mauna Loa Observatory in Hawaii since 1974 (Lin et al., 2014), interannual variability of springtime O_3 (Lin et al., 2015a) and the representativeness of free tropospheric O_3 measurements over the WUS (Lin et al., 2015b).

With anthropogenic emissions and methane held constant (Table 1), the FIXEMIS and IAVFIRE simulations isolate the influence from meteorology and wildfire emissions, respectively. In IAVASIA, anthropogenic emissions from East Asia (15–50° N, 95–160° E) and South Asia (5–35° N, 50–95° E) are allowed to vary from year to year as in BASE, while anthropogenic emissions in the other regions of the world, global methane and wildfire emissions are held constant as in FIXEMIS. In IAVCH$_4$, global methane is allowed to vary over time as in BASE, but with anthropogenic and wildfire emissions held constant as in FIXEMIS. The IAVASIA and IAVCH$_4$ simulations thus isolate the role of rising Asian anthropogenic emissions and global methane, respectively, by contrasting with the FIXEMIS simulation. Both BASE and IAVCH$_4$ simulations apply observed time-varying methane concentrations as a lower boundary condition for chemistry (Supplement Fig. S1). Thus, underestimates in historical methane emissions reported recently by Schwietzke et al. (2016) do not affect our results. We quantify the total contributions to surface O_3 from meteorological variability, stratosphere-to-troposphere transport, pollution from foreign continents and O_3 produced by global methane, lightning NO_x, wildfires and biogenic emissions with the Background simulation, in which North American anthropogenic emissions are zeroed out relative to BASE. We additionally draw upon two simulations with the GFDL Coupled Model CM3 following the 21st century RCP global change scenarios to project changes in WUS O_3 through 2050. Details of these CM3 simulations were described in John et al. (2012).

2.2 Anthropogenic and biomass burning emissions

We first examine how well the emission inventories in AM3 BASE represent changes in regional NO_x emissions over recent decades inferred from satellite measurements of tropospheric vertical column density (VCD_{trop}) of NO_2. The combined record of GOME and SCIAMACHY shows that VCD_{trop} NO_2 over the highly polluted region of eastern China almost tripled during 1996–2011 (Fig. 1a). In contrast, VCD_{trop} NO_2 over the EUS decreased by $\sim 50\,\%$ in the 2000s (Fig. 1b) due to NO_x State Implementation Plans (commonly known as the NO_x SIP Call) and many rules that tighten emission standards for mobile sources (McDonald et al., 2012). Similar decreases occurred in WUS cities, resulting from the NO_x control programs to achieve O_3 and regional haze planning goals. These trends are consistent with those reported by a few recent studies (e.g., Hilboll et al., 2013), including those using OMI NO_2 data (Russell et al., 2012; Duncan et al., 2016). For comparison with satellite data, we sample the model archived every 3 h closest to the time of satellite overpass for the SCIAMACHY and GOME products we use in Fig. 1 (10:00–10:30 local time). Trends in VCD_{trop} NO_2 are similar to those in NO_x emissions (orange lines versus red triangles in Fig. 1a–b), indicating that any changes in NO_x chemical lifetime or partitioning have negligible influence in our model, consistent with NO_2 loss against OH being minor during the morning overpasses of GOME and SCIAMACHY. The emission inventory used in BASE, from Lamarque et al. (2010) with annual interpolation after 2000 to RCP8.5 (Lamarque et al., 2012), mimics the opposing changes in NO_x emissions over eastern China versus the EUS during 1996–2011, consistent with

Table 1. Summary of forcings and emissions used in AM3 hindcasts and CM3 projections.

Experiment	Time periods	Meteorology	Radiative forcings	CH_4 (chemistry)	Anthropogenic emissions	Fire emissions
BASE	1979–2014	Nudged to NCEP	Historical	Historical	Historical	Historical
Background	1979–2014	As BASE	Historical	Historical	Zeroed out in N. America; as in BASE elsewhere	Historical
FIXEMIS	1979–2014	As BASE	Historical	2000	Constant[1]	Constant[1]
IAVFIRE	1979-2014	As BASE	Historical	2000	Constant[1]	Historical
IAVASIA	1979–2012[2]	As BASE	Historical	2000	Varying in Asia as in BASE; as in FIXEMIS elsewhere	Constant[1]
$IAVCH_4$	1979–2012[2]	As BASE	Historical	Historical	Constant[1]	Constant[1]
CM3_RCP4.5	2005–2050	Free running	RCP4.5	RCP4.5	RCP4.5	RCP4.5
CM3_RCP8.5	2005–2050	Free running	RCP8.5	RCP8.5	RCP8.5	RCP8.5

[1] Averaged over the whole 1970–2010 period. [2] Note that the IAVASIA and $IAVCH_4$ simulations only extend to 2012.

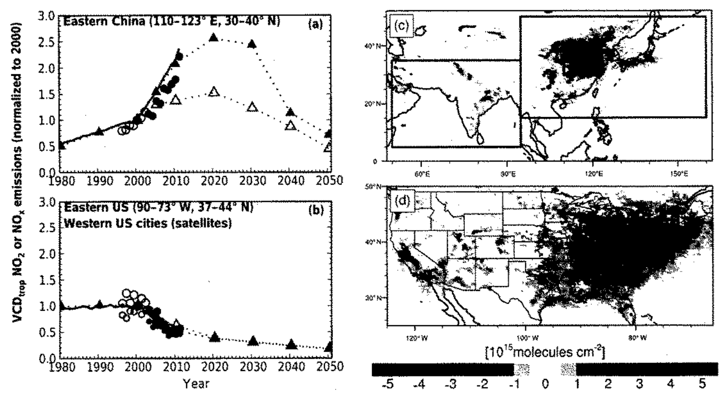

Figure 1. Changes in NO_x emissions. **(a–b)** Mean annual vertical column densities of tropospheric (VCDtrop) NO_2 normalized to the year 2000 for the eastern China and eastern US domains (black boxes on map) from GOME (1996–2002, open circles) and SCIAMACHY (2003–2011, closed circles) measurements and AM3 BASE simulations (orange lines). Triangles indicate trends in NO_x emissions (normalized to 2000) from Lamarque et al. (2010) with annual interpolation after 2000 to RCP8.5 (red) versus RCP4.5 (blue). **(c–d)** Differences in annual mean SCIAMACHY VCDtrop NO_2 from 2003–2005 to 2009–2011. The red boxes denote the regions where emissions vary over time in the IAVASIA simulation (Table 1). Satellite NO_2 data are from www.temis.nl, with the retrieval technique described in Boersma et al. (2004).

changes in VCD_{trop} NO_2 retrieved from the satellite instruments. For comparison, the RCP4.5 interpolation for 2001–2010 in CMIP5 historical simulations analyzed by Parrish et al. (2014) underestimates the increase in Chinese NO_x emissions by a factor of 2 (Fig. 1a). Recent reductions in Chinese NO_x emissions after 2011 (Duncan et al., 2016) are not represented in the inventories used in AM3.

Our BASE model applies interannually varying monthly mean emissions from biomass burning based on the RETRO inventory (Schultz et al., 2008) for 1970 to 1996 and GFEDv3 (van der Werf et al., 2010) for 1997 onwards, distributed vertically as recommend by Dentener et al. (2006). Figure S2 illustrates the interannual variability of biomass burning CO emissions from the main source regions of the Northern Hemisphere over the period 1980–2014. Boreal fire emissions in Eurasia almost doubled from 1980–1995 to 1996–2014, with large fires occurring more frequently in the recent decade, as found for the WUS (Dennison et al., 2014; Yang et al., 2015).

2.3 Ozone observation records and uncertainties

Long-term surface O_3 observation records were obtained at 70 selected rural monitoring sites with 20 (1995–2014) to 27 (1988–2014) years of continuous hourly measurements

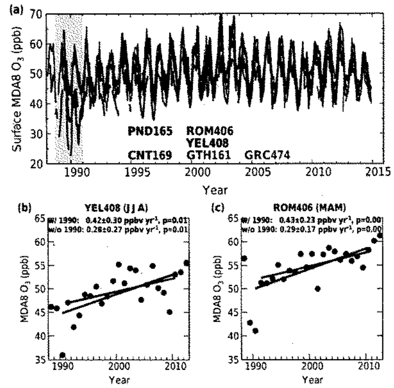

Figure 2. Measurement uncertainties. **(a)** Comparison of observed monthly mean MDA8 O_3 at WUS CASTNet sites. All sites have more than 90 % data availability in every month shown. The gray shading denotes the period when data at Yellowstone (red) and Rocky Mountain (black) were inconsistent with the other sites. **(b–c)** The 1990–2010 trends of median JJA MDA8 O_3 at Yellowstone and median MAM MDA8 O_3 at Rocky Mountain with and without data in 1990.

from the US National Park Services, the US Clean Air Status and Trends Network (CASTNet), and the US EPA Air Quality System. Cooper et al. (2012) reported trends in daytime (11:00–16:00) O_3 over 1990–2010 at 53 rural sites. We investigate trends in daily maximum 8 h averaged (MDA8) O_3 and expand the analysis of Cooper et al. (2012) using additional data to 2014 and including 17 additional sites with measurements begun in 1991–1995. All sites have at least 20 years of data. If a site has less than 50 % data availability in any season, then that particular season is discarded. The trend is calculated separately for the 5th, 50th and 95th percentiles of daily MDA8 O_3 for each season through ordinary linear least-square regression. Statistics are derived for the slope of the linear regression in units of ppb yr^{-1}, the range of the slope with a 95 % confidence limit (not adjusted for sample autocorrelation), and the p value indicating the statistical significance of the trend based on a two-tailed t test.

A cross-site consistency analysis was performed to determine robust changes in the time evolution of O_3 over the WUS during 1988–2014 (Fig. 2). The monitor at Yellowstone National Park was moved 1.5 km from the Lake Yellowstone site to the Water Tank site in 1996. While the local transport patterns are slightly different for the two sites, using MDA8 data from the well-mixed midday period minimizes the differences (Jaffe and Ray, 2007). Observed O_3 interannual variations show large-scale similarity across sites over the Intermountain West except for the earlier period 1989–1990. During this period, observations at Yellowstone and Rocky Mountain national parks show low-O_3 anomalies that do not appear at other sites, but there is no change in measurement technique. Jaffe and Ray (2007) suggest this represents large-scale variations in background O_3 that are seen in common at these two parks. However, analysis of meteorological fields and model diagnostics does not reveal any obvious transport anomaly influencing O_3 variations at these sites in 1990 (Lin et al., 2015a). Observations at Pinedale in January–February 1990 are also anomalously low relative to Grand Canyon (GRC474), Centennial (CNT169), and Gothic (GTH161). These anomalous data at the beginning of measurement records can substantially influence trends calculated from short records. For example, Cooper et al. (2012) found a summer O_3 increase of 0.42 ± 0.30 ppb yr^{-1} at Yellowstone over 1990–2010. Removing 1990, we find a weaker increase of 0.28 ± 0.27 ppb yr^{-1} (Fig. 2b). Removing 1990 at Rocky Mountain resulted in a weaker springtime O_3 increase of 0.29 ± 0.17 ppb yr^{-1} compared to 0.43 ± 0.23 ppb yr^{-1} over 1990–2010 (Fig. 2c). To assess robust O_3 changes, we thus remove these apparently uncertain measurements in 1990 from the subsequent analysis.

2.4 Model baseline sampling approach

Springtime O_3 observations at WUS high-elevation sites (≥ 1.5 km a.s.l.) typically represent baseline conditions with little influence from fresh local pollution. In a global model with $\sim 200 \times 200$ km^2 horizontal resolution, however, these remote sites can reside in the same grid cell that contains urban cities where NO_x emissions decreased over the analysis period. For example, Rocky Mountain National Park (2.7 km a.s.l.) is less than 100 km from the Denver metropolitan area in Colorado. This limitation of large-scale models in resolving urban-to-rural gradients and sharp topography results in an artificial offset of increased baseline O_3 at remote sites by decreased urban pollution within the same model grid cell. Thus, coarse-resolution models are often unable to reproduce observed O_3 increases at the high-elevation sites representative of remote baseline conditions (Fig. 3a versus b), as found in many prior modeling analyses (e.g., Parrish et al., 2014; Strode et al., 2015, and references therein). This limitation can be addressed by using a baseline selection procedure to identify conditions for sampling the model to avoid model artifacts caused by poor spatial resolution, as described below.

All measurements presented in this study are unfiltered. We implement a set of regional CO-like tracers (COt), with a 50-day exponential decay lifetime and surface emissions constant in time from each of four northern mid-latitude source regions (Lin et al., 2014). We use these COt tracers to bin modeled O_3 according to the dominant influence of different continental air regimes. To represent observed baseline conditions at WUS sites, we sample AM3

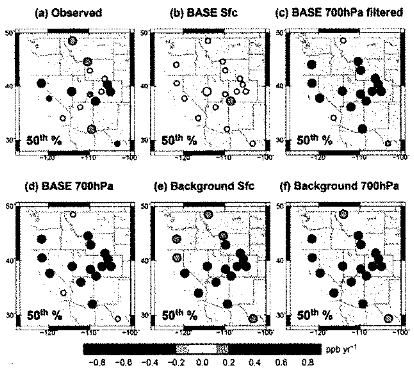

Figure 3. Influence of baseline sampling. Median spring MDA8 O_3 trends over 1988–2014 at WUS sites from **(a)** observations, **(b)** BASE model sampled at the surface, **(c)** BASE sampled at 700 hPa and filtered to remove the influence from fresh local pollution (see Sect. 2.4), **(d)** BASE sampled at 700 hPa without filtering, and **(e–f)** Background (with North American anthropogenic emissions shut off) sampled at the surface versus at 700 hPa. Note that three low-elevation (< 1.5 km) sites, Joshua Tree, Big Bend and Glacier national parks, are always sampled at the surface. Larger circles indicate sites with statistically significant trends ($p < 0.05$).

at 700 hPa (~ 3 km a.s.l.) and filter the O_3 data in the BASE simulation to remove the influence from fresh local pollution. Specifically, our filter excludes days when North American COt (NACOt) exceeds the 67th percentile for each season. This procedure yields higher calculated baseline O_3 increases (Fig. 3c), bringing it closer to observations (Fig. 3a). When sampled at 700 hPa without filtering (Fig. 3d), BASE gives statistically significant O_3 increases, but the rate of increase is ~ 0.1 ppb yr^{-1} weaker than with filtering. With North American anthropogenic emissions shut off, the model simulates significant O_3 increases that are similar at the surface (Fig. 3e) and at 700 hPa (Fig. 3f). This finding indicates that the underestimate of O_3 increases in BASE, when sampled at the surface (Fig. 3b), reflects an excessive offset from domestic pollution decreases in the model relative to observed conditions, as opposed to the insufficient mixing of free tropospheric O_3 to the surface. As individual sites display observed trends falling in between the filtered model, and those sampled at the surface versus aloft, we can use the model to interpret which sites most frequently sample baseline versus being influenced by North American anthropogenic emissions. For consistency, in the subsequent analysis we apply model baseline filtering to all WUS sites with elevations greater than 1.5 km altitude. In the EUS, where the terrain and monitor elevations are much lower than in the west and observed O_3 trends are largely controlled by regional emission changes, we always sample the model at the surface without filtering.

3 Global distribution of lower tropospheric O_3 trends

3.1 Global O_3 burden and distribution of trends

We begin by examining the global distribution of lower tropospheric O_3 trends over 1988–2014 from the BASE simulation (Fig. 4) and focus on the differences between the surface and free troposphere (~ 700 hPa), with implications for understanding the impact of trends in hemispheric baseline O_3 on surface air quality. The model indicates that surface MDA8 O_3 levels in Asia have increased significantly by 1.5–2.5 ppb yr^{-1} in the 95th percentile (Fig. 4a–b) and by 1–2 ppb yr^{-1} in the median values (Fig. 4c–d), with the largest increases occurring in southern Asia during spring and over eastern China during summer. In contrast, there is a marked decrease in surface MDA8 O_3 in WUS cities, throughout the EUS and in central Europe, particularly at the high percentiles and during summer. The increase in surface O_3 over Asia and decreases over the US and Europe are consistent with changes in regional emissions of O_3 precursors over this period (Fig. 1).

Over Southeast Asia (south of 30° N) during spring, earlier springtime O_3 photochemical production at lower latitudes coupled with active frontal transport (Liu et al., 2002; Carmichael et al., 2003; Lin et al., 2010) leads to a comparable or even greater increase in O_3 in the free troposphere than at the surface (Fig. 4c versus e). In contrast, over central eastern China during summer the simulated trends of O_3 in the free troposphere are at least a factor of 3 weaker than in surface air (Fig. 4d versus f), consistent with the analysis of MOZAIC aircraft data over Beijing in 1995–1999 versus 2003–2005 (Ding et al., 2008). Mean O_3 at 700 hPa above parts of North America and Europe show little change in summer or even increase during spring in the model, similar to the trends at 500 hPa (Fig. S3), despite the significant decreases in surface air. The global tropospheric O_3 burden in the BASE simulation increases by approximately 30 Tg over the past 35 years (Fig. 5a), attributed mainly to changes in anthropogenic emissions. Over the 2004–2015 OMI/MLS satellite era, however, meteorological variability contributes approximately half to the total simulated decadal trends of O_3 burden (Fig. 5a), indicating that attribution of the satellite-derived decadal trends of global tropospheric O_3 burden requires consideration of internal climate variability.

3.2 Comparison of observed and simulated O_3 trends in Asia

Long-term O_3 observations are very sparse in Asia, making it difficult to evaluate modeled O_3 trends. We compile available measurements from the published literature, includ-

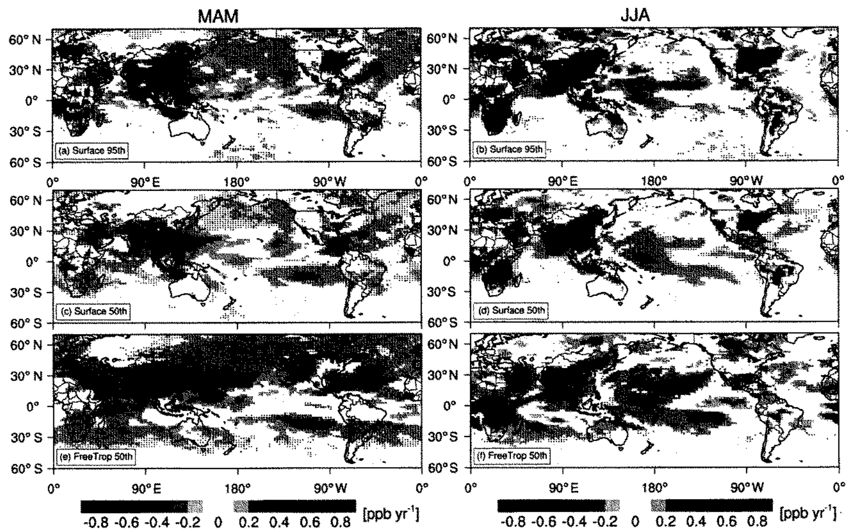

Figure 4. Global distribution of MDA8 O_3 trends from AM3 BASE over 1988–2014 for boreal spring (left) and summer (right) for the 95th percentile at the surface **(a–b)**, median at the surface **(c–d)**, and median in the free troposphere (700 hPa; **e–f**). Stippling indicates areas where the trend is statistically significant ($p < 0.05$). The color scale is designed to resolve regional features rather than extreme values and saturates. The range of the trends is -1 to $+2.5$ ppb yr^{-1}.

ing ozonesonde profiles at Hong Kong (2000–2014; www.woudc.org) and Hanoi (2005–2015; SHADOZ, Thompson et al., 2007), MOZAIC aircraft profiles collected on summer afternoons in the boundary layer (below 1250 m altitude) over Beijing for 1995–2005 (Ding et al., 2008), ground-based measurements at Mt. Tai (1.5 km a.s.l.) in central eastern China for July–August 2003–2015 (Sun et al., 2016), at the GAW stations, Shangdianzi north of Beijing for 2004–2014 (Ma et al., 2016) and Mt. Waliguan (3.8 km a.s.l.) on the Tibetan Plateau for 1994–2013 (Xu et al., 2016), at Taiwan for 1994–2007 (Lin et al., 2010), South Korea for 1990–2010 (Lee et al., 2014), Mt. Happo (1.9 km a.s.l.) in Japan for 1991–2011 (Tanimoto, 2009; Parrish et al., 2014), and a coastal site at Hong Kong in southern China for 1994–2007 (Wang et al., 2009).

Recently, Zhang et al. (2016) compiled sparse O_3 profiles above Southeast Asia from IAGOS commercial aircraft and ozonesondes from Hanoi for 1994–2004 versus 2005–2014 and found a total springtime O_3 increase of 20–25 ppb between the two periods (~ 2 ppb yr^{-1}). However, our model indicates an increase of up to 1 ppb yr^{-1} for free tropospheric O_3 over Southeast Asia in spring (Fig. 4e). We illustrate the possible influence of sampling deficiencies on the O_3 trends inferred from sparse observations (Fig. 5). The ozonesonde frequency is four profiles per month at Hong Kong and only one to two profiles per month at Hanoi. To determine the representativeness of O_3 trends derived from these sparse measurements, we compare observations and model results co-sampled on sonde launch days, with the "true average" determined from O_3 fields archived every 3 h from the model, as in our prior work for WUS sites (Lin et al., 2015a, b). Figure 5b and c show the comparisons for the annual trends of O_3 over 900–600 hPa. The trends are generally consistent across the sonde data, model co-sampled and "true average" results for Hong Kong, with an increase of 0.5 ± 0.1 ppb yr^{-1} over 2000–2014. Observations at Hanoi show an apparently rapid O_3 increase of 1.1 ± 0.2 ppb yr^{-1} over 2005–2014. AM3 BASE, when sampled sparsely as in the ozonesondes, captures the observed variability ($r^2 = 0.7$), whereas the "true average" over this period indicates the trend (0.7 ± 0.1 ppb yr^{-1}) is only 63 % of that inferred from observations. Moreover, interannual variability of O_3 resulting from wildfire emissions and meteorology in IAVFIRE is as large as the total O_3 change in

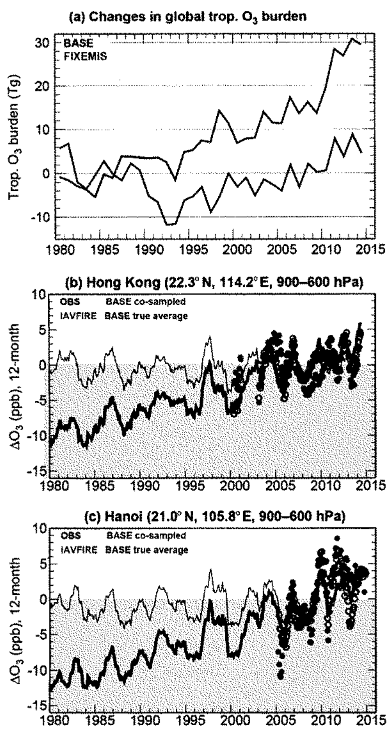

Figure 5. **(a)** Time series of changes in global tropospheric O_3 burden relative to the 1981–1990 mean from BASE and FIXEMIS simulations (Table 1). **(b)** Time series of 12-month running mean anomalies (relative to the 2005–2014 mean) of O_3 averaged over 900–600 hPa at Hong Kong from the averages of ozonesonde samples (black circles) and the BASE model co-sampled on sonde launch days (orange circles) versus the true average from BASE and IAVFIRE with continuous daily sampling (solid lines). **(c)** Same as **(b)**, but for Hanoi.

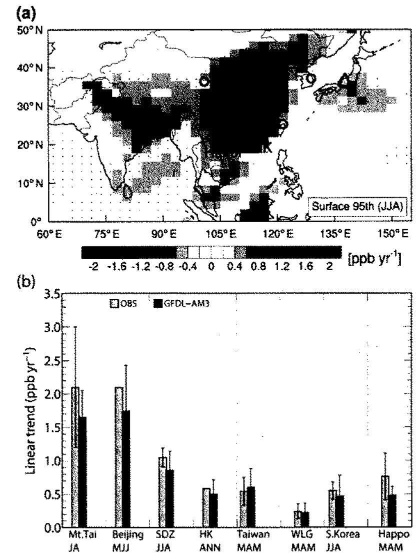

Figure 6. Surface O_3 trends in Asia. **(a)** Observation sites superimposed on a map of the 95th percentile summer MDA8 O_3 trends over 1995–2014 from AM3 BASE. **(b)** Comparison of median O_3 trends from AM3 (1995–2014) with observations (see text for periods): in central eastern China at Mt. Tai (July–August, Sun et al., 2016), Beijing (May–June–July, Ding et al., 2008) and Shangdianzi (SDZ) (JJA, Ma et al., 2016); in South China at Hong Kong (HK) (annual average, Wang et al., 2009) and Taiwan (MAM, Lin et al., 2010); at Mt. Waliguan (WLG) in western China (MAM, Xu et al., 2016); in South Korea (JJA, Lee et al., 2014) and Mt. Happo Japan (MAM, Tanimoto, 2009). For Mt. Happo (triangle on map) AM3 is sampled at 700 hPa and filtered for the influence from Asian continental air – more representative of observed baseline conditions in spring.

BASE over the short period 2005–2014. We conclude that measurement sampling artifacts influence the O_3 trends reported by Zhang et al. (2016).

Expanding the comparison to a suite of sites across East Asia (Fig. 6), we find that AM3 captures the key features of observed O_3 trends in Asia, including their seasonal to regional variations, summertime increases (1–2 ppb yr^{-1}) in central eastern China where NO_x emissions have approximately tripled since 1990 (Fig. 1a), and springtime increases (0.5 ppb yr^{-1}) at Taiwan and Mt. Happo that are driven by pollution outflow from the Asian continent. Note that to place the trends derived from the short observational records into a broader context, we show the 20-year trends over 1995–2014 from the model, except for South Korea (1990–2010) and Happo, Japan (1991–2011). We match the time period in the model with observations at these two sites because AM3 shows weaker O_3 increases when data for the recent years are included, which likely reflects the offsetting effects of regional emission reductions in South Korea and Japan.

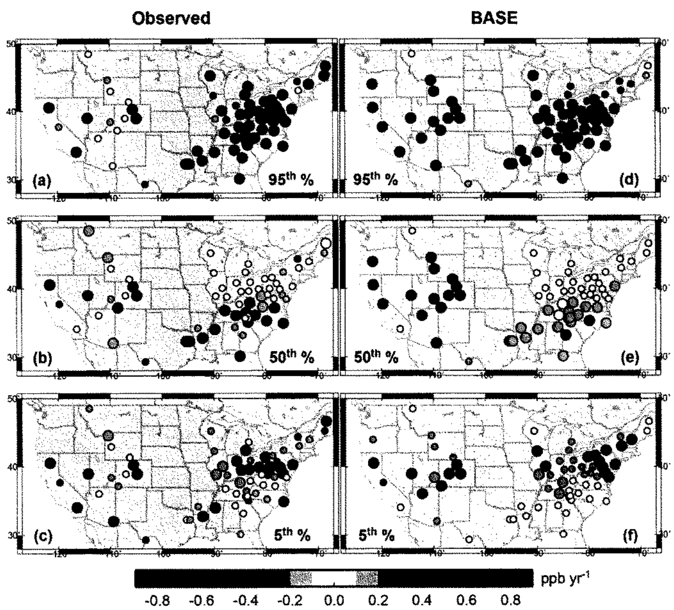

Figure 7. Linear trends in spring (MAM) MDA8 O_3 over 1988–2014 at US rural sites for the 95th, 50th, and 5th percentiles as observed (left) and simulated (right) in AM3 BASE. Larger circles indicate sites with statistically significant trends ($p < 0.05$). For WUS high-elevation sites, the model is sampled at 700 hPa and filtered to remove local influence (see text in Sect. 2.4).

Parrish et al. (2014) show that three CMIP5-like models underestimate the observed springtime O_3 increase at Mt. Happo by a factor of 4. This discrepancy may reflect a combination of factors: (1) underestimates of Asian emission growth in the RCP4.5 interpolation after 2000 used in CMIP5 historical simulations (Fig. 1a); (2) trends driven by interannual meteorological variability that free-running CMIP5 models are not expected to reproduce exactly; (3) an excessive offset from Japanese pollution decreases in the models owing to their coarse resolution and limitation in resolving observed baseline conditions at Mt. Happo. Sampling our BASE model at 700 hPa above Happo, we find an O_3 increase of 0.35 ± 0.13 ppb yr^{-1}. When focusing on days strongly influenced by outflow from the East Asian continent (Chinese COt $\geq$ 67th), the model O_3 trend increases to 0.48 ± 0.13 ppb yr^{-1}, approximating the observed increase of 0.76 ± 0.35 ppb yr^{-1} at Mt. Happo (Fig. 6b). The observed and simulated trends are not statistically different given the overlapping confidence limits. The larger confidence limit (uncertainty) derived from the Happo observations reflects the measurement inconsistency before 1998 and instrumental problems after 2007 (Tanimoto et al., 2016). We conclude that GFDL-AM3 captures 65–90 % of the observed O_3 increases in Asia, lending confidence in its application to assess the global impacts of rising Asian emissions.

4 Regional and seasonal variability of US surface O_3 trends

We next focus our analysis on the US, where dense, high-frequency, long-term, reliable measurements of surface O_3 facilitate process-oriented model evaluation. Comparisons of surface O_3 trends over 1988–2014 at 70 rural monitoring sites across the US as observed and simulated in AM3 BASE are shown in Fig. 7 for spring, Fig. 8 for summer, Fig. 9 for winter, and in Fig. S4 for autumn. The trends are calculated separately for the 5th, 50th and 95th percentiles of the daily MDA8 O_3 concentration distribution, with larger circles on

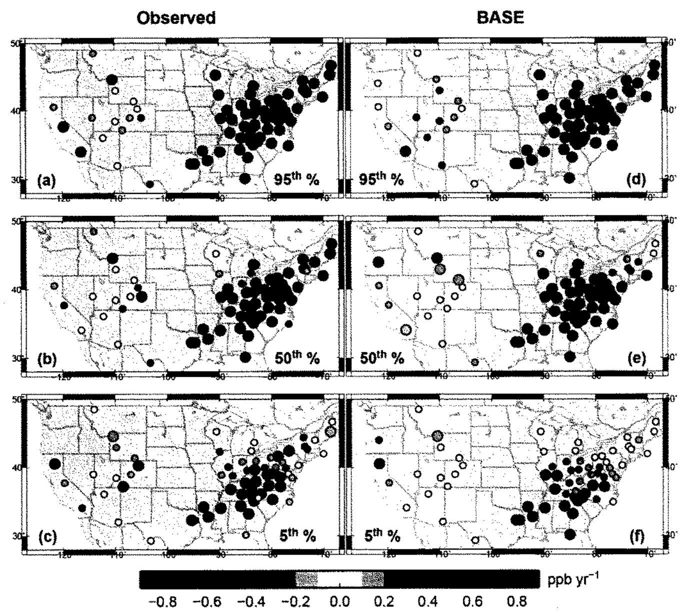

Figure 8. As in Fig. 7, but for summer (JJA). Note that the color scale saturates at ±0.8.

the maps indicating sites with statistically significant trends ($p < 0.05$). We first discuss observations (Sect. 4.1), followed by model evaluation and trend attribution (Sect. 4.2).

4.1 Observations

In spring (Fig. 7), observations indicate spatial heterogeneity in O_3 trends across the Intermountain West and the northeastern (north of 38° N) and southeastern US. At the 95th percentile (Fig. 7a) the pattern of observed trends is homogeneous across the northeastern and southeastern US, with approximately 85 % of the sites having statistically significant O_3 decreases of 0.4–0.8 ppb yr^{-1} and no sites showing a significant increase. In contrast, significant increases occur at 25 % of the sites in the Intermountain West. Only Joshua Tree National Park located downwind of the Los Angeles Basin shows a significant decrease at the 95th percentile. At the 50th percentile (Fig. 7b) there are significant O_3 decreases of 0.2–0.4 ppb yr^{-1} in the southeast and little overall change in the northeast, while significant increases of 0.2–0.5 ppb yr^{-1} occur at 50 % of the sites in the Intermountain West. Significant springtime O_3 increases occur at all observed percentiles at Lassen Volcanic National Park in California, Great Basin National Park in Nevada, Rocky Mountain National Park and US Air Force Academy in Colorado. At the 5th percentile (Fig. 7c) significant O_3 increases occur at most sites in the northeast, while little change and some negative trends are found in the southeast. The occurrence of the greatest observed O_3 decreases for the highest percentiles is consistent with high-temperature O_3 production being more NO_x-limited (Pusede et al., 2015) and thus more responsive to decreases in NO_x emissions.

The north-to-south gradient in springtime O_3 trends over the EUS reflects the earlier seasonal transition from NO_x-saturated to NO_x-sensitive O_3 production regimes in the southeast, where plentiful radiation in spring enhances HO_x supply and biogenic isoprene emissions begin earlier than in the northeast. The different response of springtime O_3 to NO_x controls in the southeast versus northeast noticed in this work is not present in prior analyses for shorter time periods (1990–2010 in Cooper et al., 2012, and 1998–2013 in Simon et al., 2015). We find 72 % of the southeastern sites experiencing significant median O_3 decreases in spring over

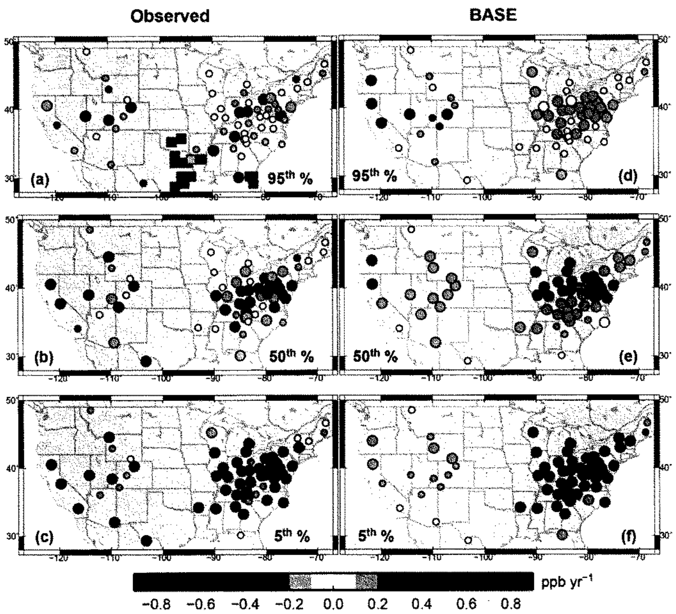

Figure 9. As in Fig. 7, but for winter (DJF). Large squares in **(a)** denote AQS sites with significant O_3 decreases in the 95th percentile.

1988–2014, while Cooper et al. (2012) found only 8 %. Sites with significant 95th percentile springtime O_3 decreases in the EUS are also much more common in our study (85 % versus 43 % in Cooper et al. (2012). In the 5th percentile, 45 % of the northeastern sites in our analysis have significant spring O_3 increases, with only 15 % in Cooper et al. (2012) Stronger O_3 reductions in the southeast than the northeast also occur during autumn (Fig. S4), reflecting an extension of biogenic isoprene emissions and NO_x-sensitive O_3 production in the southeast to autumn.

In summer (Fig. 8), as radiation intensifies and isoprene emissions peak seasonally, the O_3 production becomes more NO_x-limited across both the southeastern and northeastern US, where NO_x emission controls have led to significant O_3 decreases of 0.8–1.8 ppb yr^{-1} in the 95th percentile and 0.4–0.8 ppb yr^{-1} in the median value (Fig. 8a–b). In the southeast, significant decreases have also occurred at the lowest percentiles during summer (Fig. 8c), in contrast to the weak response during spring (Fig. 7c). Many northeastern states in the late 1990s and early 2000s did not turn on power plant NO_x emission controls until the O_3 season (May–September), which may contribute to observed differences between spring and summer O_3 trends. Compared to the 1990–2010 trends reported in Cooper et al. (2012), the EUS summer O_3 decreases reported here with additional data to 2014 are 33 % stronger. Despite reductions in precursor emissions in the WUS cities (Fig. 1d), there are no significant summer O_3 decreases at the intermountain sites, except in Yosemite and Joshua Tree national parks for the 95th percentile. Instead, a significant summer increase of ~ 0.3 ppb yr^{-1} occurs across the entire O_3 distribution at Yellowstone. Significant summer increases are found in the 5th percentile for Lassen, Mesa Verde, and Rocky Mountain national parks.

In winter (Fig. 9), observed O_3 increases are more common than in spring and summer across the US. The wintertime O_3 increases are strongest in the lowest percentiles over the EUS, indicating the influence from weakened NO_x titration as a result of regional NO_x emission controls (see also Gao et al., 2013; Clifton et al., 2014; Simon et al., 2015). Even during winter, some decreasing O_3 trends are found in the highest percentiles over the southeast (Fig. 9a), most prominently in Texas (Dallas and Houston), where tropical climate and year-round active photochemistry makes O_3 most responsive to regional NO_x emission controls. Despite the greatest NO_x emission reductions over the past decade in the central and northeastern US regions, observed O_3 reductions have been most pronounced in the southeast, particularly in spring and autumn.

4.2 Model evaluation and attribution of observed O_3 trends

The BASE simulation with GFDL-AM3 captures the salient features of observed O_3 trends over 1988–2014 at rural sites across the US: (1) the overall springtime increases and the lack of significant trends in summer over the Intermountain West; (2) the north-to-south gradients in O_3 trends during spring and the largest decreases in the 95th percentile during summer over the EUS; (3) wintertime increases in the 5th and 50th percentiles (left versus right panels in Figs. 7 to 9). AM3 also simulates a median springtime O_3 increase of $0.32 \pm 0.11\,\mathrm{ppb\,yr^{-1}}$ over 1988–2014 ($0.64 \pm 0.50\,\mathrm{ppb\,yr^{-1}}$ over 2004–2014) at Mount Bachelor Observatory in Oregon, consistent with the positive trend ($0.63 \pm 0.41\,\mathrm{ppb\,yr^{-1}}$) observed over the shorter 2004–2015 period (Gratz et al., 2014). These analyses imply that GFDL-AM3 represents the underlying chemical and physical processes controlling the response of US surface O_3 means and extremes to changes in global-to-regional precursor emissions and climate, despite mean state biases (Figs. S5–S6).

The filtered model shows greater 95th percentile O_3 increases than observed at some WUS sites (e.g., Yosemite; Grand Canyon; Canyonlands) for both spring and summer (Figs. 7a, d and 8a, d), reflecting that observations at these sites sometimes can be influenced by transport of photochemically aged plumes from nearby urban areas and from southern California during late spring and summer. When sampled at the surface, AM3 simulates small summertime O_3 decreases in the 95th and 50th percentiles over the Intermountain West (Fig. 4b, d), consistent with observations at Yosemite, Grand Canyon, and Canyonlands (Fig. 8a, b). As illustrated in Fig. 3 for spring and discussed in Sect. 2.4, individual sites in the west display observed trends falling in between the filtered model and those sampled at the surface versus aloft.

We examine how US surface O_3 responds to changes in regional anthropogenic emissions, hemispheric background, and meteorology by comparing O_3 trends in the BASE, Background, and FIXEMIS experiments (Figs. 10–11). With North American anthropogenic emissions shut off in the Background simulation, little difference is discernable from the BASE simulation for WUS O_3 trends during spring (first versus second rows in Fig. 10), indicating the key role of hemispheric background driving increases in springtime O_3 over the WUS. With anthropogenic emissions held constant in time, FIXEMIS still shows statistically significant spring O_3 increases in the 95th percentile (Fig. 10c), approximately half of the trends simulated in BASE, for Grand Canyon, Canyonlands, Mesa Verde and Rocky Mountain national parks. Prior work shows that deep stratospheric intrusions contribute to the highest observed and simulated surface O_3 events at these sites (Langford et al., 2009; Lin et al., 2012a). Strong year-to-year variability of such intrusion events (Lin et al., 2015a) can confound the attribution of springtime O_3 changes over the WUS to anthropogenic emission trends, particularly in the highest percentile and over a short record length. Summer avoids this confounding influence when stratospheric intrusions are at their seasonal minimum, as evidenced by little O_3 change in FIXEMIS over the WUS (Fig. 11c, f). In contrast to spring, the model shows larger differences in WUS O_3 trends between BASE and Background for summer when North American pollution peaks seasonally (Fig. 10a, d versus b, e compared to Fig. 11a, d versus b, e). There are significant increases of 0.2–$0.5\,\mathrm{ppb\,yr^{-1}}$ in the 95th and 50th percentile summer background O_3 at more than 50 % of the western sites (Fig. 11b, e), offsetting the O_3 decreases resulting from US NO_x reductions and leading to little overall change in total observed and simulated O_3 at WUS rural sites during summer (Fig. 8).

Over the EUS, AM3 also simulates background O_3 increases, occurring in both the 95th and 50th percentiles, with a rate of 0.1–$0.3\,\mathrm{ppb\,yr^{-1}}$ during spring (Fig. 10b, e) and 0.2–$0.5\,\mathrm{ppb\,yr^{-1}}$ during summer (Fig. 11b, e). Based on prior model estimates that springtime background O_3 is greater in the northeast than the southeast (Lin et al., 2012a, b; Fiore et al., 2014), one might assume that the springtime O_3 increases in the 5th percentile observed over the northeast (Fig. 7c) have been influenced by a rising background. However, AM3 simulates homogeneous background O_3 trends across the entire EUS (Fig. 10b, e), indicating that the observed north-to-south gradient in O_3 trends reflects an earlier seasonal onset of NO_x-sensitive photochemistry in the southeast, as opposed to the background influence.

A warming climate is most likely to worsen the highest O_3 events in polluted regions (e.g., Schnell et al., 2016; Shen et al., 2016). With anthropogenic emissions held constant in time over 1988–2014, FIXEMIS suggests significant increases of 0.2–$0.4\,\mathrm{ppb\,yr^{-1}}$ in the 95th percentile summertime O_3 over the EUS (Fig. 11c). Using self-organizing map cluster analysis, Horton et al. (2015) identified robust increases in the occurrence of summer anticyclonic circulations over eastern North America since 1990. We find that biogenic isoprene emissions over this period increased significantly by 1–$2\,\%\,\mathrm{yr^{-1}}$ (10 to $20\,\mathrm{mg\,C\,m^{-2}\,summer^{-1}}$) throughout the EUS in the model, consistent with simulated increases in the 90th percentile JJA daily maximum temperature (Fig. 12a–b). Increases in isoprene emissions contribute to raising EUS background O_3 in summer (Fig. 11b, e). Using the Global Land-Based Datasets for Monitoring Climate Extremes (GHCNDEX; Donat et al., 2013), we find increases in the number of warm days above the 90th percentile and

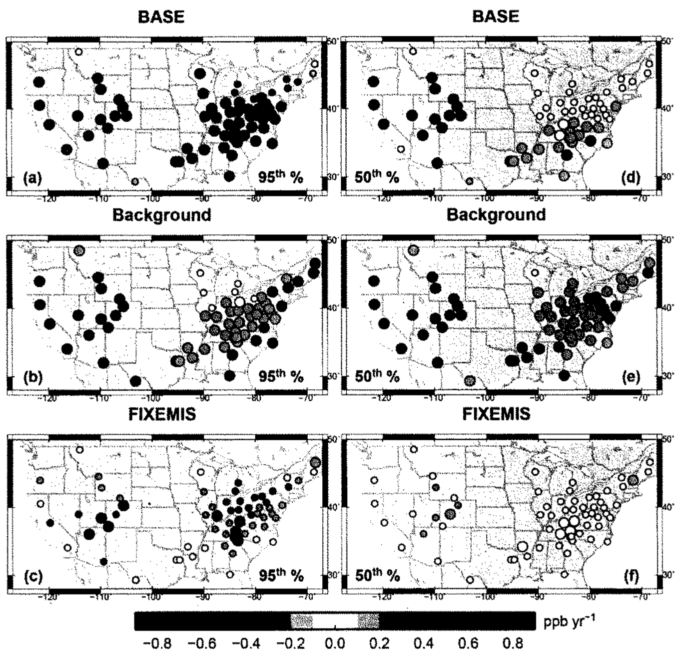

Figure 10. Linear trends in the 95th (left) and 50th (right) percentile springtime MDA8 O_3 over 1988–2014 at US rural sites from BASE (top), Background (middle) and FIXEMIS simulations (bottom). Larger circles indicate sites with statistically significant trends ($p < 0.05$). Top panels are repeated from Fig. 7d, e. Note that the 95th (50th) percentile is sampled separately from the Background and FIXEMIS simulations without depending on the times when the BASE simulation is experiencing the 95th (50th) percentile days.

maximum temperature over the southeastern US in August (Fig. 12c–d). The trends in temperature extremes are similar between June and August, but there is no significant trend in July (not shown). While changes in regional temperature extremes on 20- to 30-year time series may reflect internal climate variability (Shepherd, 2015), we suggest that increasing hot extremes and biogenic isoprene emissions over the last 2 decades may have offset some of the benefits of regional NO_x reductions in the EUS.

5 Impacts of rising Asian emissions, methane and wildfires on western US O_3

5.1 Historical western US O_3 trends in spring

Further indications of the factors driving baseline O_3 changes over the WUS can be inferred by examining the time series at several high-elevation sites, which most frequently sample baseline O_3 in the free troposphere during spring (Sect. 2.4). Figure 13 shows the results, both observed and simulated, for six such monitoring sites: Great Basin National Park in Nevada (2.1 km a.s.l.), Rocky Mountain National Park (2.7 km a.s.l.) in Colorado, US Air Force Academy (1.9 km a.s.l.) in Colorado Springs, Yellowstone National Park (2.4 km a.s.l.) and Pinedale (2.4 km a.s.l.) in Wyoming, and Mesa Verde National Park (2.2 km a.s.l.) in the Colorado–New Mexico–Arizona–Utah four-corner

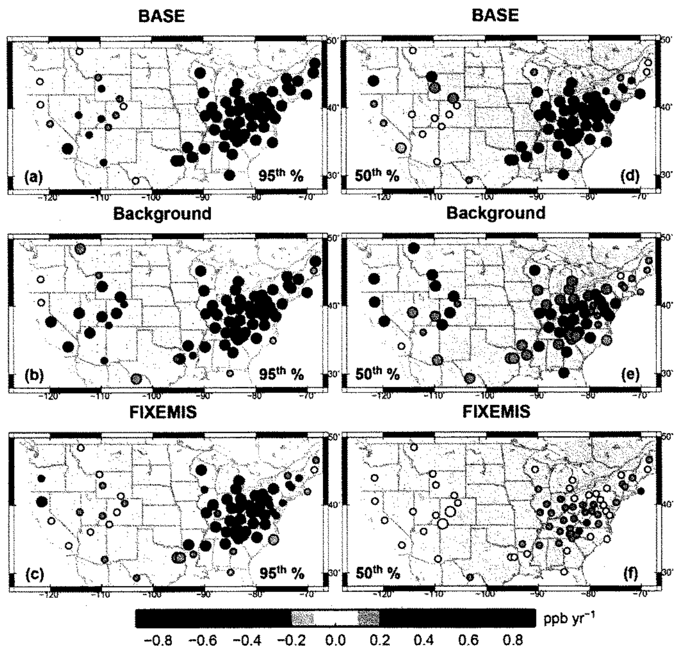

Figure 11. As in Fig. 10, but for summer. Top panels are repeated from Fig. 8d, e.

region. The observed median values of springtime MDA8 O_3 have increased significantly at a rate of 0.2–0.5 ppb yr^{-1} over the past 20–27 years at these sites, except Pinedale, where the increase in background O_3 is likely offset by the O_3 decrease due to recent emission control for the large oil and gas production fields in this area (http://deq.wyoming.gov/aqd/winter-ozone/resources/technical-documents/). When filtered to remove the influence from fresh local pollution (Sect. 2.4), AM3 BASE captures the long-term trends of O_3 observed at these sites.

Correlating AM3 Background with observed O_3 indicates that most of the observed variability reflects changes in the background, with fluctuations in stratospheric influence contributing to anomalies on interannual timescales (e.g., the 1999 anomaly, Lin et al., 2015a), whereas Asian influence dominates the decadal trends as discussed below. The O_3 reduction resulting from US anthropogenic emission controls is less than 0.1 ppb yr^{-1} (BASE minus Background) at these baseline sites. We show model results for the entire 1980–2014 period for Great Basin, Rocky Mountain, and the US Air Force Academy to provide context for observed trends in the 2 most recent decades (Fig. 13a). In the 1980s when Chinese NO_x emissions (~ 4 Tg yr^{-1} NO) were much lower than US NO_x emissions (~ 15 Tg yr^{-1} NO) (Granier et al., 2011), there was little overall O_3 change over the WUS in the model. From the mid-1990s onwards, with NO_x emissions in China rising steeply (Fig. 1a) and surpassing US emissions in the 2000s, the O_3 trends at remote WUS sites appear to be dominated by trends of background, reflecting rising emissions outside the US. The largest spring O_3 increases from 1981–1990 to 2003–2012 at 700 hPa extend from Southeast Asia to the subtropical North Pacific Ocean to the southwestern US (Fig. S7a), consistent with the influence of rising Asian precursor emissions.

Table 2 contains a summary of the drivers of O_3 trends in the model at seven CASTNet sites that exhibit a significant spring O_3 increase observed over 1988–2012. Here we focus our attribution analysis on the period 1988–2012 (in-

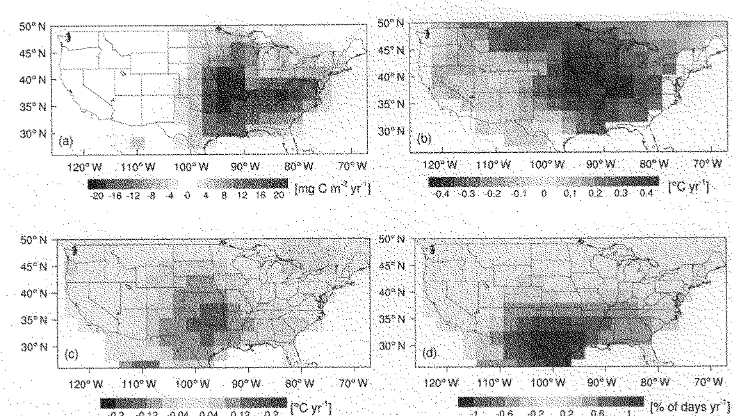

Figure 12. The 1990–2012 trends in **(a)** model JJA total biogenic isoprene emissions, **(b)** model 90th percentile JJA daily maximum temperature, **(c)** the warmest daily maximum temperature and **(d)** the frequency of warm days (i.e., those above the 90th percentile for the base period 1961–1990) for August obtained from the GHCNDEX dataset (Donat et al., 2013; available at http://www.climdex.org/viewdownload.html). Stippling denotes areas where the change is statistically significant ($p < 0.05$). Note that the trends are calculated for the 1990–2012 period, instead of 1988–2014, to avoid the influence from hot extremes in 1988 and cold conditions in 2014 (Sect. 6). When these years are included, the trends in **(c)** and **(d)** are swamped by the anomalies. The trends in **(a)** and **(b)** are similar between 1990–2012 and 1988–2014.

Table 2. Summary of springtime median MDA8 O_3 trends (in ppb yr^{-1}) over 1988–2012 at WUS sites from observations and AM3 simulations. Trends with the 95 % confidence intervals and levels of significance (bold: < 1 %; italic: 1–5 %; plain: ≥ 5 %) were estimated by the two-tailed t test.

Experiment	Lassen	Great Basin	Rocky Mountain	Mesa Verde	Yellowstone	Yosemite	Chiricahua
Observed	**0.38 ± 0.14**	**0.38 ± 0.26**	**0.37 ± 0.18**	**0.30 ± 0.18**	*0.21 ± 0.19*	*0.37 ± 0.32*	**0.17 ± 0.10**
BASE*	**0.33 ± 0.11**	**0.34 ± 0.12**	**0.32 ± 0.13**	**0.37 ± 0.14**	**0.21 ± 0.11**	**0.35 ± 0.17**	*0.25 ± 0.19*
Background	**0.31 ± 0.12**	**0.40 ± 0.13**	**0.45 ± 0.13**	**0.43 ± 0.17**	**0.30 ± 0.11**	**0.41 ± 0.16**	**0.32 ± 0.21**
$Background_{EA}$	**0.41 ± 0.12**	**0.39 ± 0.18**	**0.50 ± 0.15**	**0.52 ± 0.20**	**0.40 ± 0.16**	**0.47 ± 0.17**	**0.47 ± 0.21**
IAVASIA*	**0.29 ± 0.13**	**0.31 ± 0.11**	**0.25 ± 0.11**	**0.27 ± 0.11**	**0.19 ± 0.11**	**0.24 ± 0.14**	0.15 ± 0.15
$IAVASIA_{EA}$	**0.26 ± 0.16**	**0.26 ± 0.16**	**0.35 ± 0.13**	**0.32 ± 0.13**	**0.27 ± 0.16**	**0.31 ± 0.18**	**0.25 ± 0.15**
$IAVCH_4^*$	*0.18 ± 0.12*	**0.20 ± 0.11**	*0.12 ± 0.09*	*0.16 ± 0.12*	0.09 ± 0.12	0.15 ± 0.16	0.04 ± 0.15
IAVFIRE	0.10 ± 0.12	*0.14 ± 0.12*	*0.17 ± 0.14*	*0.16 ± 0.14*	0.11 ± 0.13	0.15 ± 0.16	0.08 ± 0.17
FIXEMIS	0.08 ± 0.12	*0.12 ± 0.12*	*0.16 ± 0.12*	*0.13 ± 0.12*	0.09 ± 0.13	0.12 ± 0.16	0.04 ± 0.16
O_3Strat	0.18 ± 0.18	0.20 ± 0.25	0.18 ± 0.18	0.25 ± 0.23	0.15 ± 0.18	0.27 ± 0.30	0.07 ± 0.24

The * mask indicates data filtered to represent baseline conditions (NACOt ≤ 67th). The EA subscript indicates that data were filtered to represent transport conditions favoring the import of Asian pollution (EACOt ≥ 67th).

stead of 1988–2014) because the IAVASIA and $IAVCH_4$ simulations only extend to 2012. Meteorology varies from year to year in all experiments. Thus, we quantify the contributions of rising Asian emissions in IAVASIA, global methane in $IAVCH_4$, and wildfire emissions in IAVFIRE by subtracting out the slope of the linear regression of seasonal O_3 means in FIXEMIS. Simulated O_3 with anthropogenic emissions varying in both South and East Asia but held constant elsewhere shows statistically significant increases of 0.1–0.2 ppb yr^{-1} ($p \leq 0.01$; IAVASIA minus FIXEMIS in Table 2), consistent with trends of 0.2 ppb yr^{-1} estimated by scaling results from HTAP phase 1 multi-model sensitivity experiments with Asian emissions reduced by 20 % (Reidmiller et al., 2009). This Asian influence can explain 50–65 % of the modeled background O_3 increase in spring (Table 2).

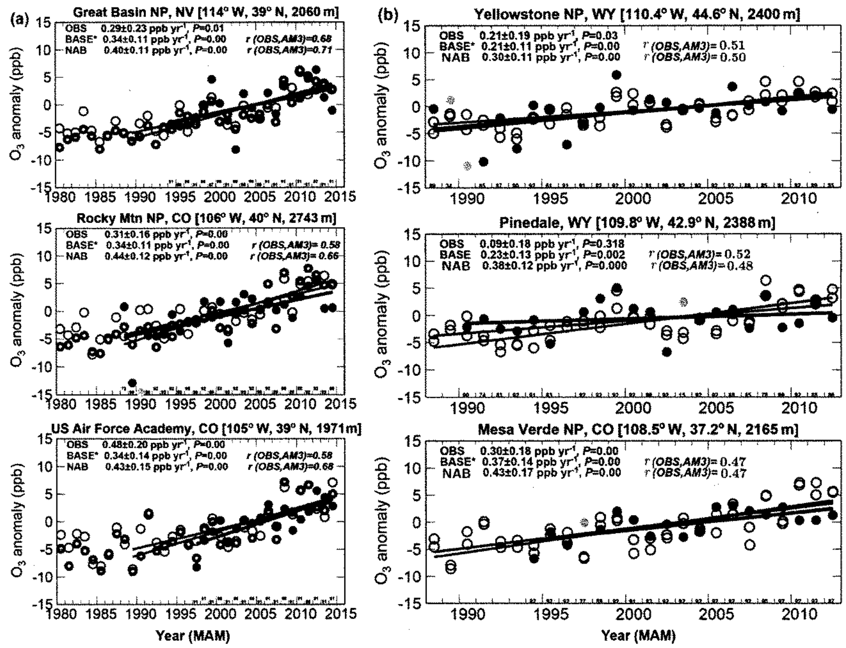

Figure 13. **(a)** Time series of median spring MDA8 O_3 anomalies (relative to the 1995–2014 mean) at Great Basin, Rocky Mountain, and US Air Force Academy as observed (black) and simulated in AM3 BASE filtered for baseline conditions (red; see Sect. 2.4) and in Background with North American anthropogenic emissions zeroed out (NAB; green). Presented at the top of the graph are statistics from the linear fit and correlations between observations and simulations. Numbers at the bottom of the graph denote the sample size of observations for each year. Gray dots indicate uncertain observations that are removed from the linear fit (see Sect. 2.3).**(b)** Same as Fig. 13a, but for Yellowstone, Pinedale, and Mesa Verde over the period 1988–2012.

With only methane varying, the model trends are less than 0.1 ppb yr^{-1} (IAVCH$_4$ minus FIXEMIS), accounting for an average of 15 % of the background increase. The contribution from wildfire emissions during spring is of minor importance (IAVFIRE minus FIXEMIS, Table 2). A stratospheric O_3 tracer (O_3Strat) in AM3 (Lin et al., 2012a, 2015a) demonstrates a positive but insignificant trend in stratospheric O_3 transport to the sites. We examine the trends of lower tropospheric O_3 at these sites when transport conditions favor the import of Asian pollution into western North America, as diagnosed by the East Asian CO tracer (EACOt) exceeding the 67th percentile for each spring. Similar to the conclusion of Lin et al. (2015b), we find that the rate of O_3 increase in the Background simulation is greater by 0.05–0.1 ppb yr^{-1} under strong transport from Asia than without filtering. Filtering the IAVASIA simulation for Asian influence also results in greater O_3 increases than filtering for baseline conditions (Table 2).

Rising Asian emissions even influence trends of O_3 downwind of the Los Angeles Basin during spring. O_3 measured in Joshua Tree National Park shows an increase of 0.31 ± 0.25 ppb yr^{-1} in spring over 1990–2010 (Cooper et al., 2012), despite significant improvements in O_3 air quality in the Los Angeles Basin (Warneke et al., 2012). The O_3 record extended to 2014 shows a decline in the 95th percentile O_3 in Joshua Tree National Park for both spring and summer (Figs. 7–8), whereas the 5th percentile continues to increase in spring and there is no significant trend in the median. Sampling the AM3 Background simulation at this site indicates a rising background (0.31 ± 0.14 ppb yr^{-1}). Air-

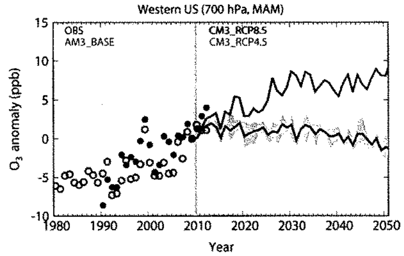

Figure 14. Future projections. Time series of median springtime O_3 changes relative to 2010 in GFDL AM3 hindcast (orange circles) and CM3 future simulations for RCP8.5 (red) versus RCP4.5 (blue; shading represents the range of three ensemble members), sampled at 700 hPa over the WUS (35–45° N, 120–105° W). Black circles indicate observed changes averaged from the Lassen, Great Basin, and Rocky Mountain national parks.

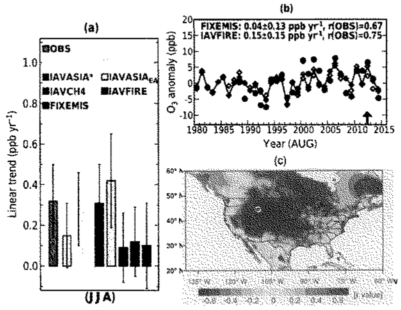

Figure 15. Summertime O_3 in Yellowstone National Park. (a) Median JJA MDA8 O_3 trends over 1988–2012 at Yellowstone from observations (black) and simulations sampled at 700 hPa for BASE without filtering (pink), BASE filtered for baseline conditions (hatched pink), IAVASIA (solid purple, baseline), IAVASIA filtered for Asian influence (EACOt ≥ 67th, hatched purple), IAVCH4 (cyan), IAVFIRE (orange) and FIXEMIS (red). (b) Time series of anomalies in August median MDA8 O_3 at Yellowstone as observed (black) and simulated by the model sampled at the surface, with constant (red) and time-varying wildfire emissions (orange). Trends over 1988–2014 are reported. (c) Interannual correlations of JJA mean MDA8 O_3 observed at Yellowstone with JJA mean daily maximum temperature from observations (Harris et al., 2014).

craft measurements in May–June 2010 indicate the presence of Asian pollution layers 2 km above southern California with distinct sulfate enhancements coincident with low organic mass (Lin et al., 2012b), supporting the conclusion that rising Asian emissions can contribute to trends of O_3 observed in this region. Yosemite National Park (1.6 km a.s.l.) and Chiricahua National Monument (1.5 km a.s.l.) are also influenced by increases in Asian emissions and concurrent decreases in local pollution in California. O_3 observed at Yosemite shows an increase from 1995 to around 2012 (0.37 ± 0.32 ppb yr^{-1}; Fig. S8), which the model attributes primarily to rising Asian emissions (Table 2), but observations have remained constant since then, reflecting an offset by O_3 decreases in California (Fig. 4).

5.2 Projecting western US springtime O_3 for the 21st Century

Under the RCP8.5 scenario, Chinese NO_x emissions are projected to peak in 2020–2030, reflecting an increase of ~ 50 % from 2010 (Fig. 1a), followed by a sharp decrease, reaching 1990 levels by 2050. Global methane increases by ~ 60 % from 2010 to 2050 under RCP8.5 (Fig. S1). Under the RCP4.5 scenario, in contrast, NO_x emissions in China change little over 2010–2030 and global methane remains almost constant from 2010 to 2050. NO_x emissions in the US decrease through 2050 under both scenarios, by ~ 40 % from 2010. A number of studies have examined future US O_3 changes under the RCPs (e.g., Gao et al., 2013; Clifton et al., 2014; Pfister et al., 2014; Fiore et al., 2015; Barnes et al., 2016). However, as discussed earlier, the trends of O_3 in the model when sampled near the surface are overwhelmingly dominated by US anthropogenic emission trends. Thus, the future O_3 changes estimated by these prior studies do not represent baseline conditions, particularly the response to rising Asian emissions. In Fig. 14 we show changes in WUS free tropospheric (700 hPa) O_3 relative to 2010 in the CM3 future simulations under RCP8.5 versus RCP4.5. Historical hindcasts and observations are also shown for context. Under RCP4.5, springtime O_3 over the WUS shows little overall change over 2010–2050. Under RCP8.5, in contrast, springtime WUS O_3 increases by ~ 10 ppb from 2010 to 2030 and remains almost constant from 2030 to 2050, consistent with the projected trends in Asian emissions and global methane.

5.3 Trends and variability of western US O_3 in summer

Yellowstone National Park is the only site with statistically significant summer O_3 increases observed across all percentiles (Fig. 8a–c). The 1988–2012 trends for the median observed and simulated O_3 are summarized in Fig. 15a. Observations show an increase of 0.32 ± 0.18 ppb yr^{-1} for JJA, with a greater rate of increase in June (0.38 ± 0.25 ppb yr^{-1}) than in July–August (0.26 ± 0.18 ppb yr^{-1}). AM3 BASE sampled at 700 hPa and filtered for baseline conditions (hatched pink bar in Fig. 15a) captures the observed increase. Without baseline filtering (solid pink bar), North American emission reductions offset almost 50 % of the simulated

O_3 increase at Yellowstone, causing the model to underestimate the observed O_3 trend. The model attributes much of the observed summer O_3 increase at Yellowstone to rising Asian emissions, with IAVASIA simulating an O_3 increase of 0.31 ± 0.19 ppb yr^{-1} under baseline conditions, increasing to 0.42 ± 0.23 ppb yr^{-1} under conditions of Asian influence (EACOt $\geq$ 67th percentile). The stronger increase measured in June than in July–August is consistent with the influence of the Asian summer monsoon producing a surface O_3 minimum in July–August in East Asia (e.g., Lin et al., 2009), as well as the seasonality of intercontinental pollution transport. Changes in methane, wildfires, and meteorology over this period are of minor importance for the JJA O_3 trends at Yellowstone.

Enhanced wildfire activity in hot and dry weather is thought to be a key driver of interannual variability of surface O_3 in the Intermountain West in summer (Jaffe et al., 2008; Jaffe, 2011). However, hot and dry conditions also facilitate the buildup of O_3 produced from regional anthropogenic emissions, which can complicate the unambiguous attribution of observed O_3 enhancements. Using August data at Yellowstone as an example, we isolate the relative contribution of these two processes to observed O_3 with the IAVFIRE versus FIXEMIS experiments (Fig. 15b). Here we sample AM3 at the surface to account for any influence of varying boundary layer mixing depths. Even without interannual variations of wildfire emissions, FIXEMIS captures much of the observed year-to-year variability of August mean O_3 at Yellowstone ($r = 0.67$). IAVFIRE with interannually varying fire emissions only moderately improves the correlations ($r = 0.75$). FIXEMIS also captures the observed O_3 increase from the early 1990s to around 2002, likely reflecting warmer temperatures and deeper mixing depths allowing more baseline O_3 to mix down to the surface. Over the entire 1988–2014 (or 1980–2014) period, IAVFIRE gives ~ 0.1 ppb yr^{-1} greater O_3 increases in August than FIXEMIS, consistent with an overall increase in boreal wildfire activity (Figs. S2 and S7b).

Figure 16 shows year-to-year variability in surface MDA8 O_3 enhancements from wildfires during summer, as diagnosed by the differences between IAVFIRE and FIXEMIS. The results are shown for individual months since fires are highly episodic. During the summers of 1998, 2002, and 2003, biomass fires burned a large area of Siberia and parts of the North American boreal forests, raising carbon monoxide across the Northern Hemisphere as detected from space (Yurganov et al., 2005; van der Werf et al., 2010). Long-range transport of Siberian fire plumes resulted in 2–6 ppb enhancements in surface MDA8 O_3 at the US western coast and in parts of the Intermountain West in AM3. The model calculates enhancements in monthly mean MDA8 O_3 of up to 8 ppb from the intense wildfire events in northern California during July 2008 (Huang et al., 2013; Pfister et al., 2013), over Texas–Mexico during June 2011 (Wang et al., 2015), and in Wyoming–Utah during August 2012 (Jaffe et al., 2013). The AM3 estimates are roughly consistent with a previous analysis of boundary layer aircraft data with and without fire influences (as diagnosed by CH_3CN) during June 2008 over California (Pfister et al., 2013).

While fires during hot and dry summers clearly result in enhanced O_3 at individual sites for some summers, the ability of AM3 with constant fire emissions to simulate variability of O_3 for a high (e.g., 1988, 2002, 2006) versus low (e.g., 1997, 2009) fire year (Fig. 15b) indicates that biomass burning is not the primary driver of observed O_3 interannual variability. Year-to-year variability of JJA mean MDA8 O_3 observed at Yellowstone is strongly correlated ($r > 0.6$) with observed large-scale variations in JJA mean daily maximum temperature across the Intermountain West (Fig. 15c). Correlations for other ground stations show a similar large-scale feature. Similar to the conclusion from Zhang et al. (2014), our analysis indicates that the correlation between O_3 and biomass burning reported by Jaffe et al. (2008) and Jaffe (2011) at rural sites reflects common underlying correlations with temperature rather than a causal relationship of fire with O_3. At remote mountain sites (e.g., Yellowstone), warmer surface temperatures lead to deeper mixed layers that facilitate mixing of free tropospheric O_3-rich air down to the surface. At sites near sources of air pollution, hot conditions enhance regional O_3 production and orographic lifting of urban pollution to mountaintop sites during daytime, as occurs at Rocky Mountain National Park located downwind of the Denver metropolitan area during summer (Sect. 5.4). Reactive volatile organic compound (VOC) emissions from fires may enhance O_3 production in NO_x-rich urban areas (Baker et al., 2016), although evaluating these impacts needs high-resolution models and better treatment of sub-grid-scale fire plumes.

5.4 Ozone trends in the Denver metropolitan area

Efforts to improve air quality have led to a marked decrease in high-O_3 events in the Los Angeles Basin as illustrated by the annual 4th highest MDA8 O_3 at Crestline – a regionally representative monitor operated continuously from 1980 to the present (Fig. 17a). In striking contrast, the 4th highest MDA8 O_3 in the Denver metropolitan area shows little change over the past decades, despite significant reductions in NO_x (Fig. 1) and CO emissions (-80 % from 1990 to 2010; Cooper et al., 2012). Recent field measurements indicate that increased VOC emissions from oil and natural gas operations are an important source of O_3 precursors in the Denver–Julesberg Basin (Gilman et al., 2013; Halliday et al., 2016; McDuffie et al., 2016). However, total VOC emissions in Denver may not be increasing over time due to the marked reductions in VOC emissions from vehicles (Bishop and Stedman, 2008, 2015). We seek insights into the causes of the lack of significant O_3 responses to emission controls in Denver by separately analyzing trends in spring and summer (Fig. 17b–c).

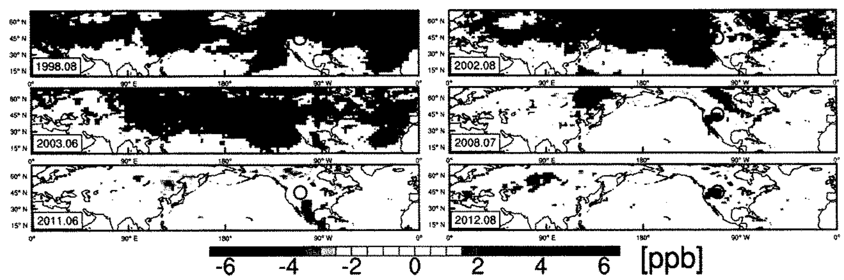

Figure 16. Surface MDA8 O_3 enhancements from wildfire emissions for individual months in the years with large biomass burning in boreal regions (1998, 2002, 2003) and over the WUS (2008, 2011, 2012), as diagnosed by the differences between IAVFIRE and FIXEMIS. The black circle denotes the location of Yellowstone National Park.

The $\sim 200 \times 200\,km^2$ AM3 model is not expected to resolve the urban-to-rural differences between Rocky Mountain National Park and the Denver metropolitan area. However, if observed O_3 variability in Denver correlates with that at remote sites in the Intermountain West, then model attribution for the remote sites can be used to infer sources of observed O_3 in Denver. This is demonstrated in Fig. 17b for spring using data at three representative sites in Denver, Rocky Flats North, National Renewable Energy Lab (NREL), and Welby, with continuous measurements since the early 1990s. Year-to-year variability of median MDA8 O_3 at these sites during spring correlates strongly with that in Great Basin National Park ($r = 0.7$), a fairly remote site in Nevada not influenced by urban emissions from Denver. Median spring O_3 observations in Denver increased significantly by $\sim 0.3\,ppb\,yr^{-1}$, similar to the rate of increase in Great Basin National Park, which the model attributes to rising background (Fig. 13a), implying that the tripling of Asian emissions since 1990 also raised mean springtime O_3 in the Denver metropolitan area. Trends in the 95th percentile are statistically insignificant.

During summer, changes in regional emissions and temperature have the greatest impacts on the highest observed O_3 concentrations in polluted environments. Figure 17c shows times series of July–August 95th percentile MDA8 O_3 in Denver, together with the distribution of daily maximum temperature. In every year since 1993, the highest summer MDA8 O_3 observed at these sites exceeds the 70 ppb NAAQS level. There is a small negative trend that is swamped by large interannual variability. The summers with the highest observed O_3 coincide with those with the highest observed temperatures, such as 1998, 2003, 2007, 2011 and 2012. During these summers, enhancements of MDA8 O_3 were also recorded in Rocky Mountain National Park, reflecting enhanced lifting of pollution from Denver under warmer conditions (Brodin et al., 2010). Applying quantile regression (e.g., Porter et al., 2015) to daily observations at Rocky Flats North over 1993–2015, we find a $2\,ppb\,°C^{-1}$ sensitivity of 95th percentile July–August O_3 to changes in maximum daily temperature. We suggest that the substantial increases in extreme heat occurrence over central North America over the last 2 decades, as found by Horton et al. (2015), contribute to raising summer O_3 in Denver, which offsets O_3 reductions that otherwise would have occurred due to emission controls in Denver. Potential shifts in the O_3 photochemistry regime can also contribute to trends of summer O_3 in Denver, although advancing this knowledge would require a high-resolution air quality model.

6 Impacts of heat waves and droughts on eastern US summer O_3

We discuss in this section interannual variability and long-term changes in summer O_3 over the EUS, where air stagnation and high temperatures typically yield the highest O_3 observed in surface air (e.g., Jacob and Winner, 2009). Evaluating the ability of models to simulate the high-O_3 anomalies during historical heat waves and droughts is crucial to establishing confidence in the model projection of pollution extremes under a warming climate. Figure 18a shows comparisons of July mean MDA8 O_3 at one regionally representative site, the Pennsylvania State University (PSU) CASTNet site, from observations and model simulations. With time-varying emissions, the BASE model simulates an O_3 decrease ($-0.45 \pm 0.32\,ppb\,yr^{-1}$) consistent with observations ($-0.67 \pm 0.33\,ppb\,yr^{-1}$) and captures the observed July mean O_3 interannual variability ($r = 0.82$) that is correlated with large-scale variations in daily maximum temperature

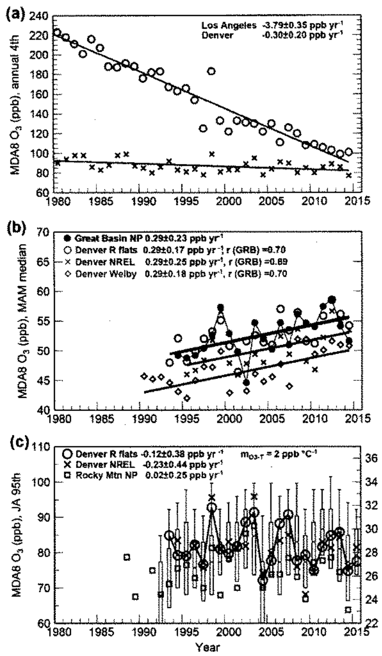

Figure 17. Surface O_3 trends in Denver. **(a)** Comparison of observed trends in annual fourth highest MDA8 O_3 at Crestline Los Angeles (brown) and in Denver (blue, computed from all monitors available in Denver non-attainment counties). **(b)** Time series of observed median MAM MDA8 O_3 at Great Basin National Park (red), in comparison with three monitors in Denver. **(c)** Time series of observed 95th percentile July–August MDA8 O_3 in Denver, together with statistics (25th, 50th, 75th, 95th) of observed July–August daily maximum temperature at Rocky Flats (red, right axis).

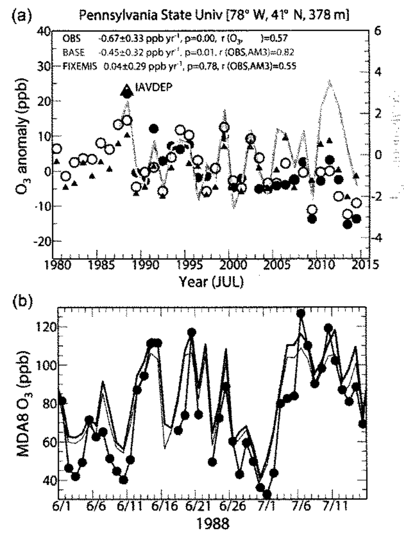

Figure 18. (a) Time series of July mean MDA8 O_3 anomalies (relative to 1988–2014) at the Pennsylvania State University (PSU) CASTNET site as observed (black) and simulated by the GFDL-AM3 model with time-varying (purple) and constant anthropogenic emissions (red), along with observed anomalies in July mean daily max temperature (gray lines; right axis). The green triangle denotes the 1988 O_3 anomaly from a sensitivity simulation using BASE emissions but with 35 % decreases in V_{d,O_3} (IAVDEP). **(b)** Time series of daily MDA8 O_3 at PSU from 1 June to 16 July in 1988 from observations (black), BASE (purple), and IAVDEP simulations (green).

($r = 0.57$). In particular, O_3 pollution extremes are successfully simulated during the EUS summer heat waves of 1988, 1995, 1999, 2002, 2011 and 2012 (Leibensperger et al., 2008; Fiore et al., 2015; Jia et al., 2016). Year-to-year variations in meteorology can explain 30 % of the total observed O_3 variability ($r = 0.55$), as inferred by FIXEMIS with constant anthropogenic emissions. If US anthropogenic emissions remained at 1990s levels (as in FIXEMIS), then anomalies in July mean MDA8 O_3 would have been 10 ppb greater during the 2011 and 2012 heat waves. Loughner et al. (2014) found that half of the days in July 2011 would have been classified as O_3 exceedance days for much of the mid-Atlantic region if emissions had not declined.

Figure 19a compares the probability density functions of MDA8 O_3 at 40 EUS surface sites for JJA in the pre-NO_x SIP Call (1988–2002) versus post-NO_x SIP Call (2003–2014) periods and during the extreme heat waves of 1988 versus 2012. Following the NO_x SIP Call, the probability distribution of observed JJA MDA8 O_3 over the EUS shifted downward (solid black versus dotted gray lines in Fig. 19a). The median value declined by 9 ppb and the largest decreases occurred in the upper tails, leading to weaker day-to-day O_3 variability and a narrower O_3 range (standard deviation σ decreased from 16.4 to 12.9 ppb). These observed O_3 changes driven by regional NO_x reductions are even more prominent when comparing the heat waves of 1988 versus 2012 (solid

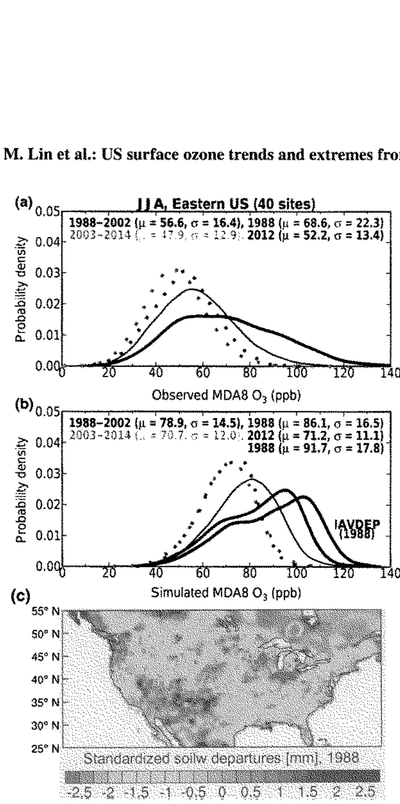

Figure 19. **(a)** Comparisons of probability distributions of summertime MDA8 O_3 from 40 EUS CASTNet sites for the pre-NO_x SIP Call (1988–2002; solid black) versus post-NOx SIP Call (2003–2014; dashed gray) periods and during the extreme heat waves of 1988 (solid purple) versus 2012 (dashed brown). The median (μ) and standard deviation (σ) are shown (ppb). **(b)** Same as **(a)**, but from AM3 BASE. Also shown is the O_3 distribution in 1988 from a sensitivity simulation with 35 % decreases in V_{d,O_3} in drought areas (green). **(c)** Standardized soil moisture departures for JJA 1988 (calculated by dividing anomalies by the 1979–2010 climatological standard deviation, using data from the NOAA Climate Prediction Center).

purple versus dotted brown lines in Fig. 19a): $\sigma = 22.3$ versus 13.4 ppb and median value $\mu = 68.6$ versus 52.2 ppb.

Figure 19b shows the corresponding comparisons using the results from AM3 BASE. Despite the high mean model bias (~ 20 ppb), AM3 captures the overall structure of the changes in the surface O_3 distributions and thus the response of surface O_3 to the NO_x SIP Call, including the reductions of high-O_3 events during the heat wave of 2012 compared to 1988. Nevertheless, there is a noticeable difference between the observations and simulations in the shape of MDA8 O_3 probability distributions for summer 1988, particularly in the upper tail of the distribution above 110 ppb (purple lines in Fig. 19a versus b). The BASE model also underestimates the observed July mean O_3 anomaly at PSU in 1988 by ~ 10 ppb (purple versus black dots in Fig. 18a). One possible explanation for these biases is that drought stress can effectively reduce the O_3 deposition sink to vegetation, leading to an increase in surface O_3 concentrations as found during the 2003 European heat wave (Solberg et al., 2008), whereas AM3 does not include interannually varying dry deposition velocities.

The North American drought of 1988 ranks among the worst episodes of drought in the US (e.g., Seager and Hoerling, 2014), with JJA soil moisture deficits occurring over the northern Great Plains–Midwest region with magnitudes of 1–2.5 mm standardized departures from the 1979–2010 climatology (Fig. 19c). Huang et al. (2016) found that monthly mean O_3 dry deposition velocities (V_{d,O_3}) for forests decreased by 33 % over Texas during the dry summer of 2011. Based on this estimate, we conduct a sensitivity simulation for 1988 using BASE emissions but decreasing monthly mean V_{d,O_3} from May to August by 35 % in the areas over North America (20–60° N) where soil moisture deficits in 1988 exceed -1.0σ mm (Fig. 19c). This experiment (hereafter referred to as IAVDEP) simulates ~ 10 ppb higher July mean MDA8 O_3 at the PSU CASTNet site than the BASE model and matches the observed O_3 anomaly in 1988 relative to the record mean (green symbol in Fig. 18a). The impact is largest (up to 15 ppb) on days when observed MDA8 O_3 exceeds 100 ppb (Fig. 18b; $T_{max} \geq 30$ °C). Simulated JJA MDA8 O_3 at EUS sites in IAVDEP shows an upward shift in the probability distribution, particularly in the upper tail above 110 ppb (green versus purple lines in Fig. 19b), bringing it closer to observations in 1988 (Fig. 19a). The O_3 standard deviation in IAVDEP ($\sigma = 18$ ppb) shifts towards that in observations ($\sigma = 22$ ppb) relative to the BASE model ($\sigma = 16$ ppb).

Quantile mapping can be applied to correct systematic distributional biases in surface O_3 compared to observations (Rieder et al., 2015), but this approach has limitations if there are structural biases in the O_3 distribution due to missing physical processes in the model (e.g., variations of V_{d,O_3} with droughts). Travis et al. (2016) suggest that the National Emission Inventory (NEI) for NO_x from the US EPA is too high nationally by 50 %. Decreasing US NO_x emissions by this amount corrects their model bias for boundary layer O_3 by 12 ppb in the southeast for summer 2013, while surface MDA8 O_3 in their model is still biased high by 6 ± 14 ppb, which the authors attribute to excessive boundary layer mixing. US NO_x emissions in the emission inventory used in AM3 (Sect. 2.2) are approximately 15 % lower than those from the NEI. The 35 % decrease in NO_x emissions from the pre-NO_x SIP Call to the post-NO_x SIP Call in the model reduces mean O_3 by 8 ppb in the EUS, implying that the NO_x emission bias could correct 40 % of our model mean bias of ~ 20 ppb. These estimates support the idea that the common

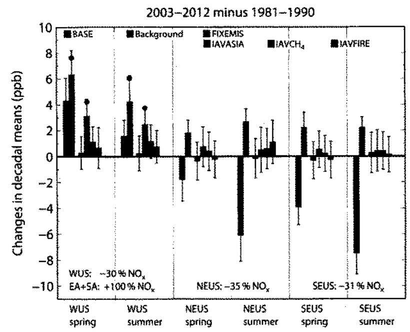

Figure 20. Summary of US surface O_3 trends and drivers. Changes in decadal mean MDA8 O_3 from 1981–1990 to 2003–2012 simulated in a suite of GFDL-AM3 experiments for spring and summer for the western (32–46° N and 123–102° W), northeastern (37–45° N and 90–65° W) and southeastern (30–36° N and 95–77° W) US domains. Observations are not shown because limited data are available during 1981–1990. Experiments are color-coded, with the error bars indicating the range of the mean change at the 95 % confidence level. Filled circles represent the changes under Background (green) and IAVASIA (purple) when filtered for Asian influence (EACOt $\geq$ 67th), while other results are from the unfiltered models. The text near the bottom of the plot provides the change in NO_x emissions over the same period for each region.

model biases in simulating surface O_3 over the southeastern US (e.g., Fiore et al., 2009) may partly reflect excessive NO_x emissions. Some of the positive O_3 biases could be also due to the averaging over a deep vertical box in the model surface layer ($\sim$ 60 m in AM3) that can not resolve near-surface gradients (Travis et al., 2016).

7 Conclusions and recommendations

Through an observational and modeling analysis of interannual variability and long-term trends in sources of O_3 over the past 35 years, we have identified the key drivers of O_3 pollution over the US. We initially evaluated the trends of O_3 in Asia resulting from rising Asian precursor emissions (Figs. 4–6). Our synthesis of available observations and simulations indicates that surface O_3 over East Asia has increased by 1–2 ppb yr^{-1} since 1990 (i.e., 25–50 ppb over 25 years), with significant implications for regional air quality and global tropospheric O_3 burden. Shifting next to the US, we find 0.2–0.5 ppb yr^{-1} increases in median springtime MDA8 O_3 measured at 50 % of 16 WUS rural sites, with 25 % of the sites showing increases across the entire O_3 concentration distribution, despite stringent US domestic emission controls (Fig. 7). While many prior studies show that global models have difficulty simulating O_3 increases observed at rural baseline sites (e.g., Parrish et al., 2014; Strode et al., 2015), we reconcile observed and simulated O_3 trends in GFDL-AM3 with a novel baseline sampling approach (Figs. 3 and 13). We suggest that the common model–observation disagreement in baseline O_3 trends reflects limitations of coarse-resolution global models in resolving observed baseline conditions. This representativeness problem can be addressed by filtering model O_3 for hemispheric-scale baseline conditions using the easy-to-implement, low-cost regional CO-like tracers. This approach allows trends of O_3 measured at baseline sites to be compared directly with multi-decadal global model hindcasts, such as those being conducted for the Chemistry-Climate Model Initiative (CCMI; Morgenstern et al., 2017).

The ability of the GFDL-AM3 model to reproduce observed US surface O_3 trends lends confidence in its application to attribute these observed trends to specific processes (Figs. 7 to 11). We summarize the overall statistics in Fig. 20, drawing upon the decadal mean O_3 changes from 1981–1990 to 2003–2012 in the BASE and sensitivity simulations. The changes in BASE are over the WUS 4.3 ± 1.8 ppb for spring and 1.6 ± 1.2 ppb for summer; over the northeast, -1.8 ± 1.7 ppb for spring and -6.0 ± 2.0 ppb for summer; and over the southeast, -3.9 ± 1.4 ppb for spring and -7.5 ± 1.6 ppb for summer. Increasing O_3 in the WUS under BASE coincides with an increase in background O_3 by 6.3 ± 1.9 ppb for spring and 4.2 ± 2.0 ppb for summer. Under conditions of strong transport from Asia (East Asian COt $\geq$ 67th), the background trend rose to 7.6 ± 2.2 ppb for spring and 6.0 ± 2.1 ppb for summer (green dots in Fig. 20). The WUS background O_3 increase reflects contributions from increases in Asian anthropogenic emissions (accounting for 50 % of background increase in spring; 52 % in summer), rising global methane (13 % in spring; 23 % in summer), and variability in biomass burning (6 % in spring; 12 % in summer; excluding the meteorological influence).

We conclude that the increase in Asian anthropogenic emissions is the major driver of rising background O_3 over the WUS for both spring and summer in the past decades, with a lesser contribution from methane increases over this period. The tripling of Asian NO_x emissions since 1990 contributes up to 65 % of modeled springtime background O_3 increases (0.3–0.5 ppb yr^{-1}) over the WUS, outpacing O_3 decreases resulting from 50 % US NO_x emission controls ($\leq$ 0.1 ppb yr^{-1}; Table 2 and Fig. 10). Springtime O_3 observed in the Denver metropolitan area has increased at a rate similar to remote rural sites (Fig. 17b). Mean springtime O_3 above the WUS is projected to increase by $\sim$ 10 ppb from 2010 to 2030 under the RCP8.5 global change scenario but to remain constant throughout 2010 to 2050 under the RCP4.5 scenario (Fig. 14). As NO_x emissions in China continue to decline in response to efforts to improve air quality (Krotkov et al., 2016; Liu et al., 2016), rising global methane and NO_x emissions in the tropical countries (e.g., India) in Asia, where O_3 production is more efficient, may become more important in the coming decades. A global perspective is necessary when designing a strategy to meet US O_3 air quality objectives.

During summer, a tripling of Asian anthropogenic emissions from 1988 to 2014 approximately offsets the benefits of 50 % reductions in US domestic emissions, leading to weak or insignificant O_3 trends observed at most WUS rural sites (Figs. 8 and 11). Rising Asian emissions contribute to observed summertime O_3 increases (0.3 ppb yr^{-1}) at Yellowstone National Park. Our findings confirm the earliest projection of Jacob et al. (1999) with a tripling of Asian emissions. While wildfire emissions can result in 2–8 ppb enhancements to monthly mean O_3 at individual sites in some summers, they are not the primary driver of observed O_3 interannual variability over the Intermountain West (Figs. 15 and 16). Instead, boundary layer depth, high temperatures and the associated buildup of O_3 produced from regional anthropogenic emissions contribute most to the observed interannual variability of O_3 in summer. Summertime O_3 measured in Denver during pollution episodes frequently exceeds the 70 ppb NAAQS level, with little overall trend despite stringent precursor emission controls (Fig. 17c), likely due to the effects of more frequent occurrences of hot extremes in the last decade.

In the eastern US, if emissions had not declined, the 95th percentile summertime O_3 would have increased by 0.2–0.4 ppb yr^{-1} over 1988–2014 (Fig. 11c), due to more frequent hot summer extremes and increases in biogenic isoprene emissions (1–2 % yr^{-1}) over this period (Fig. 12). Regional NO_x reductions alleviated the O_3 buildup during the recent heat waves of 2011 and 2012 relative to earlier heat waves (e.g., 1988, 1995, 1999). GFDL-AM3 captures year-to-year variability in monthly mean O_3 enhancements associated with large-scale variations in temperatures (Figs. 18 and 19). However, there is a need to improve the model representation of O_3 deposition sink to vegetation, in particular its reduced efficiency under drought stress, as we demonstrated for the severe North American drought of 1988. Such land–biosphere couplings are poorly represented in current models and further work is needed to examine their impacts on O_3 pollution extremes in a warming climate.

Following the NO_x SIP Call, surface O_3 in the eastern US declined throughout its probability distribution, with the largest decreases occurring in the highest percentiles during summer (-0.8 to -1.8 ppb yr^{-1}; Fig. 8). Spatially, historical O_3 decreases during non-summer seasons were more pronounced in the southeast, where the seasonal onset of biogenic isoprene emissions and NO_x-sensitive O_3 production occurs earlier than in the northeast (Figs. 7, 9 and S4). The 95th percentile O_3 concentration in the southeast has even decreased during winter. Despite high mean-state biases, GFDL-AM3 captures the salient features of observed O_3 trends over the eastern US, including wintertime increases in the 5th and 50th percentiles in the northeast, greater springtime decreases in the southeast than the northeast, and summertime decreases throughout the O_3 concentration distribution. These results suggest that NO_x emission controls will continue to provide long-term O_3 air quality benefits in the southeastern US during all seasons.

8 Data availability

All data derived from observations and model simulations used in this study are archived at NOAA GFDL and are available to the public upon request to Meiyun Lin.

The Supplement related to this article is available online at doi:10.5194/acp-17-2943-2017-supplement.

Competing interests. The authors declare that they have no conflict of interest.

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Attachment

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ADEQ Arizona Department of Environmental Quality

Memorandum

Date: June 13, 2018
To: Timothy S. Franquist, Director, Air Quality Division
From: Yi Li, Environmental Engineering Specialist III
Subject: Investigation of intrastate, interstate and international contributions to high concentrations of ozone in Yuma, Arizona

Executive Summary

Air quality monitoring in Yuma, Arizona has shown the area is violating the 2015 National Ambient Air Quality Standard (NAAQS) for ozone. However, in comparison to many other ozone nonattainment areas (such as the Phoenix-Mesa Nonattainment Area), the Yuma area emits much less ozone precursors (nitrogen oxides and volatile organic compounds). This indicates that high concentrations of ozone in the Yuma area are the result of transport into the area and not due to local emissions. This memorandum summarizes two analyses of ozone concentrations in the Yuma Area: (1) a comparison of ground-based meteorological and ozone monitors in Yuma, Arizona, United States, and San Luis Rio Colorado, Sonora, Mexico; and (2) an analysis of data from the NASA Ozone Monitoring Instrument on the Aura satellite.

Ground-Based Monitor Data

The ground based monitors straddle the international border and are 18 miles (29 km) apart. Data collected by the monitors shows that the ambient ozone concentration is highly correlated at both sites (r^2=0.72), and that higher ozone concentrations at the Yuma site are associated with wind coming from the south and southwest.

NASA Ozone Monitoring Instrument Data

Given the location of Yuma at the nexus of Arizona, California, and Mexico, we thought it most appropriate to look at relative change concentrations in Arizona, northwestern Mexico and southern California from 2005 to 2017. Due to interference from the ozone layer of the stratosphere, we are not able to obtain direct ozone concentration data. Therefore, the ozone precursor Nitrogen Dioxide (NO_2) was investigated. Our analysis found: (1) NO_2 concentrations are highest in southern California and steadily decreasing, (2) NO_2 concentrations are lower in Arizona and also decreasing, and (3) NO_2 concentrations in northeastern Mexico are low but increasing. We also found that the area directly around the monitor was decreasing in concentrations for the 2005 to 2017 period, with most of the decrease from Arizona and California.

Background

Yuma, Arizona is the county seat of Yuma County, which shares a border with California and the Mexican states of Sonora and Baja California. The 2017 Yuma design value for ambient ozone concentrations (the design value covers the years 2015-17) was near the levels measured in the Phoenix-Mesa nonattainment area for the same period (Figure 1). The design value was 72 ppb in Yuma and 76 ppb in Phoenix-Mesa.

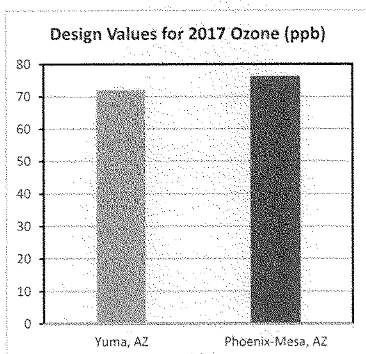

Figure 1 2017 Ozone Design Values

Elevated ozone concentrations are understood to be generated by high emissions of ozone precursors (mainly NO_2 and volatile organic compounds), which is in turn associated with human activity. However, when looking at levels of emissions and human activity, the Yuma area is much less than the Phoenix-Mesa area (Figure 2).

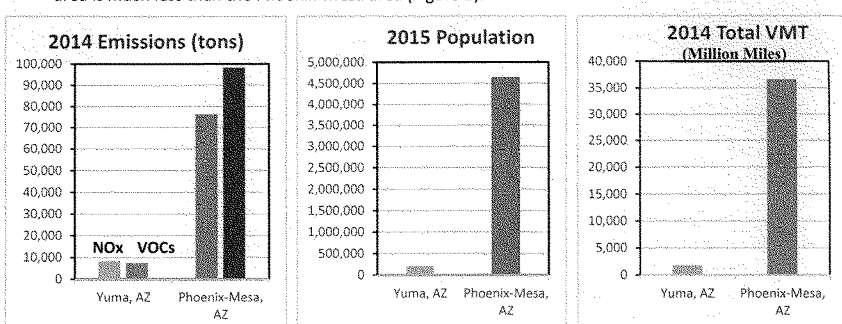

Figure 2 Emissions and Human Activity in Yuma and Phoenix-Mesa Areas

Ground-Based Monitoring Data

In addition to the ozone monitor in Yuma, ADEQ placed a monitor in San Luis Rio Colorado, Sonora Mexico. The monitors are 18 miles apart and on opposite sides of the international border. The location of the monitors is in Figure 3.

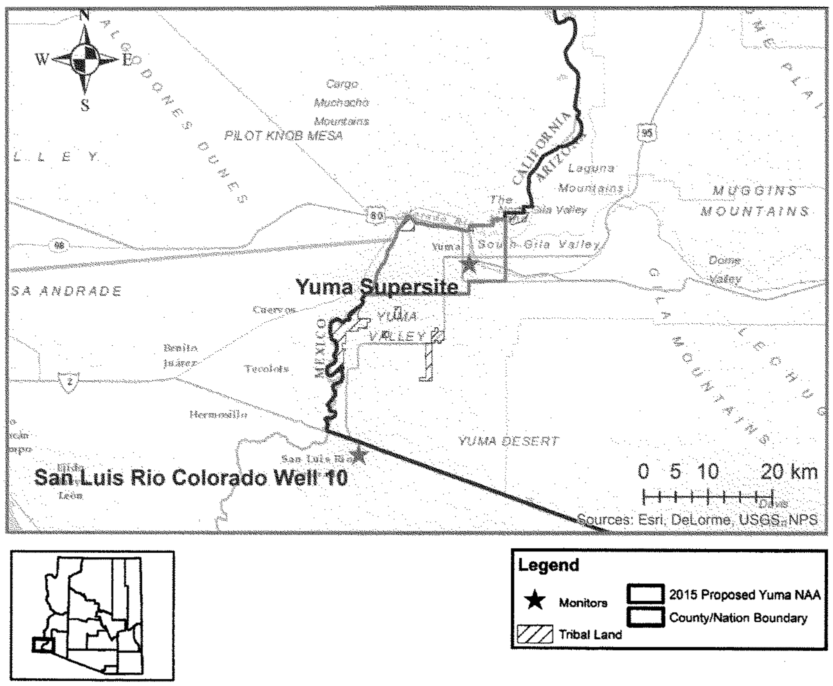

Figure 3 Ozone Monitoring Locations

Data collected by the monitors for the 2017 ozone season is in Figures 4 and 5. In Figure 4, the data is shown with the Yuma measurements on top. In Figure 5, the data is shown with both stations superimposed. The ozone concentrations at both sites are correlated with an r-squared value of 0.72.

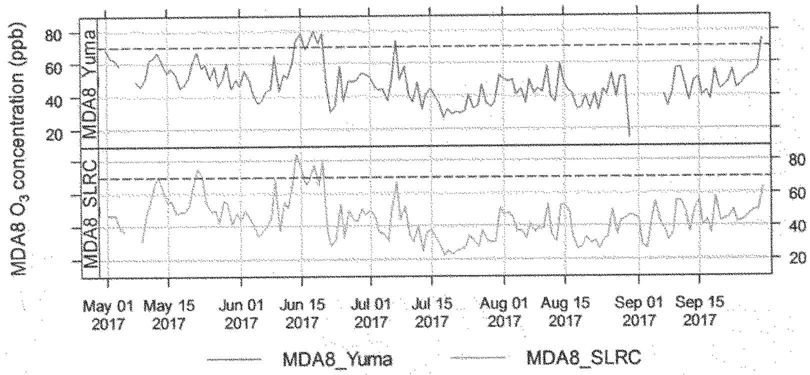

Figure 4 Ozone concentrations side-by-side

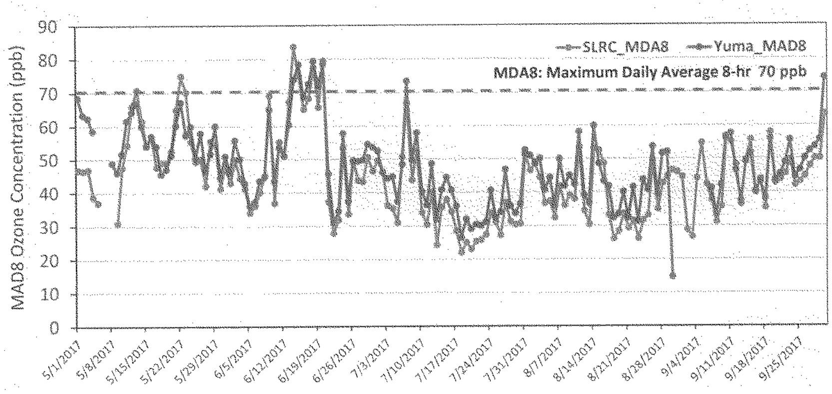

Figure 5 Ozone concentrations superimposed

Figure 6 presents the ozone concentration contribution from each wind direction on most days at both sites. Due south contributions are shaded orange and southwest contributions are shaded yellow. The wind direction on days when ozone concentrations exceeded the federal standard was from the south 80% of the time (31% due south, 43% from the southwest, and 6% from the southeast).

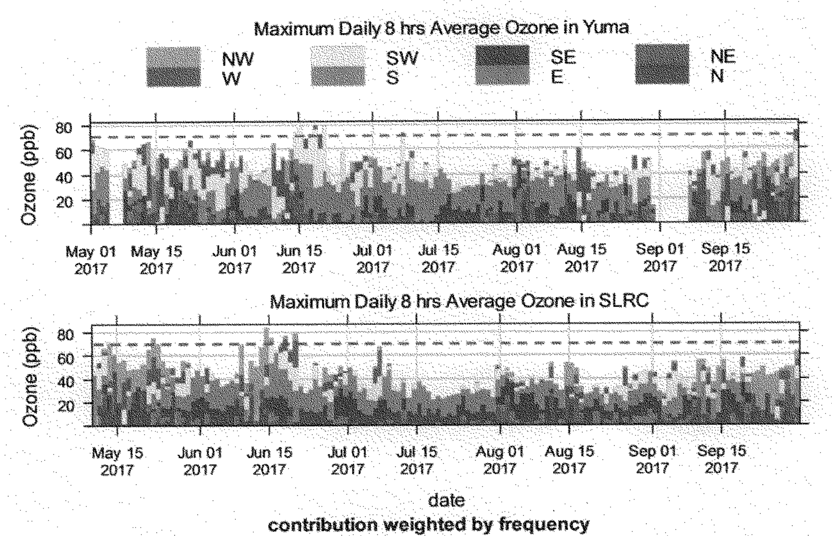

Figure 6 Ozone contribution by wind direction in Yuma and San Luis Rio Colorado

NASA Ozone Monitoring Instrument Data

Instrumentation

The Ozone Monitoring Instrument (OMI) is a spectrometer on NASA's Aura satellite (launched on July 15, 2004). The OMI instrument is a nadir viewing (downward facing) imaging spectrograph that measures the solar radiation backscattered by the Earth's atmosphere and surface over the entire wavelength range from 270 to 500 nm with a spectral resolution of about 0.5 nm. OMI combines the advantages of previous satellites (e.g., GOME, SCHIMACHY, OMPS etc), measuring the complete spectrum in the ultraviolet/visible wavelength range with a very high spatial resolution (13 km × 24 km) and daily global coverage (~ local time 1:45 pm).

Due to interference from the ozone layer of the stratosphere, we are not able to obtain direct ozone concentration. As an ozone precursor, nitrogen oxides (NO_2) play an important role in formation of ground-level ozone through several series of reactions with volatile organic compounds (VOCs) catalyzed by sunlight (Figure 7).

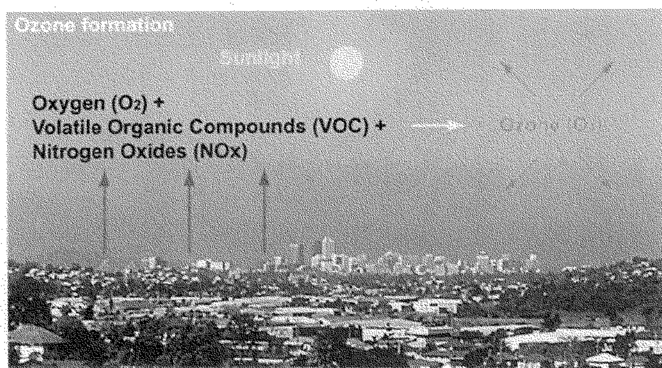

Figure 7 Diagram of Ground-level Ozone Formation

Methods

The OMI observes visible and ultraviolet (270-504 nm) solar backscatter radiation, which can be used to retrieve tropospheric NO_2 column densities with the Differential Optical Absorption Spectroscopy (DOAS) method. Since October 2004, OMI has provided NO_2 column densities retrieved by a spectral fitting algorithm. OMI observations have been widely used to study the trend of NO_2 column densities (Lamsal et al., 2015; Liu et al., 2016; Duncan et al., 2016, Majid et al., 2017). Over ten years of NO_2 data from OMI highlights air quality improvement throughout the U.S. (https://www.nasa.gov/content/goddard/new-nasa-images-highlight-us-air-quality-improvement/).

Since there is no NO_2 monitor near Yuma, AZ, in order to determine the regional emissions contributing to the Yuma ozone problem, we applied a hybrid inversion method to reveal the NO_2 spatial distributions and most importantly characterize the trends of NO_2 in Arizona, southern California, and northern Mexico. There are three operational OMI NO_2 products and their available information is listed in the table below:

Table 1. Information of OMI NO_2 operational products

Product Name	Acronym	Data Period	Reference
BErkeley High Resolution	BEHR	2005 – 2015	Russell et al.(2011); Laughner et al.(2016)
NASA standard product	NASA SP	2005 – 2017	Krotkov et al.(2017); Bucsela et al.(2013)
Dutch OMI NO_2	DOMINO	2005 – 2017	Boersma et al.(2007)

Note: More information on these three products can be found at Russell et al. (2011)

OMI NO_2 vertical column densities from Level 2 products are gridded to 0.5°x0.667° grid cells using quality flags and filtering criteria following the methods used in Jiang et al. (2018) and Qu et al. (2017). We processed the NO_2 retrieval data obtained from those three products for Yuma and its downwind areas including southern California, Arizona and Northern Mexico from 2005 to 2015. The whole region is within the area defined by latitude 25°N to 40°N and longitude 100°W to 125°W. The unit of retrieval NO_2 concentrations is molecules cm^{-2}, which is different from the parts per billion (ppb) we normally use. In order to clearly show the changes of retrieval NO_2 concentrations in the last ten years, the percentage difference is calculated using the equation below:

$$\frac{(2014-2015\ \text{Average})-(2005-2006\ \text{Average})}{(2005-2006\ \text{Average})}\times 100\%$$

Results

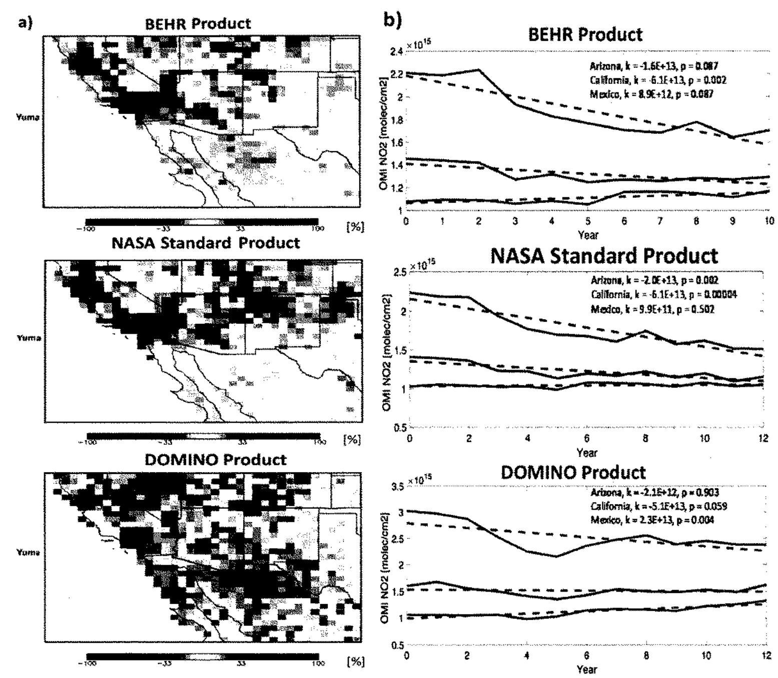

Figure 8 Percentage changes (%) of retrieval NO2 concentrations (a) and trend analysis (b) from three OMI NO2 products

Figure 8a shows a decreasing trend in southern California and Arizona. Especially, we notice a significant NO_2 decrease in metropolitan areas such as Los Angeles, San Francisco, and Phoenix; however, an increasing trend of NO_2 is spotted in northern Mexico.

In order to qualify the trends in each area, we averaged the annual NO_2 concentration(s) (only the area shown in the Figure 8a) and grouped them as California, Arizona and Mexico, respectively. Trend analysis was conducted for each area using Theil regression (Theil, 1992) and the Mann–Kendall test (Gilbert, 1987; Marchetto et al., 2013). We defined an increasing (decreasing) trend as a positive (negative) slope of the Theil regression, while the statistical significance of a trend was determined by the Mann–Kendall test (p value). A 90th percentile significance level ($p < 0.10$) was assumed as in a previous study (Hand et al., 2012). The results of trend analysis are presented in the Figure 8b. The trends from the three products show the same patterns, that NO_2 is decreasing in Southern California and Arizona, while increasing in Mexico (except NASA SP, which showed no significant trend for Mexico). The results from another NO_2 study recently conducted by Majid et al. (2017) also showed a similar trend for California and Arizona (Figure 8).

Future Work

Volatile Organic Compounds (VOCs), as another important ozone precursor, should also be investigated. Unfortunately, OMI only has one product available for formaldehyde (HCHO) for the period from 2005 to 2015. This data is currently being reviewed with a summary available in the near future.

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BRIEF

Poverty and Health

August 25, 2014

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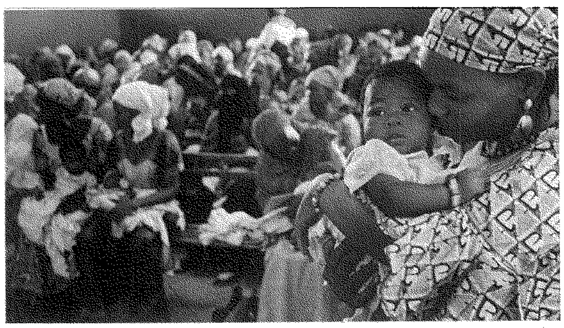

Context

Poverty is a major cause of ill health and a barrier to accessing health care when needed. This relationship is financial: the poor cannot afford to purchase those things that are needed for good health, including sufficient quantities of quality food and health care. But, the relationship is also related to other factors related to poverty, such as lack of information on appropriate health-promoting practices or lack of voice needed to make social services work for them.

Ill health, in turn, is a major cause of poverty. This is partly due to the costs of seeking health care, which include not only out-of-pocket spending on care (such as consultations, tests and medicine), but also transportation costs and any informal payments to providers. It is also due to the considerable loss of income associated with illness in developing countries, both of the breadwinner, but also of family members who may be obliged to stop working or attending school to take care of an ill relative. In addition, poor families coping with illness might be forced to sell assets to cover medical expenses, borrow at high interest rates or become indebted to the community.

Strong health systems (http://www.worldbank.org/en/topic/health/x/healthsystems) improve the health status of the whole population, but especially of the poor among whom ill health and poor access to health care tends to be concentrated, as well as protect households from the potentially catastrophic effects of out-of-pocket health care costs. In general, poor health is disproportionately concentrated among the poor.

Strategy

The World Bank's work in the area of health equity and financial protection is defined by the 2007 Health, Nutrition and Population Strategy (http://go.worldbank.org/QY4FTNVJR1). The strategy identifies "preventing poverty due to illness (by improving financial protection)" as one of its four strategic objectives and commits the Bank's health team, both through its analytical work and its regional operations, to addressing vulnerability that arises from health shocks.

The strategy also stresses the importance of equity in health outcomes in a second strategic objective to "improve the level and distribution of key health, nutrition and population outcomes... particularly for the poor and the vulnerable".

The Bank supports governments to implement a variety of policies and programs to reduce inequalities in health outcomes and enhance financial protection. Generally, this involves mechanisms that help overcome geographic, social and psychological barriers to accessing care and reducing out-of-pocket cost of treatment. Examples include:

1. Reducing the direct cost of care at the point of service, e.g. through reducing/abolishing user fees for the poor or expanding health insurance to the poor (including coverage, depth and breadth).
2. Increasing efficiency of care to reduce total consumption of care, e.g. by limiting "irrational drug prescribing," strengthening the referral system, or improving the quality of providers (especially at the lower level).
3. Reducing inequalities in determinants of health status or health care utilization, such as reducing distance (through providing services closer to the poor), subsidizing travel costs, targeted health promotion, conditional cash transfers.
4. Expanding access to care by using the private sector or public-private partnerships.

The Bank's health team also promotes the monitoring of equity and financial protection by publishing global statistics on inequalities in health status, access to care and financial protection, as well as training government officials, policymakers and researchers in how to measure and monitor the same.

Results

Examples of how World Bank projects have improved health coverage for the poor and reduced financial vulnerability include:

The **Rajasthan Health Systems Development Project** (http://www.worldbank.org/projects/P050655/rajasthan-health-systems-development-project?lang=en)resulted in improved access to care for vulnerable Indians. The share of below-poverty line Indians in the overall inpatient and outpatient load at secondary facilities more than doubled between 2006 and 2011, well exceeding targets. In the same period, the share of the vulnerable tribal populations in the overall patient composition tripled.

The **Georgia Health Sector Development Project** (http://www.worldbank.org/projects/P040555/health-sector-development-project?lang=en) supported the government of Georgia in implementing the Medical Insurance Program for the Poor, effectively increasing the share of the government health expenditure earmarked for the poor from 4% in 2006 to 38% in 2011. It also increased the number of health care visits of both the general population and the poor, but by more for the poor (from 2 per capita per year to 2.6) than for the general population (from 2 to 2.3) over the same time period.

The **Mekong Regional Health Support Project** (http://www.worldbank.org/projects/P079663/mekong-regional-health-support-project?lang=en) helped the government of Vietnam to increase access to (government) health insurance from 29% to 94% among the poor, as well as from 7% to 68% among the near-poor. Hospitalization and consultation rates, at government facilities, also increased among both the poor and near-poor.

RELATED

Analyzing Health Equity Using Household Survey Data (http://www.worldbank.org/en/topic/health/publication/analyzing-health-equity-using-household-survey-data)

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MEDICINE AND PUBLIC ISSUES

Poverty and Ill Health: Physicians Can, and Should, Make a Difference

Michael McCally, MD, PhD; Andrew Haines, MD; Oliver Fein, MD; Whitney Addington, MD; Robert S. Lawrence, MD; and Christine K. Cassel, MD

A growing body of research confirms the existence of a powerful connection between socioeconomic status and health. This research has implications for both clinical practice and public policy and deserves to be more widely understood by physicians. Absolute poverty, which implies a lack of resources deemed necessary for survival, is self-evidently associated with poor health, particularly in less developed countries. Over the past two decades, economic decline or stagnation has reduced the incomes of 1.6 billion people. Strong evidence now indicates that relative poverty, which is defined in relation to the average resources available in a society, is also a major determinant of health in industrialized countries. For example, persons in U.S. states with income distributions that are more equitable have longer life expectancies than persons in less egalitarian states.

There are numerous possible approaches to improving the health of poor populations. The most essential task is to ensure the satisfaction of basic human needs: shelter, clean air, safe drinking water, and adequate nutrition. Other approaches include reducing barriers to the adoption of healthier modes of living and improving access to appropriate and effective health and social services. Physicians as clinicians, educators, research scientists, and advocates for policy change can contribute to all of these approaches. Physicians and other health professionals should understand poverty and its effects on health and should endeavor to influence policymakers nationally and internationally to reduce the burden of ill health that is a consequence of poverty.

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Poverty and social inequalities may be the most important determinants of poor health worldwide. Socioeconomic differences in health status exist even in industrialized countries where access to modern health care is widespread (1). In this paper, we make a formal argument for physician concern and action about poverty based on the following assertions. Physicians have a professional and a moral responsibility to care for the sick and to prevent suffering. Poverty is a significant threat to the health of both individual persons and populations; thus, physicians have a social responsibility to take action against poverty and its consequences for health. Physicians can help improve population health by addressing poverty in their roles as clinicians, educators, research scientists, and participants in policymaking.

Concepts of Poverty and Health

Poverty is a multidimensional phenomenon that can be defined in both economic and social terms. An economic measure of poverty identifies an income sufficient to provide a minimum level of consumption of goods and services. A sociologic measure of poverty is concerned not with consumption but with social participation (2). Poverty leads to a person's exclusion from the mainstream way of life and activities in a society (3). There is a difference between absolute poverty, which implies a lack of resources deemed necessary for survival in a given society, and relative poverty, which is defined in relation to the average resources available in a society. Economic measures are easy to obtain, but social measures may provide a better understanding of the causes and consequences of poverty. Steps have been taken toward the development of indices of deprivation, which have promising uses in health services and public health research (4).

In 1978, the World Health Organization (WHO), in the Alma-Ata Declaration, spelled out the dependence of human health (defined broadly) on social and economic development and noted that adequate living conditions are necessary for health (5). Despite their knowledge of this, governments and major development organizations have largely continued to view health narrowly as a responsibility of the medical sector, outside the scope of economic development efforts. Consequently, governments have encouraged many large-scale but narrowly focused economic development efforts, ignoring the connection between poverty and health (6). In developed countries, governments promote various practices, such as heavy pesticide applications, that are designed to increase economic development and competitiveness but that are environmentally unsound and personally unhealthy.

Poverty Causes Death and Illness on a Massive Scale

During the second half of the 1980s, the number of persons in the world who were living in extreme poverty increased. Currently, extreme poverty afflicts more than 20% of the world's population. A recent report from WHO points out that up to 43% of children in the developing world—230 million children—have low height for their age and that about 50 million children have low weight for their height (7). Micronutrient malnutrition (deficiencies of vitamin A, iodine, and iron) affects about 2 billion persons worldwide.

It has been estimated that if developing countries enjoyed the same health and social conditions as the most developed nations, the current annual toll of more than 12 million deaths in children younger than 5 years of age could be reduced to less than 400 000. An average person in one of the least developed countries has a life expectancy of 43 years; the life expectancy of an average person in one of the most developed countries is 78 years (7). This is not to deny that real gains in health have occurred in recent decades. For example, since 1950, life expectancy at birth in several developing countries has increased from 40 to more than 60 years. Similarly, worldwide, mortality rates for children younger than 5 years of age decreased from 280 to 106 per 1000, on average. Some countries show much sharper declines (7), but indices of health in these countries still fall far short of those in wealthier nations.

Poverty and Sustainable Development

The relation between poverty and health is complex, and we believe that it is best understood in the framework of a new notion of "ecosystem health," which places poverty and health in the nexus of environment, development, and population growth (8). Ecosystems provide the fundamental underpinning for public health in both developed and less developed countries, not only through food production, for example, but also through their roles in economic development. For instance, they supply forest resources and biomass fuels and serve as habitats for the vectors of disease (9). Sustainability is produced by using resources in ways that meet the needs of current populations without compromising the ability of future generations to meet their own needs (10) and is predicated on the need to ensure a more equitable sharing of today's resources. Meeting the needs of the world's poor implies limitation of the current use of resources by industrialized nations.

Barriers to the benefits of development include rapid population growth, environmental degradation, and the unequal distribution of resources. At one extreme, traditional, preindustrial societies are characterized by relatively high birth rates coupled with high death rates attributable to acute infectious diseases and the hazards of childbearing; this leads to slow population growth. At the other extreme, in the most developed countries, population stability has occurred. In the intermediate situation, in less developed countries, population stability has not been reached, and the global population thus continues to increase. In some less developed countries, a "demographic trap" exists in which the development of resources cannot keep pace with the requirements of the growing population and poverty is worsened (11). The most developed countries escape the trap by buying additional essential resources in the global marketplace to make up the difference.

Environmental degradation exaggerates the imbalance between population and resources, increases the costs of development, and increases the extent and severity of poverty. For example, the need for fuel wood, timber for export, and farmland results in deforestation, which increases soil erosion, flooding, and mud slides and reduces agricultural productivity. As a result, biological diversity is lost, production becomes increasingly reliant on pesticides and fertilizers, and use of expensive fossil fuels increases. Water is a critical resource. In Punjab, the breadbasket of India, the major aquifer is decreasing at a rate of 20 cm per year, threatening health by reducing agricultural productivity and the supply of clean water (12). Economic development without regard to long-term environmental and social consequences also threatens sustainability by damaging the systems that sustain healthy communities.

Inequalities in Health Are Socially Determined

The strong and pervasive relation between an individual person's place in the structure of a soci-

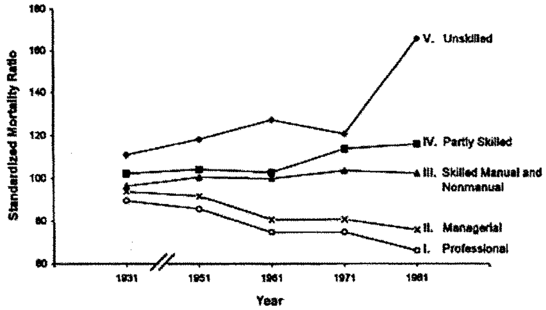

Figure 1. Comparison of standardized mortality ratios for men 15 to 64 years of age by social class over five decades in England and Wales. Figures have been adjusted to the classification of occupations used in 1951. Information on men 20 to 64 years of age in Great Britain was obtained from Black and colleagues (18).

ety and his or her health status has been clearly shown in research conducted over the past 30 years (13–16). In 1973, Kitagawa and Hauser (17) published convincing evidence of an increase in the differential mortality rates according to socioeconomic level in the United States between 1930 and 1960. They found that rates of death from most major causes was higher for persons in lower social classes. In Britain, research into health inequalities was summarized in 1980 in The Black Report (18), which was updated in 1992 (19) and is currently under review by an official working group. The report was prepared by a labor government-appointed research working group chaired by Sir Douglas Black, formerly Chief Scientist at the Department of Health and, at the time, President of the Royal College of Physicians. The Black Report concluded that "there are marked inequalities in health between the social classes in Britain" (**Figure 1**). Marmot and colleagues, in the well-known Whitehall studies of British civil servants begun in 1967, showed that mortality rates are three times greater for the lowest employment grades (porters) than for the highest grades (administrators) and that no improvement occurred between 1968 and 1988 (20–22).

Such findings could, in theory, be due to differences in age, smoking, nutrition, types of employment, accident rates, or living conditions, but the Whitehall study participants were from a relatively homogeneous population of office-based civil servants in London. They had largely stable, sedentary jobs and access to comprehensive health care. A second observation of the Whitehall investigations, confirmed by the Multiple Risk Factor Intervention Trial (MRFIT) studies in the United States, is that conventional risk factors (smoking, obesity, low levels of physical activity, high blood pressure, and high plasma cholesterol levels) explain only about 25% to 35% of the differences in mortality rates among persons of different incomes (**Figure 2**) (23, 24).

An equally striking finding is Wilkinson's observations of the relation between income distribution and mortality (25, 26). Wilkinson assembled two sets of observations. First, he found no clear relation between income or wealth and health when comparisons were drawn between countries (for example, there is no relation between per capita gross domestic product and life expectancy at birth in comparisons between developed countries at similar levels of industrialization). But Wilkinson also showed a strong relation between income inequality and mortality within countries, a relation that has been confirmed more recently (27, 28). The countries with the longest life expectancy are not necessarily the wealthiest but rather are those with the smallest spread of incomes and the smallest proportion of the population living in relative poverty. These countries (such as Sweden) generally have a longer life expectancy at a given level of economic development than less equitable nations (such as the United States).

Recent analysis of U.S. data supports earlier observations that the distribution of wealth within societies is associated with all-cause mortality and suggests that the relative socioeconomic position of the individual in U.S. society may be associated with health. Populations in U.S. states with income distributions that are more equitable have longer life expectancies than do those in less egalitarian states, even when average per capita income is taken into account (27, 28). Authors of the studies that revealed these findings recently introduced the notion of "social capital," which is defined as civic engagement and levels of mutual trust among community members, as an important variable intervening between income inequality and health status (29). Evans and associates (15) suggest that one's control of the work environment is an important connection between social and occupational class and mortality.

The Robin Hood index, also known as the Pietra ratio, is used to estimate the percentage of total income that would have to be transferred from groups above the mean to groups below the mean to equalize income distribution. A higher Robin Hood index value represents greater disparity in incomes. The strong correlation between income distribution and mortality rates shows that income disparity, in addition to absolute income level, is a powerful indicator of overall mortality (**Figure 3**) (27).

Inequalities in Income and Health Are Worsening

Many of the improvements in life expectancy and infant mortality rates that have occurred around the world are overshadowed by the countervailing influence of increasing disparities between rich and poor. Since 1980, economic decline or stagnation has affected 100 countries, reducing the incomes of 1.6 billion persons (19). Between 1990 and 1993, the average income decreased by 20% or more in 21 countries, particularly countries in eastern Europe and the countries of the former Soviet Union (30). The net worth of the world's 358 richest persons is equal to the combined income of the poorest 45% of the world's population: 2.3 billion persons. Between 1960 and 1991, the ratio of the global income of the richest 20% of the world's population relative to the poorest 20% increased from 30:1 to 61:1 (30, 31).

Many recent improvements in population health have been threatened and, in some cases, reversed at the same time that income differentials have widened. For example, the proportion of underweight children in Africa may decrease from 26% in 1990 to 25% in 2005, but the total number of underweight children is projected to increase from 31.6 million to 39.2 million because of population growth.

In the United States and the United Kingdom, income distribution has become more unequal. According to the United Nations Development Programme, income distributions within each of these countries are now among the most unequal distri-

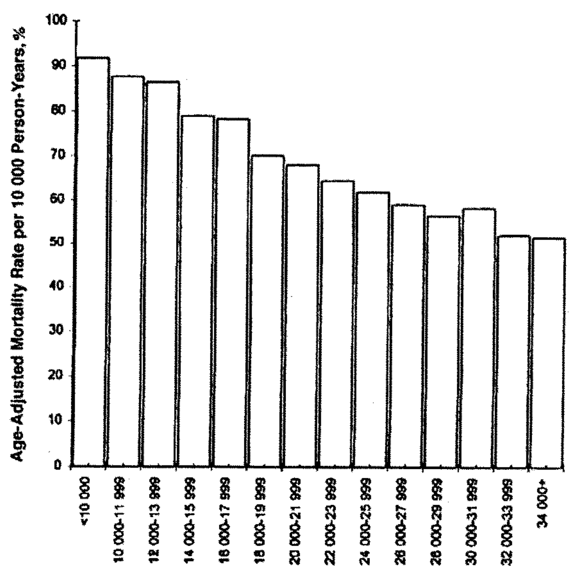

Figure 2. Income and age-adjusted mortality rates among 300 000 white men in the United States. Data obtained from Smith and colleagues (23)

butions in the world's industrialized countries (31, 32). For example, in the United Kingdom, the proportion of persons with an income less than half of the national average increased from less than 10% in 1982 to more than 20% in 1993, and unskilled men in Scotland now have a mortality rate three times that of professional men (33). This represents a widening from a twofold differential in the early 1970s. In the United Kingdom, the difference in mortality rates between rich and poor has increased because mortality rates have decreased faster among the rich than among the poor (34), and the proportion of children below the official poverty line has tripled in the past 10 years (35, 36). In the United States, inequality in income increased in all states except Alaska between 1980 and 1990 (37).

Effective Interventions Reduce Ill Health Due to Poverty

Some evidence suggests that improving the income of the poorest persons improves health in both developed and less developed countries. International data have been used to show that the doubling of per capita income (adjusted for purchasing power parity) from $1000, using 1990 figures, corresponds to an increase of 11 years in life expectancy. The relation flattens off above an average per capita income of approximately $5000 (**Figure 4**) (30). The distribution of income within households also influences health. It has been suggested, for example, that it takes 10 times more spending to achieve a given improvement in child nutrition in Guatemala when income is earned by the father than when it is earned by the mother because the mother is more likely to spend the money on essentials for the family (30).

An important, possibly unique, randomized trial in Gary, Indiana, suggests that increasing the income of poor expectant mothers receiving welfare increased the birthweight of their babies (38). Education, particularly for mothers, has dramatically affected health. In Peru, for instance, the children of mothers with 7 or more years of education have a reduction in child mortality of nearly 75% compared with the children of mothers with no schooling. Studies in several countries have shown that mothers who have completed secondary or higher education are much more likely to treat childhood diarrhea appropriately with oral rehydration therapy. Families are also likely to be smaller when women are more educated (30).

A recent systematic review of the effectiveness of health service interventions, predominantly in industrialized countries, to reduce poverty-related inequalities in health suggests several characteristics of interventions that may be successful, although they do not directly affect income (39). These include programs that target high-risk groups; outreach programs that include home visits; and programs that overcome barriers to the use of services by providing transportation or convenient access and by using prompts and reminders. Large-scale multidisciplinary interventions involving a range of agencies and programs may be cost-effective. The Special Supplemental Food Program for Women, Infants and Chil-

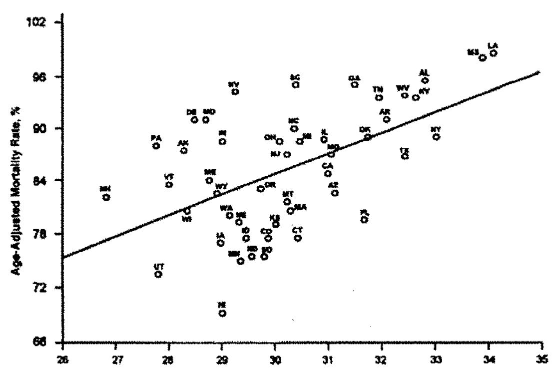

Figure 3. Age-adjusted mortality in the United States in 1990 and the Robin Hood index of income inequality. Circles represent the states of the United States. Data were not available for New Mexico, Rhode Island, and Virginia. Adapted from Kennedy and colleagues (27) with permission.

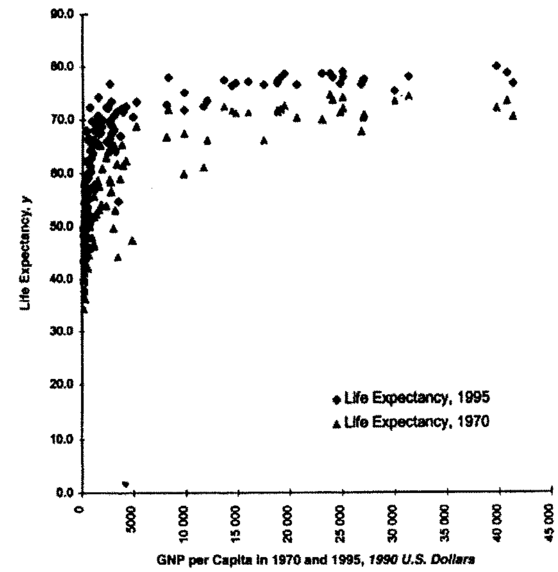

Figure 4. Life expectancy at birth and gross national product (*GNP*) in 1970 and 1995 in rich and poor countries in 1990 U.S. dollars. Triangles represent life expectancy in 1970, diamonds represent life expectancy in 1995. Data obtained from World Development Indicators, World Bank, 1995.

dren (WIC) was initiated in 1972 in the United States and provides healthy food, education about nutrition, and health services to low-income women and their children. Data analysis suggests substantial reductions in the number of babies with low and very low birth weights as a result (40). The project paid for itself through equivalent savings in medical care. Project Head Start provides preschool children and their families with education, health care, and social services. Short- and long-term benefits have been shown in health, developmental, and social outcomes (41).

Economic analysis confirms that primary care interventions, including measures designed to reduce childhood malnutrition, improve immunization against childhood diseases, provide chemotherapy against tuberculosis, provide condoms and education to combat the spread of HIV, and reduce smoking (including consumer taxes on tobacco) are cost-effective (42).

Physicians Have Special Responsibilities

It is widely accepted that physicians have a special and central professional responsibility to treat disease and reduce mortality rates, a responsibility that arises from their knowledge of medicine and medical practice (43). The physician–patient relationship is a fiduciary one, based on the inherent responsibility of physicians to deserve the trust of patients. Professionalism also extends this relationship to society, which confers on the profession respect and certain kinds of autonomy and authority. In the context of the physician–society relationship, the physician's fiduciary responsibility takes the form of concern for the public health. Most major traditions of medical ethics suggest that physicians have a special responsibility for the care of poor persons, defined as those who cannot afford to pay for treatment (44).

In addition, physician responsibilities in patient care extend to the social context of health and disease. Physicians regularly attempt to influence both patients' lifestyles and their environments to help prevent illness. They do so because illness is often precipitated by behavioral and social factors. Physicians in practice have an obligation to act on behalf of the general public welfare (for example, by reporting infectious diseases to the proper authorities). Recently, it has become widely accepted that physicians should work to promote smoking cessation, encourage use of seatbelts, and prevent firearm injury. Health hazards should not be ruled out as medical concerns because their remedy requires social or political action. Although the proper form and extent of political involvement for physicians may at times be controversial, concern for the health of the public has been an important responsibility of the medical profession at least since the Industrial Revolution (45).

It may be argued that although physicians have a responsibility to care for persons who are ill even though they are poor and cannot pay, medicine has no particular responsibility with respect to the general condition of poverty. Physicians' efforts to mitigate poverty may be seen as going beyond the bounds of the patient–physician relationship. However, efforts against poverty may have parallels in widely accepted attempts by physicians to prevent child abuse or health hazards in the workplace. Although patients may not ask to be protected from toxins or abuse, physicians have agreed that they have a responsibility to assist patients who may be in danger and, when possible, to prevent harm. If poverty is connected to ill health in a direct and powerful way, it can be argued that physicians have some degree of responsibility for addressing poverty itself to the best of their ability.

Physicians Can Help Mitigate the Health Inequalities Caused by Poverty

A panel convened by the King's Fund of London recently proposed four types of interventions to correct health inequalities related to poverty: addressing social and economic factors; reducing barriers to the adoption of healthier ways of living; improving the physical environment; and improving access to appropriate, effective health and social services (46). Physicians have clear roles to play in each of these efforts.

Physicians can address social and economic factors both on the level of the individual patient and on the level of the community. By being aware of socioeconomic factors, such as insurance status, educational background, occupational history, housing conditions, and social isolation, physicians can make more comprehensive diagnoses and tailor therapies to patients' needs. Unfortunately, in residency training, the social history (if it is taken at all) is often labeled "noncontributory." Raik and colleagues (47) examined the content of resident case presentations on inpatient rounds and found remarkably low rates of mention of socioeconomic factors. Physicians as teachers can address these factors on rounds and in describing their own patients to trainees and colleagues.

On the community level, physicians can advocate for public policies to improve the health of the disadvantaged. Jarman (48) showed that physicians know that it is more complicated and takes more time to care for poor patients than for patients who are not poor. With this evidence, he was able to persuade the National Health Service in the United Kingdom to take patient economic status into account in rewarding general practitioners who work in deprived areas. Given the growth of managed care in the United States, physicians should be at the forefront of those calling for poverty-based risk adjustments to capitated payments.

As research scientists, physicians can advance the understanding of the mechanisms by which deprivation leads to ill health and the development of more effective interventions to reduce inequality in health (49). Similarly, physicians who are aware of the adverse effects of international debt on health can urge debt relief for the poorest countries (50).

Physicians may also be able to assist in removing barriers to healthy lifestyles—for example, campaigning against the promotion of tobacco, which is increasingly being targeted to adolescents in less developed countries and in minority communities in the United States (51).

Physicians can affect environmental factors associated with poverty by advocating for legislation to maintain and improve the quality of air, drinking water, and food. Physician-led public health efforts in the United States have been instrumental in reducing the incidence of lead poisoning, which is strongly associated with poverty. Internationally, physicians are participating in local initiatives surrounding Agenda 21, developed at the 1992 Earth Summit in Rio de Janeiro, Brazil. More than 1300 local communities in 31 countries have developed their own action plans, many of which feature health issues. Through the WHO Healthy Cities Project, cities have addressed such issues as smoking, sanitation, air pollution, and socioeconomic differences in health (52).

Approaches to improving access to effective health and social services in the United States and elsewhere have been extensively reviewed (39, 53). However, more than 800 million persons lack access to health services worldwide, and the increasing imposition of user fees (copayments and deductibles) in many countries has exacerbated inequities in care (54). Physicians and their associations should lead the movement for universal access to health care (55).

An international meeting on health and poverty hosted by WHO and Action in International Medicine (which has approximately 100 affiliated organizations in more than 30 countries) urged associations of health professionals to engage in activities to reduce health inequalities due to poverty (56). Dr. Gro Harlem Brundtland, the newly appointed Director General of WHO, has indicated that she intends to make the reduction of ill health due to poverty a priority for her term of office (57). The United Nations Declaration of Human Rights includes access to the basic necessities of life, such as food and water, as well as health care. However, 50 years after the Declaration was written, we are still far from providing this access to everyone. Physicians have an important role to play in helping to transform the rhetoric of the Declaration into reality.

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Timothy S. Franquist

Mr. Franquist was appointed the Arizona Department of Environmental Quality's Air Quality Director in May 2016. He previously served as the Air Quality Division deputy director from November 2014 through May 2016. Since becoming director, Franquist has led Air Quality's effort to become nationally recognized for the agency's work on international transport of ozone, exceptional event demonstrations, permitting, and air quality meteorology.

Franquist has been with ADEQ for more than 14 years, 12 of which he served in air quality. Prior to State service, Franquist worked in a variety of environmental positions, including private sector consulting, county government, and environmental non-government organizations.

Franquist received his bachelor's degree in Environmental Science and Policy from The University of Maryland and his master's in Environmental Management from Arizona State University.

Mr. NORMAN. Thank you, Mr. Franquist.

I now recognize Dr. Craft for her testimony.

TESTIMONY OF DR. ELENA CRAFT, SENIOR HEALTH SCIENTIST, ENVIRONMENTAL DEFENSE FUND

Dr. CRAFT. Thank you. Chairman Biggs, Ranking Member Bonamici, and Members of the Committee, thank you for the invitation to be here to testify regarding the National Ambient Air Quality Standards for ground level ozone.

My name is Elena Craft. I serve as a senior scientist at Environmental Defense Fund, a national nonpartisan, science-based environmental organization where I manage a team working to identify strategies and opportunities to reduce harmful air pollution, such as ozone, from pollution hotspots. EDF is a national organization with over two million members that links science, economics, law, and private sector partnerships to solve our most serious environmental challenges.

EDF and its members are deeply concerned about harmful air pollution, including ground level ozone. I am lucky enough to be joined today by a few moms from Moms Clean Air Force. Nationally, Moms Clean Air Force is a community of over a million moms and dads strong. They are mobilizing and engaging communities across the country on air quality issues because they care about their kids. They care about the tiny lungs that are developing. They care about making sure that their kids make it to school instead of to the doctor's office or to the hospital because of an asthma attack. They care about the long-term health implications of living in areas that don't meet health-based standards, standards supported fervently by doctors and public health professionals across the nation.

Fortunately for almost 50 years, the Clean Air Act has provided bipartisan, time-tested solutions for reducing harmful pollution and protecting public health. National Ambient Air Quality Standards for deadly pollutants like ground level ozone form the foundation of the Clean Air Act's health-based protections. These bipartisan, consensus-backed standards save lives and protect American families.

But they are under threat. EPA Administrator Scott Pruitt is attempting to rescind, weaken, or delay many of these clean air standards. For instance, the Administrator has opened a loophole for super polluting, heavy duty long haul trucks. These glider vehicles are not required to deploy same modern pollution controls as other new long haul trucks. Gliders emit 43 times as many NOx, or nitrogen oxides, during highway driving than trucks with modern emission control systems. Allowing this loophole has resulted in significant increases in NOx. One years' worth of glider sales accounts for more NOx emissions than all of the emissions generated as a result of the VW emissions billion-dollar cheating scandal.

The Administrator has likewise neglected his responsibility to ensure protections are in place for downwind States and communities. For examples, the States of Connecticut, Delaware, and Maryland all submitted Good Neighbor petitions to EPA under Section 126 of the Clean Air Act, seeking relief from upwind emissions from coal-fired power plants that cause health-harming ozone pollution within their borders, pollution that forms some of the background that you'll hear about today.

Ozone does not discriminate. No matter where it comes from, the effect on the human body, on our kids' lungs, is the same. If we are in agreement that we value clean air, that we want our kids to breathe air that meets health-based standards recommended by the public health and medical communities, then the fastest way to achieve that clean air is to deploy the controls and policies that we know work. The controls that for almost 50 years have reduced aggregate pollution in our country by 73 percent, while GDP has grown 253 percent.

Most of our country, including the San Antonio area, and all of Arizona, is expected to be in attainment with the 2015 Ozone standard by 2025 because of strong Federal policies, like the clean car standards, the clean power plan, and the cross-state air pollution rule.

If we are serious about fulfilling the bipartisan agreement that serves as a bedrock environmental protection for our nation, then we must protect these policies and we must continue to support the scientific process that serves as the foundation for developing them. While there may be some challenges associated in isolated areas of the West, far and away, we should be more concerned with the current Administration's egregious attack on policies that will deliver tens of thousands of tons of emission reductions and that are critical in helping all communities across the country meet health-based standards. The Clean Air Act is important in reducing hospital visits, saving lives, and reducing healthcare costs.

Thank you for the opportunity to be here.

[The prepared statement of Ms. Craft follows:]

Before the United States House Committee on Science, Space, and Technology
Subcommittee on Environment Hearing - State Perspectives on Regulating Background Ozone

Testimony of Elena Craft, Ph.D.
Senior Scientist
Environmental Defense Fund
June 21, 2018

Chairman Biggs, Ranking Member Bonamici and Members of the Committee, thank you for the opportunity to testify regarding the National Ambient Air Quality Standards (NAAQS) for ground-level ozone.

My name is Elena Craft. I serve as a Senior Scientist at Environmental Defense Fund (EDF), a national nonpartisan science-based environmental organization, where I manage a team working to identify strategies and opportunities to reduce harmful air pollution such as ozone from pollution hotspots. EDF is a national environmental organization with over 2 million members that links science, economics, law, and private-sector partnerships to solve our most serious environmental challenges. In addition, I have an adjunct appointment at the University of Texas Health Sciences Center School of Public Health in Houston and I am also a Kinder Fellow at Rice University.

EDF and its members are deeply concerned about harmful air pollution, including ground-level ozone, and I greatly appreciate the opportunity to testify on these critical public health protections.

I. An Extensive Body of Scientific Evidence Demonstrates that Ozone Pollution Harms Human Health

Ground-level ozone, a component of smog, is a harmful air pollutant that irritates the lungs, exacerbates lung conditions like asthma, and is linked to a wide-array of serious heart and lung diseases. Scientific evidence spanning several decades shows that human exposure to ozone can cause a broad range of respiratory effects, including inflammation of the airways, asthma attacks, chronic obstructive pulmonary disease (COPD), and other health harms that can lead to increased use of medication, school absences, hospital admissions, and emergency room visits.[1]

EPA has estimated that the 2015 ozone standard will save hundreds of lives, prevent 230,000 asthma attacks in children, and prevent 160,000 missed school days for children each year.[2]

Between 2008 and 2015, there were more than 1,000 new studies that further confirmed the already well-documented health and environmental harms associated with ozone.[3] In particular, EPA concluded:

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[1] EPA, *Integrated Science Assessment for Ozone and Related Photochemical Oxidants*, Executive Summary (2013), *available at* https://www.epa.gov/isa/integrated-science-assessment-isa-ozone-and-related-photochemical-oxidants (last visited Apr. 27, 2018).
[2] EPA, *Regulatory Impact Analysis of the Final Revisions to the National Ambient Air Quality Standards for Ground-Level Ozone*, EPA-452/R-15-007, at ES-16, tbl.ES-6 (2015).

> Scientific evidence shows that ozone can cause a number of harmful effects on the respiratory system, including difficulty breathing and inflammation of the airways. For people with lung diseases such as asthma and COPD (chronic obstructive pulmonary disease), these effects can aggravate their diseases, leading to increased medication use, emergency room visits and hospital admissions.
>
> Evidence also indicates that long-term exposure to ozone is likely to be one of many causes of asthma development. In addition, studies show that ozone exposure is likely to cause premature death.[4]

Very recent evidence from studies published within the last year further solidifies the link between ozone exposure and an increased risk of death. One key study assessed ozone impacts in 61 million Medicare beneficiaries across thirteen years in the United States and found that the risk of death associated with ozone exposure continued below the current 8-hour NAAQS standard of 70 parts per billion (ppb).[5] The authors of this landmark study concluded that there was no threshold below which exposure to ozone did not produce adverse health consequences.[6] Another study found that long-term seasonal ozone was also associated with premature mortality and that reduction of just 5ppb of summertime average ozone across the country would save 9,537 lives per year.[7]

This body of scientific and technical literature also demonstrates that the risk of these harmful health effects is even more pronounced for people with asthma and other respiratory diseases, children, older adults, and people who work or are active outdoors. An estimated 20 million people over the age of 18 have asthma in the U.S. and an estimated 6.1 million children under the age of 18 have asthma.[8] Asthma disproportionately impacts communities of color and lower-income communities.[9]

Children, in particular, are considered the most at-risk group because they breathe more air per unit of body weight, are more active outdoors, are more likely to have asthma than adults, and are still developing their lungs and other organs. In fact, EPA's Children's Health Protection Advisory Committee (CHPAC)—a body of external experts that provides the Administrator with recommendations concerning children's health— recommended a substantially stronger standard

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[3] EPA, Fact Sheet, *Overview of EPA's Updates to the Air Quality Standards for Ground-Level Ozone* ("2015 Ozone Standard Fact Sheet"), *available at* https://www.epa.gov/sites/production/files/2015-10/documents/overview_of_2015_rule.pdf ; *see also* EPA, Integrated Science Assessment for Ozone and Related Photochemical Oxidants, Final Report (Feb. 2013), *available at* http://cfpub.epa.gov/ncea/isa/recordisplay.cfm?deid=247492#Download.

[4] 2015 Ozone Standard Fact Sheet.

[5] Di Q, Dai L, Wang Y, Zanobetti A, Choirat C, Schwartz JD, Dominici F., *Association of Short-term Exposure to Air Pollution With Mortality in Older Adults*, 318 JAMA 2446–2456 (2017), doi:10.1001/jama.2017.17923

[6] *Id.*

[7] Di, Q., Wang, Y., Zanobetti, A., Wang, Y., Koutrakis, P., Choirat, C., Dominici, F. and Schwartz, J.D., *Air pollution and mortality in the Medicare population*. 376 NEW ENGLAND J. OF MED., 2513-2522 (2017), *available at* http://www.nejm.org/doi/full/10.1056/NEJMoa1702747.

[8] Centers for Disease Control and Prevention, National Center for Health Statistics, 2016 *available at* https://www.cdc.gov/nchs/fastats/asthma.htm

[9] *Id.*

to protect the health of children. CHPAC found that "[c]hildren suffer a disproportionate burden of ozone-related health impacts due to critical developmental periods of lung growth in childhood and adolescence that can result in permanent disability."[10]

Implementing the strengthened ozone health standard is essential to begin addressing the health harms that children, sensitive populations, and all Americans face due to ozone exposure.

II. Millions of Americans Are Exposed to Unhealthy Levels of Air Pollution

Nationwide, millions of Americans are exposed to unhealthy levels of air pollution. A recent report by the American Lung Association (ALA), *State of the Air 2018*, which looked at air quality from 2014 to 2016, found that ozone pollution "worsened significantly" compared to the prior year's report.[11] The American Lung Association notes that from 2014 to 2016 "more than 133.9 million people live in the 215 counties that had unhealthy ozone or particle pollution."[12] And of the report's top twenty-five areas for unhealthy levels of ozone pollution, some improved, but sixteen had worse ozone from 2014 to 2016,[13] which underscores the importance of implementing the more protective, 2015 ozone standard.

Figure 1, below, shows the American Lung Association's list of the twenty-five areas across the country that face the highest levels of ozone pollution, which demonstrates that these heavily-polluted areas are not limited to any specific geographic area.[14]

[10] Letter from Sheela Sathyanarayana MD MPH, Chair, Children's Health Protection Advisory Committee to Christopher Frey PhD, CASAC Review of the Health Risk and Exposure Assessment for Ozone and Policy Assessment for the Review of the Ozone NAAQS: Second External Review Drafts, (May 19, 2014), *available at* https://www.epa.gov/sites/production/files/2014-12/documents/2014.05.19_chpac_ozone_naaqs.pdf.
[11] American Lung Association, *State of the Air 2018*, Key Findings, *available at* http://www.lung.org/our-initiatives/healthy-air/sota/key-findings/
[12] *Id.*
[13] *Id.*, Ozone, *available at* http://www.lung.org/our-initiatives/healthy-air/sota/key-findings/ozone-pollution.html.
[14] *Id.* at 20, *available at* http://www.lung.org/assets/documents/healthy-air/state-of-the-air/sota-2018-full.pdf.

FIGURE 1: People at Risk in 25 Most Ozone-Polluted Cities

RANKINGS

People at Risk In 25 Most Ozone-Polluted Cities

2018 Rank[1]	Metropolitan Statistical Areas	Total Population[2]	Under 18[3]	65 and Over[3]	Pediatric Asthma[4,6]	Adult Asthma[5,6]	COPD[7]	CV Disease[8]	Poverty[9]
1	Los Angeles-Long Beach, CA	18,688,022	4,353,354	2,444,450	334,698	1,119,385	628,200	7,942	1,433,318
2	Bakersfield, CA	884,788	258,054	91,719	19,840	48,388	25,731	377	57,988
3	Visalia-Porterville-Hanford, CA	610,222	184,746	64,889	14,204	32,845	17,612	260	39,595
4	Fresno-Madera, CA	1,134,612	323,032	136,983	24,836	62,984	34,873	482	78,731
5	Sacramento-Roseville, CA	2,567,451	595,320	389,039	45,770	155,308	91,493	1,090	209,852
6	San Diego-Carlsbad, CA	3,317,749	728,325	446,038	55,996	201,462	112,570	1,413	254,999
7	Modesto-Merced, CA	810,232	227,322	98,506	17,477	45,364	25,251	345	57,294
8	Phoenix-Mesa-Scottsdale, AZ	4,661,537	1,138,270	703,512	91,762	331,403	233,308	2,213	373,254
9	Redding-Red Bluff, CA	242,907	53,835	48,295	4,139	15,160	9,825	103	22,749
10	New York-Newark, NY-NJ-CT-PA	23,689,255	5,145,013	3,539,645	458,494	1,721,736	1,038,329	13,759	1,826,564
11	Houston-The Woodlands, TX	6,972,374	1,860,373	739,774	147,214	389,479	241,094	3,688	550,064
12	Las Vegas-Henderson, NV-AZ	2,404,336	551,082	374,922	36,391	150,570	129,535	1,242	205,979
13	San Jose-San Francisco-Oakland, CA	8,751,807	1,874,550	1,250,653	144,121	539,410	309,563	3,721	708,929
14	Denver-Aurora, CO	3,470,235	803,223	427,601	64,700	234,863	112,500	1,483	167,799
15	El Centro, CA	180,883	51,832	22,953	3,985	10,037	5,646	77	12,757
16	Dallas-Fort Worth, TX-OK	7,673,305	2,016,215	862,921	159,749	432,736	273,449	4,058	624,821
17	Washington-Baltimore-Arlington, DC-MD-VA-WV-PA	9,665,892	2,205,657	1,282,504	199,530	692,877	423,744	5,526	762,909
18	Salt Lake City-Provo-Orem, UT	2,514,748	765,804	241,347	44,770	145,432	66,492	654	122,337
19	Fort Collins, CO	339,993	68,025	50,096	5,479	23,835	11,703	145	17,434
20	Hartford-West Hartford, CT	1,476,637	301,063	243,852	33,160	123,604	69,574	887	115,420
21	Chico, CA	226,864	45,489	40,815	3,497	14,266	8,676	96	19,679
22	Chicago-Naperville, IL-IN-WI	9,882,634	2,300,124	1,348,267	170,477	683,560	473,577	6,620	775,469
23	Atlanta--Athens-Clarke County--Sandy Springs, GA	6,451,262	1,606,983	760,202	142,134	420,082	367,638	4,180	572,742
24	Philadelphia-Reading-Camden, PA-NJ-DE-MD	7,179,357	1,583,881	1,110,738	135,570	550,637	380,103	4,487	572,192
24	Sheboygan, WI	115,427	25,986	19,797	2,159	7,662	5,385	68	9,052

Notes:

1. Cities are ranked using the highest weighted average for any county within that Combined Metropolitan Statistical Area or Metropolitan Statistical Area.
2. **Total Population** represents the at-risk populations for all counties within the respective Combined Metropolitan Statistical Area or Metropolitan Statistical Area.
3. Those **under 18** and **65 and over** are vulnerable to $PM_{2.5}$ and are, therefore, included. They should not be used as population denominators for disease estimates.
4. **Pediatric asthma** estimates are for those under 18 years of age and represent the **estimated** number of people who had asthma in 2016 based on state rates (BRFSS) applied to population estimates (U.S. Census).
5. **Adult asthma** estimates are for those 18 years and older and represent the **estimated** number of people who had asthma in 2016 based on state rates (BRFSS) applied to population estimates (U.S. Census).
6. **Adding** across rows does not produce valid estimates. Adding the disease categories (asthma, COPD, etc.) will double-count people who have been diagnosed with more than one disease.
7. **COPD** estimates are for adults 18 and over who have been diagnosed within their lifetime, based on state rates (BRFSS) applied to population estimates (U.S. Census).
8. **CV disease** is cardiovascular disease, and estimates are for adults 18 and over who have been diagnosed within their lifetime, based on state rates (BRFSS) applied to population estimates (U.S. Census).
9. **Poverty** estimates come from the U.S. Census Bureau and are for all ages.

Source: American Lung Association, *State of the Air 2018*, *available at* http://www.lung.org/assets/documents/healthy-air/state-of-the-air/sota-2018-full.pdf

In my home state of Texas, *State of the Air 2018* found there were over 400 orange, red, or purple high ozone days (denoting specific ranges of severity for adverse health outcomes) in the counties examined in the report from 2014 to 2016. Fourteen counties received a grade of F in Texas for ozone pollution.[15]

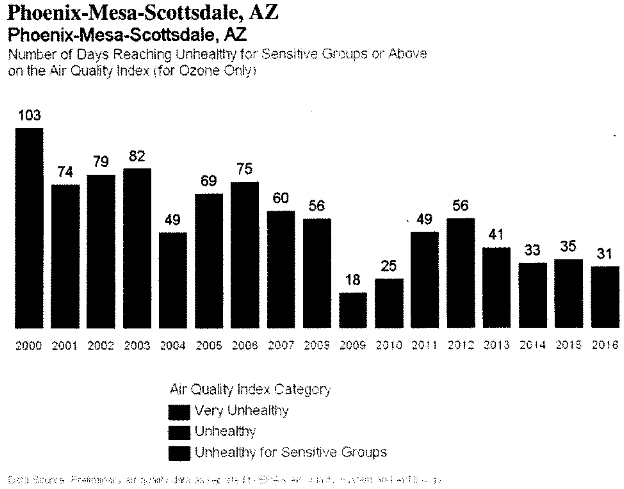
San Antonio, Texas is one of several areas in my home state that is particularly at risk. EPA has still not determined whether air quality in the San Antonio area meets the 2015 standard, despite the fact that monitors in the area have exceeded the 70ppb design value for many years. While EPA unlawfully delays, the citizens and children of San Antonio suffer the consequences as we

[15] *Id.* at 152.

move toward the height of summer ozone season. *State of the Air 2018* estimates the number of individuals from these sensitive populations living in the San Antonio area. Among other sensitive groups, the report estimated that over 58,767 children suffering from pediatric asthma and 168,266 adults suffering from asthma live in the eight counties in the San Antonio area.[16] The report projects that there are 109,113 individuals suffering from COPD, 171,929 individuals suffering from cardiovascular disease, and 1,524 suffering from lung cancer also live within those eight counties. The report ranked the San Antonio-New Braunfels area twenty-seventh for high ozone days out of 227 metropolitan areas. By failing in its duty to determine whether the San Antonio area meets the 2015 standard, EPA is unlawfully delaying needed air pollution protections for this region.

Other areas across the country, including in the Intermountain West suffer from elevated levels of ozone pollution. For instance, two areas in Arizona are on ALA's top 25 most ozone polluted areas. EPA reports the Phoenix-Mesa-Scottsdale area had thirty-one days of unhealthy ozone levels in 2016.[17]

FIGURE 2: Number of Days Reaching Unhealthy for Sensitive Groups in Phoenix-Mesa-Scottsdale, AZ



Source:
https://gispub.epa.gov/OAR_OAQPS/SeasonReview2016/index.html?appid=81efd40145584349a40b0869e20ffc3d

Indeed, though summer ozone season is just beginning across much of the country, there have already been a number of alerts for high ozone pollution, including in Arizona, Pennsylvania, and Texas (see the appendix of alerts issued or reported as of June 13, 2018).

[16] The eight Texas counties for which EPA has not made a final area designation include: Atascosa, Bandera, Bexar, Comal, Guadalupe, Kendall, Medina, and Wilson.
[17] US EPA, *A look back: Ozone in 2016, available at*
https://gispub.epa.gov/OAR_OAQPS/SeasonReview2016/index.html?appid=81efd40145584349a40b0869e20ffc3d

III. Bipartisan, Time-Tested History of Clean Air Act's Health-based Standards

Fortunately, for almost 50 years, the Clean Air Act has provided bipartisan, time-tested solutions for reducing harmful pollution and protecting public health. National Ambient Air Quality Standards for deadly air pollutants like ground-level ozone form the foundation of the Clean Air Act's health-based protections. These bipartisan, consensus-backed standards save lives and protect American families.

The Clean Air Act establishes a carefully-calibrated structure which provides for two distinct phases for setting or updating these vital standards. First, EPA is charged with establishing a health-protective standard. These standards are informed by an extensive volume of peer-reviewed literature as well as by a panel of scientific advisors. Following the establishment of these standards, a separate implementation process rooted in cooperative federalism takes place, whereby EPA works to carry out the NAAQS program in conjunction with the states and local air quality regulators.

The language crafted by Congress in 1970 is straightforward. It instructs EPA's Administrator to, first, establish standards that "are requisite to protect the public health" with "an adequate margin of safety."[18] The statute is clear that the standards be set based exclusively on public health considerations and to be precautionary in safeguarding against adverse health effects. As a matter of Congressional design, the level at which the standards are set is to be based on public health considerations alone. The question of what factors may be considered in the standard-setting process has also been consistently answered by the decisions of prior EPA Administrators and numerous judicial decisions of the federal court of appeals in Washington, D.C., as well as by the U.S. Supreme Court.[19]

Ultimately, this question was emphatically answered by a unanimous Supreme Court. Justice Antonin Scalia, writing for the high Court, explained that the text of the Clean Air Act is clear in that only public health factors may be considered. Justice Scalia then set forth the inquiry the Administrator must make in establishing the nation's health-based air quality standards—one that is thoroughly anchored in protecting public health:

> The EPA, "based on" the information about health effects contained in the technical "criteria" documents compiled under § 108(a)(2), 42 U.S.C. § 7408(a)(2), is to identify the maximum airborne concentration of a pollutant that the public health can tolerate, decrease the concentration to provide an "adequate" margin of safety, and set the standard at that level. Nowhere are the costs of achieving such a standard made part of that initial calculation.[20]

After the health-based standard is established, the Clean Air Act then provides a prominent role for consideration of costs in national, state, and local decisions about the pollution control strategies deployed to achieve the standard. The statute provides for the consideration of costs in

[18] Clean Air Act § 109(b)(1), 42 U.S.C. § 7409(b)(1).
[19] *See, e.g., Am. Lung Ass'n v. EPA*, 134 F.3d 388 (D.C. Cir. 1998); *Natural Res. Def. Council v. Adm'r, EPA*, 902 F.2d 962 (D.C. Cir. 1990), vacated in part on other grounds, 921 F.2d 326 (D.C. Cir. 1991); *Am. Petroleum Inst. v. Costle*, 665 F.2d 1176 (D.C. Cir. 1981); *Lead Indus. Ass'n, Inc. v. EPA*, 647 F.2d 1130 (D.C. Cir. 1980); *Whitman v. Am. Trucking Ass'ns, Inc.*, 531 U.S. 457, 465 (2001).
[20] *Whitman*, 531 U.S. at 465.

setting emission limits for cars, SUVs, trucks, buses, construction equipment, aircraft, fuels, power plants, and industrial facilities.

States and local governments, in turn, are distinctly responsible for designing the air quality management plans for their communities and entrusted with determining how the burden is allocated to restore healthy air. As Justice Scalia succinctly explained, "[i]t is to the States that the Act assigns initial and primary responsibility for deciding what emissions reductions will be required from which sources."[21]

IV. EPA Strengthened the Health-based Standard for Ozone in 2015—An Action Grounded in an Extensive Body of Scientific Literature and that Enjoys Broad, Public Support

This time-tested and bipartisan framework has delivered significant pollution reductions, all while the U.S. economy has continued to grow. EPA's most recent action to update the nation's health-based ozone standards, finalized in 2015, resulted in a more protective standard of 70ppb. EPA's action was grounded in the extensive body of scientific literature, described above, documenting that the previous standard of 75ppb was not requisite to protect public health.

There is strong public support for the 2015 ozone standard. The American Lung Association conducted polling in April 2018 that demonstrated continued, cross-partisan, public support for the standard, noting:

> Three-quarters of voters support EPA enforcing these stricter limits on smog—with a majority of all respondents strongly supporting. In every demographic group polled, more voters supported than opposed enforcement of the standards.[22]

Leading health and medical associations, including the American Lung Association, American Academy of Pediatrics, American Public Health Association, American Thoracic Society, Trust for America's Health, Asthma and Allergy Foundation of America, Health Care Without Harm, and National Association of County and City Health Officials, supported strengthening the previous, 2008 ozone standard.[23] The American Academy of Pediatrics forcefully reiterated that "[o]zone pollution in the air disproportionately impacts children, whose unique health and developmental needs make them more susceptible to pollutants."[24] Community and environmental justice groups such as Voces Verdes and We ACT for Environmental Justice also supported lowering the standard.[25]

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[21] *Id.*

[22] American Lung Association Press Release, New Poll: Voters Overwhelmingly Support Stricter Limits on Smog, April 24, 2018, *available at* http://www.lung.org/about-us/media/press-releases/new-poll-smog.html

[23] Comments from American Academy of Pediatrics et al. to the US Environmental Protection Agency, March 17, 2015, *available at* http://www.lung.org/assets/documents/advocacy-archive/national-health-and-medical.pdf

[24] American Academy of Pediatrics Press Release, AAP Statement on New EPA Ozone Standards, October 1, 2015, available at: https://www.aap.org/en-us/about-the-aap/aap-press-room/Pages/EPAOzonefinalstd.aspx

[25] *See* Voces Verdes Press Release, Voces Praises New Proposed Limits On Ozone; Supports Health Protective Standard, November 26, 2014, available at: http://www.vocesverdes.org/voces-in-action/3636/voces-praises-new-proposed-limits-on-ozone-supports-health-protective-standard; WE ACT for Environmental Justice, "Why WE ACT and its Allies Sued EPA for Cleaner Air," *available at* https://www.weact.org/2017/12/act-allies-sued-epa-cleaner-air/.

The 2015 ozone standard also received broad support from elected officials at all levels, including a diverse coalition of seventy mayors representing communities from all across the nation. The mayors stated that the prior 75ppb standard was "widely acknowledged by the medical community as insufficient to protect public health."[26] The letter went on to underscore:

> As local elected officials representing big cities and small towns, we want to express our strong support for the Environmental Protection Agency's (EPA) work to update the ozone (or smog) standard. . . . As mayors, we are on the front lines of protecting the safety and well-being of our constituents and this long-overdue update will reap tremendous benefits for our communities. [27]

V. The NAAQS Work and Are Achievable with Made-in-America Technology Solutions

Many highly cost-effective, commonsense clean air measures are available to help secure pollution reductions needed to achieve the improved air quality standards. The 48-year history of the Clean Air Act shows that the nation's public health standards are achievable, through available technologies and innovation by states and businesses. The broad environmental technologies, goods, and services sector was a more than $1 trillion global market, with the U.S. providing exports of nearly $48 billion in 2015.[28]

Moreover, our nation has often worked to achieve greater reductions than required, sooner, and at lower costs than estimated. Indeed, there are many clean air measures already underway that will help protect states, communities, and families from ozone pollution. EPA noted in its recent Air Trends report that most counties (outside of California) would be in attainment with the 2015 ozone standard by 2025, stating that "[f]ederal rules, including the Cross-State Air Pollution Rule, Mercury and Air Toxics Standards, the Tier 3 Vehicle Emissions and Fuels Standards, and the Clean Power Plan, will help reduce ozone-forming pollution in the years ahead."[29]

Other examples of reductions that will help meet the 2015 ozone standard include the cost-effective standards to reduce emissions from the oil and gas sector. EPA's emissions standards for new and modified oil and gas sources are modeled after successful state programs in Colorado and Wyoming. In Colorado, for instance, state standards have helped to reduce equipment leaks by seventy-five percent, while oil and natural gas production has increased.

[26] Mayors Smog Letter to President Obama, (Sept. 21, 2015) *available at* https://slcgreen.files.wordpress.com/2015/09/mayors-smog-letter-final-copy-9-21-2015.pdf

[27] *Id.*

[28] U.S. Department of Commerce International Trade Administration, *2017 Top Markets Report Environmental Technologies A Market Assessment Tool for U.S. Exporters (June 2017)* at 2, https://www.trade.gov/topmarkets/environmental-tech.asp (last visited: June 19, 2018). The United States is the single largest market for the sector, which provided about $330 billion in revenue in 2016. Indeed, environmental technology is a robust industry sector in the U.S., employing 1.6 million people. For instance, the national average ozone level has gone down 31% since 1980 and more than 90% of areas originally designated nonattainment for the 1997 ozone standards now meet those standards. *Compare* U.S. EPA, https://www.epa.gov/air-trends/ozone-trends *with* U.S. EPA, By the Numbers Fact Sheet (Oct. 2015), https://www.epa.gov/sites/production/files/2015-10/documents/20151001_bynumbers.pdf.

[29] U.S. EPA, https://gispub.epa.gov/air/trendsreport/2016/, (*last accessed* June, 12 2018).

Nationally, EPA estimated these standards for new sources would reduce volatile organic compound (VOC) emissions by 210,000 tons in 2025.

Additionally, there are numerous cost-effective, readily-available emission reductions yet to be implemented. For example, as evidenced in petitions to EPA from states like Maryland and Delaware, there are coal-fired power plants in several areas of the country that are not fully utilizing their already-installed pollution controls (e.g., selective catalytic reduction) to reduce ozone-precursor emissions of oxides of nitrogen (NOx). Left unaddressed, these units' emissions will continue to contribute to local and downwind ozone air pollution in places like Maryland and Delaware, creating challenges for communities to meet and maintain the NAAQS.[30]

Lastly, more protective NOx controls for heavy-duty trucks can deliver important and highly-cost effective pollution reductions from these vehicles. Heavy-duty manufacturers are developing new, effective solutions to reduce NOx emissions from trucks and buses. Advances in combustion and fuel injection systems, turbochargers, electronic controls, diesel particulate filters, and improved selective catalytic reduction (SCR) technologies are enabling reductions in NOx and other air pollutants.[31] In addition, the South Coast Air Quality Management District (SCAQMD) in California worked with heavy-duty engine manufacturer Cummins to develop an ultra-low NOx emission compressed natural gas engine for freight trucks.[32] Electric-drive trucks are also a new avenue opening up to further reduce NOx and particulate matter (PM) emissions from heavy-duty trucks. Standards to implement these and other advanced technologies would deliver vital health protections and benefit communities nationwide.

VI. The Trump Administration's Actions to Roll Back Clean Air Protections Threaten Human Health

When it finalized the 2015 ozone standard, EPA determined that highly-cost effective clean air policies that were already on the books would help many areas meet the more protective ozone standard. Despite these important pollution reductions and well-established benefits, EPA Administrator Scott Pruitt is attempting to rescind, weaken, or delay many of these clean air standards.

Standards Applicable to Major Stationary Sources of Pollution. Administrator Pruitt has sought to weaken protections applicable to major stationary sources of air pollution, including, for example, his proposal to repeal the Clean Power Plan. However, these critical standards will reduce carbon emissions from the power sector by thirty-two percent and will reduce NOx emissions by 278,000 tons in 2030. The combined ozone and particulate matter reductions the

[30] *See* State of Maryland Department of the Environment, Petition to the United States Environmental Protection Agency Pursuant to Section 126 of the Clean Air Act (Nov. 16, 2016), *available at* http://news.maryland.gov/mde/wp-content/uploads/sites/6/2016/11/MD_126_Petition_Final_111616.pdf.
[31] *See* California Air Resources Board, Draft Technology Assessment: Lower NOx Heavy-Duty Diesel Engines (September 2015) at ES-8, http://www.arb.ca.gov/msprog/tech/techreport/diesel_tech_report.pdf.
[32] *See* South Coast Air Quality Management District, *et. al.*, Petition to EPA for Rulemaking to Adopt Ultra-Low NOx Exhaust Emission Standards for On-Road Heavy-Duty Trucks and Engines (June 3, 2016), *available at* http://www.aqmd.gov/home/news-events/current-news/2016-news-archives/nox-petition-to-epa; *see also* CARB, Draft Technology Assessment: Lower NOx Heavy-Duty Diesel Engines (September 2015) at ES-9 ("Cummins believes a 0.1 g/bhp-hr NOx level is feasible with some improvements to the current SCR technology and the conventional diesel combustion process while still allowing for fuel economy optimization.") With further improvements, the company believes NOx emissions could be reduced to 0.02 to 0.05 g/bhp-hr levels.

Clean Power Plan will deliver will help to avoid 3,600 deaths, 90,000 asthma attacks, and 1,700 hospital visits in 2030.

In addition, the Administrator has taken action to create new and dangerous loopholes in the Clean Air Act's New Source Review program. Without seeking public input, EPA has sought to make it easier for major, industrial sources of dangerous air pollution to make changes that would increase pollution from their facilities while avoiding the longstanding requirement to simultaneously deploy state-of-the-art pollution control technologies.

The Administrator has likewise neglected his responsibility to ensure protections are in place for downwind states and communities. For example, the States of Connecticut, Delaware, and Maryland all submitted "good neighbor" petitions to EPA under section 126 of the Clean Air Act seeking relief from upwind emissions from coal-fired power plants that cause health-harming ozone pollution within their borders. Those petitions ask EPA to ensure that these upwind power plants install—or, in the case of Maryland's petition, simply run already-installed—modern and cost-effective pollution controls. The Administrator has failed to respond to those petitions in the timeframes provided for under the law. As a result, in a judicial decision issued just last week concerning the State of Maryland's pending "good neighbor" petition, the court stated that it was "troubled by EPA's apparent unwillingness or inability to comply with its mandatory statutory duties within the timeline set by Congress."[33] Unfortunately, EPA issued a proposed decision on June 8, 2018 indicating that it intends to deny the pending "good neighbor" petitions from Delaware and Maryland.[34]

Standards Applicable to Mobile Sources of Pollution. The Administrator has also proposed to weaken or rescind protections applicable to mobile sources. For instance, the Administrator has proposed to withdraw a rule for super-polluting heavy-duty, long-haul trucks, which would ensure that these "glider" vehicles deploy the same modern pollution controls as other new long-haul trucks.[35] Large freight trucks and buses are one of the largest sources of NOx emissions in the U.S., contributing to harmful pollution in communities across the nation.[36] Removing protections for super-polluting "glider" trucks would result in significant increases in NOx—accounting for more NOx emissions than all of the emissions generated as a result of the Volkswagen emissions cheating scandal.[37] These NOx emissions would lead to the formation of ozone as well as increased particulate matter. Furthermore, if the Administrator moves forward with this rollback, by 2025, these super-polluting freight trucks would make up just five percent of the nation's truck fleet, but they would cause *one third* of the air pollution attributable to the fleet.[38]

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[33] *Maryland v. EPA*, Dist. Ct. of MD Case No. 17-2873, June 13, 2018 Memorandum at 14.

[34] 83 Fed. Reg. 26,666 (June 8, 2018).

[35] U.S. EPA, Proposed Rule: *Repeal of Emission Requirements for Glider Vehicles, Glider Engines, and Glider Kits*, 82 Fed. Reg. 53,444 (Nov. 16, 2017).

[36] U.S. EPA, 2013 Final Report: Integrated Science Assessment of Ozone and Related Photochemical Oxidants at 3-6, https://cfpub.epa.gov/ncea/isa/recordisplay.cfm?deid=247492.

[37] Comment of EDF, ELPC, & WE ACT for Environmental Justice on EPA's Proposed Rule, Repeal of Emission Requirements for Glider Vehicles, Glider Engines, and Glider Kits, 82 Fed. Reg. 53,442 (Jan. 5, 2018), at 11-12, https://www.regulations.gov/document?D=EPA-HQ-OAR-2014-0827-4861.

[38] U.S. EPA, *Greenhouse Gas Emissions and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles—Phase 2*; Final Rule, 81 Fed. Reg. 73,478, 73,943 (Oct. 25, 2016); *see also* HDP2 Response to Comments Section 14 Appendix A.

National Ambient Air Quality Standards. The Administrator has also taken actions designed directly to weaken the National Ambient Air Quality Standards, including, for example, unlawfully delaying implementation of the 2015 ozone standard. In response to a lawsuit filed by states and public health and environmental organizations, EPA has now moved forward to identify certain areas of the country that do not meet the 2015 standard. However the agency's action comes almost an entire year after it was due, meaning that communities with unhealthy levels of ozone will face another summer without solutions in place to clean up the air. In addition, EPA has yet to take any final action concerning the eight counties around San Antonio, resulting in delays of the health and air quality protections the Clean Air Act provides.

Moreover, Administrator Pruitt has determined that certain areas meet the national standards despite monitoring data to the contrary. The Administrator has disregarded some of these monitoring data on the grounds that the unhealthy levels of ozone pollution are the result of exceptional events. The Clean Air Act, however, provides only very narrow circumstances under which EPA may do so, animated by the Act's strong focus on the protection of public health. A recent Presidential Memorandum to Administrator Pruitt turns the exceptional events provision on its head by encouraging states to submit these demonstrations to EPA as a routine matter. In the wake of this memorandum, EPA has now relied on a series of purported exceptional events to remove counties from traditional area boundaries when setting the final nonattainment areas.

Finally, Administrator Pruitt has issued a memorandum broadly addressing implementation of the National Ambient Air Quality Standards program. Among other deficiencies, the memo implies that EPA might consider costs when setting the NAAQS, despite settled Supreme Court precedent that the standards must be based on public health considerations alone.

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These are just a few examples of highly cost-effective policies to reduce ozone pollution that are under threat by the Administrator's actions.

VII. Man-made Emissions Sources Continue to Play the Largest Role in Unhealthy Ozone Levels

Eliminating the above-described protections is deeply misguided and would result in additional, harmful air pollution in communities across the country, while removing important tools from state air quality planners who are working to restore healthy air. This is especially so because, as EPA recognized when adopting the 2015 ozone standard, the anthropogenic sources addressed by these clean air measures are the dominant contributors to unhealthy ozone levels.

Notwithstanding this finding, Administrator Pruitt has expressed an intent to reexamine the contribution of "background ozone" levels to violations of the NAAQS. However, EPA has already examined these issues in its Policy Assessment for the review of the 2015 ozone standard and again in a 2015 White Paper on *Issues Associated with Background Ozone*. Both times, the agency concluded that anthropogenic emissions sources are the dominant contributor to most modeled ozone exceedances of the NAAQS nationally and within individual regions across the country.[39] In particular, when ozone levels are at their highest, anthropogenic sources are significant contributors, and these sources can be effectively addressed.

A recent peer-reviewed publication from the Cooperative Institute for Research in Environmental Sciences supports these findings. That study examined the oil and gas sector's contribution to ozone formation on Colorado's Front Range, focusing specifically on days that exceeded the ozone NAAQS. The study found that, on individual days, oil and gas ozone precursors could contribute in excess of 30 ppb to ozone concentrations and could be the primary driver of exceedances of the ozone NAAQS in that region.[40] Another study of the Colorado Front Range found that oil and gas VOC emissions contributed approximately twenty percent to regional ozone production.[41]

These findings underscore that, even in areas across the Intermountain West where background levels are sometimes incrementally higher, anthropogenic sources are substantial contributors to exceedances of health-based standards and that there are available solutions to reduce this harmful pollution. Furthermore, EPA has tools in place to address rare instances when truly exceptional events impact air quality, and western and southwestern states including Texas,[42] Arizona,[43] and Wyoming,[44] have previously sought to use these provisions.

VIII. Conclusion

This hearing is held under the auspices of the House Committee on Science, Space, and Technology. With that in mind, it is science that informs us on how to best manage the health harms of air pollutants like ozone. A rigorous and extensive body of science demonstrates the health harms that occur because of exposure to ozone pollution. Fortunately, as Americans, we have been able to rely upon the Clean Air Act, forged on a bedrock foundation of bipartisan collaboration for our nation, to protect against these health harms. But these protections are under threat. We need leadership and cooperation from our representatives and public officials in employing common sense solutions to ensure that our nation has a vibrant economy and a healthy environment. If we continue to work together building from this legacy of bipartisan

[39] Policy Assessment for the Review of the Ozone National Ambient Air Quality Standards (hereinafter Policy Assessment) Chapter 2 and Appendix 2A; EPA, *White Paper: Implementation of the 2015 Primary Ozone NAAQS: Issues Associated with Background Ozone White Paper for Discussion* (Dec. 30, 2015) *available at* https://www.epa.gov/sites/production/files/2016-03/documents/whitepaper-bgo3-final.pdf

[40] Cheadle, L.C., et al., (2017) "Surface Ozone in the Colorado Northern Front Range and the Influence of Oil and Gas Development During FRAPPE/DISCOVER AQ in Summer 2014," Elem. Dci. Anth. 5:61. doi:10.1525/elementa.254, available at https://www.elementascience.org/articles/10.1525/elementa.254/ .

[41] McDuffie, E., et al., (2016) "Influence of Oil and Gas Emissions on Summertime Ozone in the Colorado Northern Front Range," J. Geophys. Res. Atmos., 121, *available at* http://eprints.whiterose.ac.uk/103000/.

[42] Texas Commission on Environmental Quality, Ozone Data Exceptional Event Flag Demonstrations *available at* https://www.tceq.texas.gov/airquality/airmod/docs/ozone-data-exceptional-event-flag-demonstrations.

[43] Letter from Jared Blumenfeld, EPA Region IX, to Eric Massey, Director, Air Division Arizona Department of Environmental Quality (Sep. 6, 2012) *available at* https://www.epa.gov/sites/production/files/2015-05/documents/epa_resp_ltr_tsd_090612.pdf.

[44] Letter from Shaun L. McGrath, Regional Administrator, EPA Region 8, to Todd Parfitt, Director, Wyoming Department of Environmental Quality (May 28, 2014) *available at* https://www.epa.gov/sites/production/files/2015-05/documents/june_14_2012_strat_o3_concurrence_letter_28_march_2014.pdf.

collaboration forged in law, we will continue to chart a commonsense path forward in protecting the health of our children and communities, securing a stronger and more prosperous nation.

APPENDIX: Air Quality Exceedances by Region as of June 13, 2018

TOTAL DAYS BY REGION	
REGION 1:	48
REGION 2:	45
REGION 3:	47
REGION 4:	91
REGION 5:	273
REGION 6:	178
REGION 7:	48
REGION 8:	27
REGION 9:	205
REGION 10*:	0
TOTAL DAYS:	**962**

Data retreived from:
US EPA, *available at* https://www.epa.gov/outdoor-air-quality-data/air-data-ozone-exceedances.

Accessed June 13, 2018
EPA notes: "The data for the current year is from AirNow and is presented with baseline data from AQS for comparison only. The AirNow data are not fully verified and validated through the quality assurance procedures monitoring organizations use to officially submit and certify data on the EPA AQS (Air Quality System) and, therefore, cannot be used to formulate or support regulation, guidance or any other Agency decision or position."

***There was very little complete data for Region 10 therefore it is difficult to say what the true number is.**

Biography

Dr. Elena Craft is a Senior Health Scientist at Environmental Defense Fund. For a decade, she has strategized to identify, monitor, and mitigate risk from environmental pollution from the industrial sector as well as from within the transportation sector, most specifically around port areas and freight corridors. In addition, she has facilitated development of initiatives to support public health research, including helping to establish the Hurricane Harvey Environmental Health and Housing Registry in Houston, the first registry established after a major flood event. Dr. Craft's other scientific research focuses on understanding health disparities associated with living in pollution hotspots. She holds a B.S. degree in biology from UNC Chapel Hill, a M.S. degree in toxicology from NC State University, and a Ph.D. from Duke University. She also holds an adjunct assistant professorship at the University of Texas Health Sciences Center and is a Kinder Fellow at Rice University.

Mr. NORMAN. Thank you, Dr. Craft.
I now recognize Mr. Stella for his testimony.

TESTIMONY OF MR. GREGORY STELLA, SENIOR SCIENTIST, ALPINE GEOPHYSICS

Mr. STELLA. Mr. Chairman and Members of the Committee, my name is Gregory Stella, and I thank you for giving me the opportunity to testify today on behalf of my firm, Alpine Geophysics regarding information on background ozone concentrations and its role in regulatory modeling.

I especially would like to thank Representative Biggs for the invitation to appear before you.

As air quality scientists, one of our main objectives is to reduce and understand the uncertainty involved with modeling ozone concentrations in past, present, and future timelines. Each data input, calculation, model, or method that supports our analyses have their own uncertainties that need to be studies in order to understand the impact of these elements on policy decisions.

To this end, there are a number of categories of pollutant concentrations that have inherent uncertainty in a regulatory sense. One of those categories is background ozone.

Background ozone has historically been defined as amounts of pollutant concentrations that are produced by sources other than people. Because amounts of ozone measured at ambient air quality monitors cannot be separated into background or anthropogenic origin, this amount needs to be determined using photochemical modeling and source apportionment tools.

We know that many sources of background ozone are global in origin, and the fact that ozone is not emitted directly; rather, it is formed by reaction of hydrocarbon and nitrogen species in the presence of sunlight, complicates the linkage of particular emissions to downwind ozone concentrations.

In the air quality community, we use global chemistry models to derive boundary conditions, which include background emissions, to inform our regional models. What this means is that we generate global concentrations of ozone at very coarse scale and mesh them with our own regional and local modeling platforms, which are of a much finer granularity.

To this, we add regional background ozone concentrations from models that estimate biogenic or wildfire emissions, and complete the platform with our national inventories of anthropogenic sources.

When we look at all these factors and run our own source apportionment tools with the resulting modeling platforms, we, EPA, and others have found that background ozone can range from ten percent of the modeled contribution to close to 90 percent on any single model day, with higher background contributions seen in the western high elevation monitor locations. This is a large fraction of the current 70 ppbos on NAAQS and can make it very difficult, if not impossible, for many regions of the country to attain the NAAQS.

So when that leap is made from science to policy, the various definitions of uncontrollable ozone sources become important to consider. For example, baseline ozone, U.S. background, global background, global anthropogenic background, or even international exceptional vents have all been cited as applicable to 179B petitions and potential regulatory relief under the "but for" clause of this section of the Act.

However, to be clear, relief using 179B or exceptional event exclusion does not give anyone cleaner air to breathe. It is simply recognizing a regulatory reprieve based on the language of the law.

In the air quality community, these options are not seen as a free pass to pollute. Rather, this is seen as a reality that must enter into the regulatory discussion and be understood in order to develop control programs that maximize air quality benefit with minimal societal disruption.

Unfortunately, there is a vague regulatory clarity on exactly what could be considered in many cases, and therefore, we continue to pursue direction in both definition and application as it relates to transport contribution of uncontrollable and background ozone concentration at local sources.

From a scientific perspective, improvements to understanding background ozone are being developed using collateral model attribution studies among EPA, NOAA, NASA, states, and international organizations looking to reduce the uncertainty involved with boundary conditions and the relative international contribution to domestic air quality problems. Research programs like these are vital and are drastically underfunded. Without substantive direct funding of these projects, much of the work is being performed as an aside to other projects, unacceptable for such an important issue on that critical interface of science and public policy.

In summary, it is absolutely clear that there is an ever-increasing impact of uncontrollable emission sources on the ability of our States to achieve attainment with the current air quality standards. While much work has occurred related to the understanding of background ozone, and international transport's contribution to locally observed air quality concentrations, we still have a long way to go in understanding the contribution of these sources and improving the models and methods used to quantify and qualify their use in a regulatory framework.

I thank you for your time and this opportunity to present this information before the Committee, and I will be happy to answer any questions that Members have on this topic.

[The prepared statement of Mr. Stella follows:]

Written Testimony

Gregory Stella

Alpine Geophysics, LLC

U.S. House of Representatives Committee on Science, Space, and Technology

June 21, 2018

Mr. Chairman and Members of the Committee, thank you for giving me the opportunity to testify today regarding information related to the estimation and usage of background ozone concentrations in regulatory modeling. I especially would like to thank Representative Biggs for the invitation to appear before you.

INTRODUCTION

As air quality scientists, one of our main objectives is to reduce and understand the uncertainty involved with modeling ozone concentrations in past, current, or future timelines. Each data input, calculation, model, or method that supports our analyses have their own uncertainties that need to be studied in order to understand the impact of these elements on policy decisions.

To this end, there are a number of categories of pollutant concentrations that have inherent uncertainty in a regulatory sense. One of those categories is background ozone.

Background ozone has historically been defined as amounts of pollutant concentrations that are produced by sources other than people. Because amounts of ozone measured at ambient air quality monitors cannot be separated into background or anthropogenic origin, this amount needs to be determined using photochemical modeling and source apportionment tools. We know that many sources of background ozone are global in origin, and the fact that ozone is not emitted directly, rather, it is formed by reaction of hydrocarbon and nitrogen species in the presence of sunlight complicates the linkage of particular emissions to downwind ozone concentrations.

As is shown in Figure 1, the last decade has seen significant improvement in ozone air quality over most of the U.S., based on the 4^{th} highest observed regulatory value (design value); however some parts of the country have seen flatter trends or even elevated levels of ozone largely thought to be the increased contribution of background ozone (Figure 2).

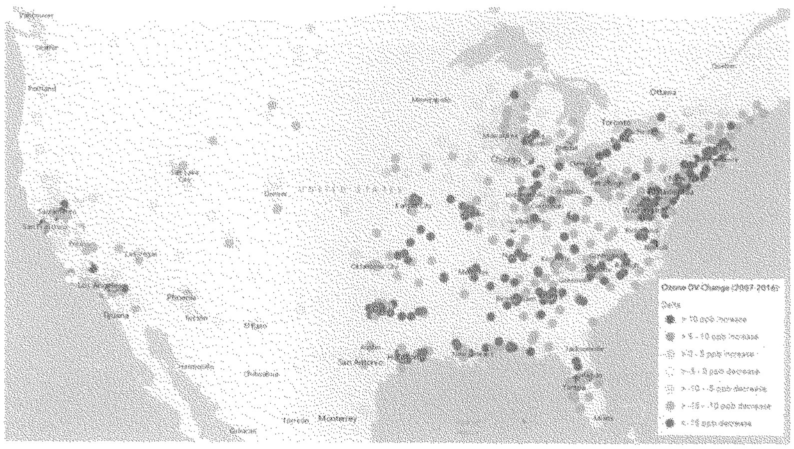

Figure 1. Trends in 2007 to 2016 MDA8 3-year ozone design values (parts per billion by volume; ppb) at AQS sites with a complete data record. Data Source: https://www.epa.gov/air-trends/air-quality-design-values

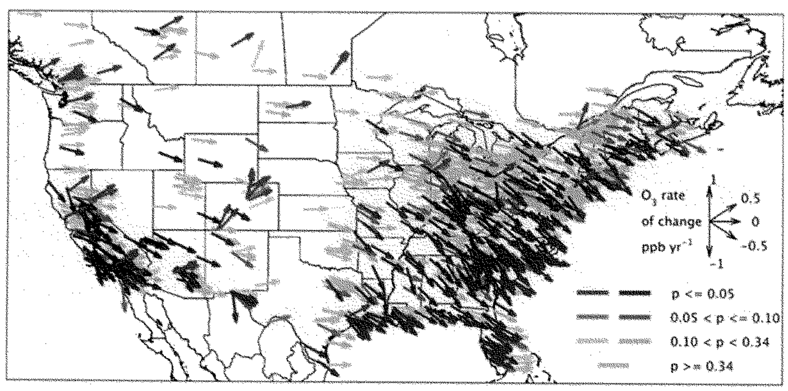

Figure 2. Trends in summer daytime average ozone, 2000 to 2014, 4[th] high maximum daily 8-hour ozone across all sites. Source: Tropospheric Ozone Assessment Report (Schultz et al., 2017)

BACKGROUND OZONE MODELS

As an air quality community, we use global chemistry models like Goddard Earth Observing System – Chemistry model (GEOS-CHEM), Model for OZone And Related chemical Tracers (MOZART), or Geophysical Fluid Dynamics Laboratory – Atmospheric Component 3 (GFDL-AM3) to derive boundary conditions, which include background emissions, to inform our regional models. What this means is that we generate global concentrations of ozone at very coarse scale and mesh them with our own regional and local modeling platforms which are of a much finer granularity.

These estimates are informed by global emission inventories of varying quality depending on the state-of-science in each source county. Here in the U.S., we support the global models with our EPA-generated National Emission Inventories (NEI), arguably of the highest quality in the world that uses continuous emission monitors, regular stack testing, and model generated quantification oftentimes corroborated with on-ground measurements. For other counties without regulatory agencies or support in inventorying its emitting sources, these data may be developed in a top-down manner using methods like population-based emission factors. To this we add regional background concentrations from models that estimate biogenic or wildfire emissions and complete the platform with our national inventories of anthropogenic sources.

One of the greatest challenges we face in using these global models is the scaling of the coarse information to match the configuration of our regional models. Each model may have a different temporal, spatial, or chemical composition compared to the regional configurations and yet provide information of great importance to our regional and local-scale policy-informing science.

For the background categories that are generated within the U.S. boundaries, we also use models to derive biogenic emissions or NOx from soil, either natural or fertilized. Models like the Biogenic Emission Inventory System (BEIS) or Model of Emissions of Gases and Aerosols from Nature (MEGAN) estimate the emission of gases and aerosols from terrestrial ecosystems into the atmosphere. Driving variables include landcover, weather, and atmospheric chemical composition. However, even with the higher quality data available to us to support these models, different versions of our biogenic models can have widely ranging results for speciated components of ozone precursor emissions leading to increased uncertainty in our background calculations.

Wildfire emissions can be based on models, like the SMARTFIRE2 system, to estimate wild land fire emission estimates augmented with local activity data (acres burned, types of fuels, fuel consumption values, etc.) obtained from ground-level surveys to make emission estimates for both wild and prescribed fires more accurate. Other options include the Fire INventory from the National Center for Atmospheric Research (NCAR) (FINN) that uses satellite observations of active fires and land cover, together with emission factors and estimated fuel loadings to provide daily, highly-resolved (1 km) open burning emissions estimates for use in regional and global chemical transport models.

CONTRIBUTION OF BACKGROUND TO MODELED OZONE CONCENTRATIONS

When we look at all these factors and run our source apportionment tools on the resulting modeling platforms, we, EPA, and others have found that background ozone can range from 10 percent of the modeled contribution to close to 90 percent on any single modeled day. Over an entire year, this can average to greater than 50 ppb of total modeled ozone depending on location; with higher background contribution seen in the western, high elevation monitor locations. This is a large fraction of the current 70 ppb ozone standard and can make it very difficult, if not impossible, for many regions of the country to attain the NAAQS. Figure 3 represents the source apportioned contribution of U.S. anthropogenic emissions compared to the regulatory design value (4^{th} highest observed day) for a 2011 modeling episode. In this example from EPA, as much as 85 percent of modeled ozone in the western Rockies region comes from categories other than U.S. anthropogenic sources with a minimum of no less than 18 percent contribution across the rest of the country.

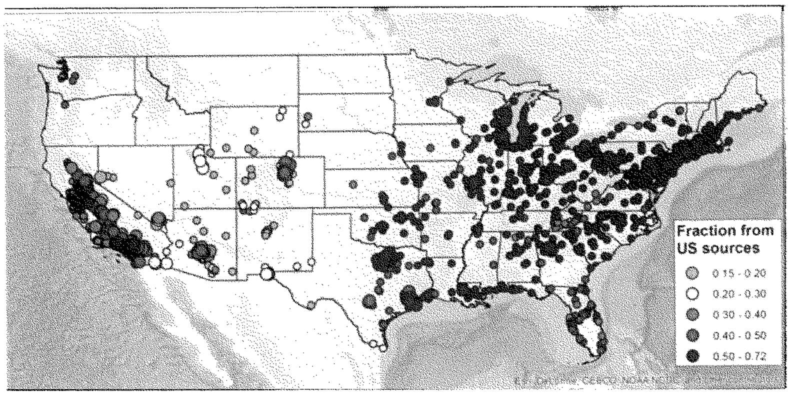

Figure 3. Map of estimated anthopogenic U.S. contribution to ozone design values based on CAMx source apportionment modeling (2011). Larger circles represent sites with 2015 DV2 > 70 ppb. Source: Dolwick, P. Mid-Atlantic States Section Annual Workshop, "Ozone: Challenges, Trends, Strategies, and New Developments." New Brunswick, NJ, October 12th, 2017.

An overall impact assessment of the influence of background ozone with respect to boundary condition modeling is extremely important as the level of the ozone NAAQS decreases and the relative contribution of boundary condition emissions increases. In many parts of the country, the contribution of controllable U.S. sources is a small portion of the overall ozone concentration which includes both background and local contribution. As the incremental cost of every ton of emissions increases, a diminishing rate of return on U.S. control programs impacting air quality, nationally, regionally, or locally is being observed with historically comparable levels of emission reductions.

REGULATORY IMPACT OF BACKGROUND OZONE

The importance of transported pollution has long been understood. The Clean Air Act has provisions to account for it. Section 179B of the Clean Air Act states, with respect to ozone, that *"any State that establishes to the satisfaction of the Administrator that, with respect to an ozone nonattainment area in such State, such State* *would have attained the national ambient air quality standard for ozone by the applicable attainment date, but for emissions emanating from outside of the United States"*.

In the 2008 ozone SIP Requirements Rule, the EPA stated that a Section 179B demonstration could include consideration of any emissions from North American or intercontinental sources. (80 FR 12293). The EPA also stated at that time that it did not believe use of section 179B was limited to nonattainment areas adjoining international borders.

More recently, however, in the *Proposed Implementation of the 2015 National Ambient Air Quality Standards for Ozone: Nonattainment Area Classifications and State Implementation Plan Requirements* (81 FR 81276), EPA requested comment on narrowing the scope of the Section to just international border states based on its anticipation that section 179B will most often be used by states with areas along the border with Mexico and Canada and the Agency's historic use of its CAA section 179B authority to approve attainment plans in the immediate vicinity of the Mexican border, including El Paso, Texas, Imperial Valley, California, and Nogales, Arizona.

So when that leap is made from science to policy, the various definitions of uncontrollable ozone sources become important to consider. For example, baseline ozone, or U.S. background, or global background, or global anthropogenic background, or international exceptional events have all been cited as applicable to 179B petitions and potential regulatory relief under the "but for" clause of this section of the Act.

This is also similar to what is seen in the application of the exceptional events rule (Section 319 of the Clean Air Act), another regulatory definition, that allows a state to request elimination of a high concentration day from its design value calculation when influence is proven from contribution from a non-recurring, uncontrollable event like a wildfire, dust storm, stratospheric intrusion, or other internationally influenced event. EPA has recently made the process easier for states to make an exceptional event exclusion request in addition to other improvements underway at the Agency and elsewhere to address these issues.

However, to be clear, relief using 179B or exceptional event exclusion does not give anyone cleaner air to breathe. It simply recognizes a regulatory reprieve based on the language of the law. In the air quality community these options are not be seen as a "free pass" to pollute. Rather this is seen as a reality that must enter into the regulatory discussion and be understood in order to develop control programs that maximize air quality benefit with minimal societal disruption. Unfortunately, there is vague regulatory clarity on exactly what could be considered in many of these cases and therefore we continue to pursue direction in both definition and application as it relates to transport contribution of uncontrollable and background ozone concentrations at local locations.

CURRENT WORK UNDERWAY

The current state-of-science related to global background ozone modeling indicates that these models can provide key inputs to regional modeling activities. However, at this time, what is important to the global modeling community is not what is important to the regional modeling community. It is up to us to use the data responsibly which means we first need to understand the inputs. Like our own national inventory, global emissions are not constant and therefore background contributions also vary from year to year. Understanding these changes to adequately include and project future years' background concentrations is extremely important if we are to define effective national, regional, or local control programs.

Nationally, we also need to understand how changing climate is related to increasing wildfire activity and international emissions; how changes in land use and drought conditions can impact biogenic background emissions; and how our own control programs can be limited by the increases in uncontrollable source contribution.

From a scientific perspective, improvements to understanding background ozone are being developed using collaborative model attribution studies among EPA, NOAA, NASA, states, and international organizations looking to reduce the uncertainty involved with boundary contribution and associated relative international contribution to domestic air quality problems. Several of these are long-term programs, like the Task Force on Hemispheric Transport of Air Pollution (HTAP) organized under the UNECE Convention on Long-range Transboundary Air Pollution (LRTAP) has been looking at improving the assessment of the quantification, temporal and spatial distribution, halogen chemistry at the global scale, vertical transport between the free troposphere and the boundary layer, international contribution, evaluation of concentrations aloft in elevated layers, and consistency in the coupling of global models to regional models. Research programs like these are critical and are drastically underfunded. Without substantive, direct funding of these projects, much of the work is being performed "on the side" of other projects; unacceptable for such an important issue on that critical interface of science and public policy.

Additional support for these programs will allow us to better understand the uncertainty involved in this area and provide the technical information necessary for states to develop plans for attaining national ambient air quality standards.

SUMMARY

In summary, it is absolutely clear that there is an ever increasing impact of uncontrollable emission sources on the ability of our states to achieve attainment with the current air quality standards. While much work has occurred related to the understanding of background ozone and international transport's contribution to locally observed air quality concentrations, we still have a long way to go in understanding the contribution of these sources and improving the models and methods used to quantify and qualify their use in a regulatory framework.

I thank you for your time and this opportunity to present this information before the Committee, and I am happy to answer any questions that Members may have on this topic.

Gregory Stella

Senior Scientist and Managing Partner

Alpine Geophysics, LLC

Mr. Stella is internationally recognized as a technical authority in the modeling and policy application of emission inventories for ozone and particulate matter pollutants and precursors. For over twenty-five years he has coordinated with both public and private workgroups, modeling centers, and stakeholders to develop, evaluate, and apply control measures and program designs in support of emissions and air quality policy decisions.

Prior to joining Alpine Geophysics in 2003, Mr. Stella was at on staff at EPA's Office of Air Quality Planning and Standards where he managed and prepared the emission inventories, control strategies, and associated temporal, spatial and speciation data for the Regional Transport NOx SIP Call, Section 126 rulemaking, Tier-2 tailpipe standards, 1-hour attainment demonstrations, Heavy-Duty Diesel Engine standards, Multi-Pollutant legislation, Clear Skies Analysis, and US/Canadian Air Quality Agreements. Mr. Stella is a recipient of two U.S. EPA Gold Medals for the NOx SIP Call Rulemaking (1999) and the Tier-2 Tailpipe Standard (2001); projects in which he participated while at EPA.

Mr. Stella received his Bachelors of Science degree in Chemical Engineering from the Johns Hopkins University in Baltimore, Maryland.

Mr. NORMAN. Thank you, Mr. Stella. I want to thank all the witnesses for testifying.

The Chair now recognizes himself for five minutes of questioning.

This is up close and personal for me, this topic. I'm a real estate developer, and to have companies to come into an area and to be on the verge of breaking ground, and then to be put into nonattainment status is tragic. And Ms. Rath, your chart showing 20 percent—80 percent basically comes from outside with no control is real.

So I direct my first question to Mr. Franquist. Can you explain the remedy a State can get from a successful 179B demonstration for international ozone?

Mr. FRANQUIST. Mr. Chairman and Members of the Committee, I can. That's what's referred to as the 179B International Transport Demonstration. The relief really looks like this. What it does is what's commonly referred to as a "but for" analysis is that under the Clean Air Act, if you don't meet a standard within the given time, you're automatically bumped up to the next higher classification of nonattainment. Under the 179B, if you can make that demonstration successfully, that will simply stop that bump up to the higher nonattainment area classification.

The challenge there is you're still in that nonattainment classification, until which time—in this case for us in Arizona, we're waiting for international emissions to drop. So the relief looks a lot like perpetual nonattainment. It looks a lot like nonattainment NSR for potentially decades, if we're waiting on international emissions to decrease.

Mr. NORMAN. Do you believe that this is a sufficient remedy compared to the amount of ozone that comes from international sources that affects the attainment?

Mr. FRANQUIST. Mr. Chairman and Members of the Committee, I do not. Again, in my testimony I want to make it very clear that we're not disputing some of the health challenges of ozone, but what often gets lost in this conversation is the health effects of poverty. And so when we look at areas like Yuma, Arizona, 19 percent unemployment, 19 percent of the residents there live below the poverty line, healthy economies matter.

And so when we're looking at public health holistically, we do need to look at how these remedies, or lack thereof, actually really, truly do protect the residents of those nonattainment areas.

Mr. NORMAN. You're from Arizona. How do the strict ozone regulations drive business away from rural counties?

Mr. FRANQUIST. Mr. Chairman and Members of the Committee, it becomes a discouraging factor. It's a very simple analysis. If you're going to have to do emission offsets, they range in Arizona anywhere from $5 to $10,000 per ton, or you can look to an area that isn't an attainment area. It's a very easy economic choice. You're going to go to the area that does not have the nonattainment area issues. So it discourages large businesses.

I would say the other challenge with what we call the traditional offset piece is that normally if a business was looking to get those offsets, what they would do is either shut down a business and capture that headroom with those emissions, or put on a pollution control device on an old business and capture those emissions. What that does is simply shuts down a business. That may not be a net gain in jobs, so that business even may be able to come into that nonattainment area, but from a job perspective, it may be a net zero or even a loss of jobs, depending on what facility they decide to shut down to get those offsets.

Mr. NORMAN. So why can't the businesses in rural counties offset ozone emissions like the businesses do in the cities?

Mr. FRANQUIST. Mr. Chairman and Members of the Committee, typically under the traditional offset programs, what you're looking to do is what I just explained, either shut down a business or put pollution controls on an existing business. When you're in a rural area, those businesses, those large companies—or even small companies—to get those offsets, are scarce to nonexistent. So when you look in the Yuma area, we simply just don't have the large heavy industry there to even generate offsets. So we have to look to what's considered non-traditional offsets, things like captured fleets, electrification of truck stops, but it's extremely difficult to generate those non-traditional offsets and also get a rule through with the EPA, because it's very difficult to prove how you qualify and enforce some of those offsets. So for the most part, states and local areas do not chase down the non-traditional offset programs.

Mr. NORMAN. Okay. Mr. Stella, what type of parameters go into the models that examine background ozone, and do you consider them reliable?

Mr. STELLA. Thank you for the question, Mr. Chairman.

There are a number of parameters related to both emissions inputs or meteorology, or even the chemistry of ozone formation that go into our local scale models, and these are largely informed by the global community. The inventories that we have here in the United States are of a higher quality than those that go into the global model, and so when we try to mesh the two, we need to best understand exactly what we're putting into our simulations.

Right now, it's the what goes in comes out sort of paradigm of the modeling, and until we can improve and understand what those conditions are, we're going to be at a loss at fully quantifying and qualifying how much international or boundary condition impact we have on our local scale monitors.

Mr. NORMAN. Thank you. The Chair now recognizes Ms. Bonamici for five minutes for questioning.

Ms. BONAMICI. Thank you, Mr. Chairman, and before I ask my questions, I want to point out that Dr. Craft included in her submitted written testimony excerpts from the American Lung Association's State of the Air 2018 study, and she notes that in her home State of Texas, there were over 400 orange, red or purple high ozone days. Fourteen counties received a grade of F in Texas for ozone pollutions. I know there are a lot of Texas members on this Committee and I wanted to point that out.

Dr. Craft, environmental challenges are often disproportionately felt by some of our most vulnerable populations. That includes children and the elderly, but also the economically disadvantaged of all ages. Some opponents of Federal ozone standards attempt to use this as a justification for not acting on air pollution by claiming that the cost of implementation will fall on impoverished communities, then suggesting that it would be better for these communities to suffer the effects of the pollution than to bear the costs.

Also, I noted Chairman Smith in his opening statement said that the NAAQS standards we're discussing today create burdens without clear benefits, so Dr. Craft, can you respond to the idea that these populations would be better off without regulations? What are the public health costs of not implementing the current standard?

Dr. CRAFT. Yes, I'd be happy to share some information about healthcare cost numbers.

Two of the largest respiratory disease challenges that we have in this country are COPD and asthma. COPD is actually the third most common cause of death in the United States. In 2014, medical costs for COPD in the U.S. was $36 billion and projected to be $50 billion by 2020. Seventy-six percent of those medical costs were primarily paid for by Medicare and Medicaid.

For asthma, peer reviewed research from this year indicates asthma costs the U.S. economy more than $80 billion annually and medical expenses, missed work days, and school days, as well as premature death.

Ms. BONAMICI. Thank you, and Dr. Craft, in your testimony you mentioned that anthropogenic sources, rather than background ozone, are the main driver of unhealthy ozone levels. And you also talk about how emissions reduction strategies do exist, but as you mentioned, they are often not implemented.

We have great potential in this country for innovation. So can you talk about the over-emphasis of background ozone and the downplaying of anthropogenic sources of air pollution by opponents of strict ozone standards, why are known emissions reductions technologies not being implemented, and what can the EPA do to encourage or enforce the use of these emissions reduction strategies?

Dr. CRAFT. Right. So there are a couple of things there.

One thing that I wanted to highlight is the way that the design values are calculated in this country to determine attainment or nonattainment is that areas look at the fourth highest average over the past three years. So it's not that an area has come into attainment or out of attainment based on some annual percentage of ozone.

So the question of background really needs to look at is background contributing to exceedance of the design value, not an exceedance of the 8-hour daily. So I just wanted to clarify that a little bit.

Could you repeat the last question that you mentioned?

Ms. BONAMICI. Yes, about the technologies. Is there some reason why—I mean, you suggested that there are technologies that exist, but they're not implemented. What are the technologies that are not being implemented and what can the EPA do to encourage or enforce the use of these emissions reduction strategies?

We've had conversations on this Committee before about regulation and policy driving innovation and technology changes, so can you talk a little bit about that?

Dr. CRAFT. Yes, and since we are talking a lot about the intermountain West, I wanted to mention a lot of controls that have been developed over the last couple of years regarding pollution controls for oil and gas development. Peer-reviewed publication from the Cooperative Institute for Research and Environmental Sciences examined the oil and gas sector's contribution to ozone formation on Colorado's front range, specifically focusing on days that exceeded the ozone NAAQS. The study found that on individual days, ozone and gas ozone precursors can contribute in excess of 30 part per billion to ozone concentrations and could be the primary driver of exceedance of the ozone NAAQS.

There are new pollution controls that have been implemented. Administrator Pruitt has issued a stay on those controls, and so right now we're not getting the benefit of those pollution controls in limiting excess emission—controls that would save the oil and gas sector money.

Ms. BONAMICI. Was there a reason stated for that—implementing that stay?

Dr. CRAFT. Not that I know of.

Ms. BONAMICI. I see my time is expired. I yield back. Thank you, Mr. Chairman.

Mr. NORMAN. Thank you. The Chair now recognizes Chairman Smith for his questions.

Chairman SMITH. All right. Thank you, Mr. Chairman.

Mr. Chairman, first of all I'd like to point out that Ms. Bonamici in her mentioning of the 14 counties in Texas that were not in attainment omitted the fact that there are 254 counties in Texas. Fourteen out of 254 ain't bad, particularly when in many of those counties, if not all of them, much of the ozone is international ozone from Mexico. My guess is that if Oregon were subjected to 75 percent of the ozone in that State coming from Canada, she might have a different view of the attainment restrictions and the application of NAAQS.

But I'd like to address my first question to Ms. Rath, and that is what has San Antonio done to remain in attainment with the 2008 ozone NAAQS?

Ms. RATH. Thank you very much, Mr. Chairman. I really have to salute both our public and our private entities for what they have implemented voluntarily out of concern for the health to ensure they are in compliance. We have had very aggressive action taken.

CPS Energy, which is our municipally owned electrical utility company, has been very, very aggressive to reduce the demand for electricity from coal-fired power plants. They implemented programs and the savings were equal to shutting down a medium-sized coal plant. They met their goal of producing 1,500 megawatts of renewable energy capacity two years ahead of schedule, and this is equal to 20 percent of their power generation. And that portfolio includes both wind, rooftop solar, and utility scale solar.

I have to really thank CPS Energy for two aggressive actions they will be doing this year that will have a significant impact upon our ozone precursors.

Chairman SMITH. Okay.

Ms. RATH. They are shutting down the Deeley plant, which is our largest and oldest coal-powered plant, shutting that down early which will have a significant improvement, and they've made tremendous investment of the technology at our remaining Spruce plant for that.

In addition——

Chairman SMITH. Okay. Let me go briefly to my next question, which is what are some of the economic consequences of a non-attainment designation?

Ms. RATH. Yes, sir. Last year, we contracted with economists at St. Mary's University to look at the cost of nonattainment in Bexar County, and at a marginal classification, the low estimate is over $117 million annually. The high estimate is over $1 billion annually. So for every year we're in nonattainment, there's a potential for over $1 billion cost to just our eight county MSA.

Chairman SMITH. Okay, and that has an impact on economic growth and jobs and income and everything else. Okay.

Ms. RATH. Very much so, yes, sir.

Chairman SMITH. Let me ask a final question to all of our panelists here today, and that is should international ozone be taken into consideration when applying NAAQS to various regions in the U.S.? Okay, Ms. Rath?

Ms. RATH. I certainly think it should. How can you hold a community or a region responsible for what's totally and completely outside of its control? If they would take international transport in consideration, we would be well under the limit because we're barely exceeding it, 72 and 73 parts per billion at our two regulatory monitors.

Chairman SMITH. Okay, thank you, and Mr. Franquist?

Mr. FRANQUIST. I would agree with Ms. Rath. I think we have to take it into consideration, especially when we're seeing studies indicate that 83 percent of the ozone in Southern Arizona is from international sources.

Chairman SMITH. Okay, thank you. Dr. Craft?

Dr. CRAFT. I would actually disagree with Ms. Rath. I would point to the 2015——

Chairman SMITH. Let me make certain I understand you. You do not think international ozone should be taken into consideration?

Dr. CRAFT. I guess what I'm saying is that if—are you talking about San Antonio specifically?

Chairman SMITH. No. No, just in general should international ozone be taken into consideration when we apply NAAQS to various regions in the U.S., wherever it might be? In other words, obviously San Antonio is an example. If you've got 75 percent of the ozone being international ozone, should that be taken into consideration?

Dr. CRAFT. Well there's two things. One is that international transport is actually a very small percentage of the ozone in the region.

I wanted to point out one inaccuracy in Mr. Franquist's opening statement——

Chairman SMITH. I'll tell you what, before you go to the other witnesses, I'd just like an answer to my question. And really, it's yes or no. Should the international ozone be taken into consideration when applying NAAQS?

Dr. CRAFT. It is taken into consideration.

Chairman SMITH. Okay. So you're saying it should be?

Dr. CRAFT. It is already, yes.

Chairman SMITH. Okay. Well saying it is doesn't answer the question as to whether you feel it should be.

Dr. CRAFT. Saying it is is saying that it is already being taken into consideration.

Chairman SMITH. And you agree with that?

Dr. CRAFT. All sources of ozone are taken into consideration in regard to the NAAQS.

Chairman SMITH. But you agree that international ozone should be taken in consideration? I assume you're saying yes.

Dr. CRAFT. Yes, it already is.

Chairman SMITH. Okay, thank you. Mr. Stella?

Mr. STELLA. From a designation perspective, I would have to say that I would agree that it is and I don't necessarily think that you can quantify that amount as you go into the designation. But from an attainment demonstration perspective, I do believe that international emissions need to be accounted for. But we have to be cautious because of the large uncertainty in predicting that amount.

Chairman SMITH. Fair enough.

Thank you, and thank you, Mr. Chairman.

Chairman BIGGS. Thank you. The Chair recognizes the gentlelady from Texas, Ms. Johnson.

Ms. JOHNSON. Thank you very much, Mr. Chairman.

I have some concerns myself about the consideration of international. Does it—when you have the ozone pollution, no matter what the source it still has an effect on health, right?

Dr. CRAFT. That's correct.

Ms. JOHNSON. So are you aware of any efforts that have been made to mediate some of that where you have an international influence?

Dr. CRAFT. Yes, EPA has actually addressed that very issue a couple of times. What I was trying to reference a bit earlier was the technical support document which was released. It's entitled "Intended Area Designations for the 2015 Ozone National Ambient Air Quality Standards Technical Support Document" that references some of the work in San Antonio. On page 21 of that technical support document, it says "From the same modeling results, a more reasonable estimate of the impacts from manmade emissions from Mexico is on the order of less than 1 part per billion," so 1 to two percent of the ozone projected for 2023 in San Antonio. That's one piece.

I wanted to also clarify one of the references made by Mr. Franquist. He mentioned 65 percent of ozone increase in the Southwest is coming from Asia. The paper that he's referencing is actually a Lin paper, and the reference is 65 percent of the increase in background, not total ozone. So that's actually less than a part per billion. I'd like to just make sure that that's accurate for the record.

Ms. JOHNSON. Now Dr. Craft, in your testimony you discuss EPA's delay in determining whether San Antonio meets the 70 parts per billion standard set in 2015. This delay is despite the fact that monitors have detected exceedances for years. What is causing that delay? Are you aware?

Dr. CRAFT. As far as I am aware, EPA is the cause of that delay. It was only in response to a lawsuit filed by States and public health and environmental organizations that EPA has even taken initial steps to identify certain areas of the country that do not meet the 2015 standard. This comes almost an entire year after the designations were due, meaning that communities with unhealthy levels of ozone will face another summer without solutions in place to clean up the air.

I wanted to highlight an additional issue that's going on in San Antonio. It is correct that ground—that folks on the ground in San Antonio have stepped up to support clean air policies. Unfortunately, the Governor of Texas vetoed clean air planning dollars for the region of San Antonio. Over a million dollars' worth of planning dollars are gone as part of a line item veto by Governor Abbott. He claimed that he wanted planning dollars to go to nonattainment areas. San Antonio, for all intents and purposes, is actually not in attainment. It's not officially designated, but it has exceeded the 70 part per billion standard for several years now.

Ms. JOHNSON. Well I'm from Dallas, and we don't have San Antonio that close around, but we are seeing more and more children and seniors getting asthma.

Have you seen any effect of that in your research in San Antonio, and what—does that make the cost and the costs on health important or not?

Dr. CRAFT. Of course, yes. I also wanted to highlight to that point very recent evidence from studies published within the last year solidifying the link between ozone exposure and an increased risk for death. The key study lead author Domenici assessed impacts in 61 million Medicare beneficiaries over 13 years in the United States and found that the risk of death associated with ozone exposure continued below the current NAAQS. That—those 61 million people are Americans who are experiencing health effects at concentrations below the current standard.

Ms. JOHNSON. Thank you very much. My time is expired.

Chairman BIGGS. The gentlelady's time is expired. The Chair now recognizes the gentlelady from Arizona, Representative Lesko.

Mrs. LESKO. Thank you, Mr. Chair. And I want to thank the entire panel for coming here and educating us on this issue. I specifically want to say thank you to Mr. Franquist, who came from Arizona. And while I was in the State Senate, I always had good dealings with your agency, and I think they do a good job.

I think it's really important—I think everybody cares about air quality. I don't think there's a question about that. I mean, my daughter had asthma. My grandchildren sometimes need to use an inhaler as well. But I really think we need to balance that with reasonable measures that we have influence over. So what I heard here today is a lot of it has to do—or at least a large part of it along the border has to do with pollution that comes over from other countries.

I do have a question for Mr. Franquist. Mr. Franquist, what changes would you propose to the current National Ambient Air Quality Standards process to improve the way that it's implemented in the States?

Mr. FRANQUIST. Mr. Chairman, Members of the Committee, I think, first of all, I would start to take a look at the five-year review cycle. Every five years the EPA has the opportunity to take a look at the NAAQS. It seems to be pretty consistent that the NAAQS goes up every single year, and that's challenging for areas that have to put in state implementation plans. You have three years to do that. It seems by the time we implement just the beginning states of state implementation plans, we're right back chasing the tiger's tail again and having to come up with new measures. So I think, you know, that's one place I would certainly start.

Again, one area that, you know, we've been working closely with Senator Flake on is removing some of the nonattainment new source review offsets and lowest achievable mission requirements for those international transport areas. It seems to me if you could make a strong demonstration that those areas are not exceeding the standard but for emissions outside this country—and I'll go back and sharpen my pencil and make sure that the Lin study—the 65 percent increase. What I do know is the U.S. EPA's modeling said 83 percent of emissions in southern Arizona are from outside of this country, and so we do need to take a strong look at how those areas with 19 percent living below the poverty line can find access to good work and therefore good health care. And so, again, I think relieving those areas of layer and offset requirements would be another good place to start.

Mrs. LESKO. Thank you. And, Mr. Chairman, I have one more question.

Chairman BIGGS. Please.

Mrs. LESKO. Thank you. Mr. Franquist, as a follow-up, what has the EPA currently done or what could they continue to do to help the states?

Mr. FRANQUIST. Mr. Chairman, Members of the Committee, we're still awaiting the implementation rule for ozone. Under the past Administration, there was a proposal that these international transport areas would be required to implement reasonable available control measures before the area was reviewed under international transport demonstrations, which simply means that these areas that are shown not to be contributing to those issues would have to go above and beyond, put control measures in place to control emissions that are coming from somewhere else outside this country. So as we look to the EPA to finalize the implementation rule, I think, you know, certainly one area would be not requiring RACM for international transport areas.

Mrs. LESKO. Thank you, sir. I yield back my time.

Chairman BIGGS. The gentlelady yields back.

The Chair recognizes the gentleman from Pennsylvania, Mr. Lamb.

Mr. LAMB. Good morning. Dr. Craft, I believe you're aware that in 2016 EDF worked with Peoples Gas and Carnegie Mellon University on a methane mapping study, basically that I think was designed to identify areas of methane leaks and figure out how Peoples and their partners could remedy them. Could you talk a little bit about that project and how it's related to ozone reduction?

Dr. CRAFT. Sure. So EDF partners with science; we partner with the private sector. The work that we have done looking into methane issues was done—that particular project was done in partnership with Google. What we did was we outfitted the Google street-view cars with methane sensors, and we drove around cities detecting methane leaks. These were primarily coming from pipelines around the city.

And we drove around a couple of cities in the United States, Boston, Indianapolis, Pittsburgh, as you mentioned, and one of the things that we noted was that the older the cities, the older the pipeline infrastructure, generally the more leaks that are there. That's important because methane emissions actually contribute to ozone formation. Globally, you can see that methane emissions are actually on the rise and contributing to estimates between 1 and 3 part per billion.

We are very interested in trying to curb those methane emissions in part because of the climate impacts. Methane is 84 times more potent as a greenhouse gas warmer over 20 years as compared to carbon dioxide. We are investing millions of dollars in launching a satellite to measure ground-level methane around the world. That's how important we think that issue is. If we can curb methane, we can actually prevent some of the ozone that is formed by those releases.

One additional item that I wanted to mention is that our organization has a peer-reviewed paper that is actually going to be coming out today looking at methane emissions and looking at the underestimates that—in terms of emissions inventories that exist.

Mr. LAMB. I'd really like to take a look at that. If you could send us a copy, I'd appreciate it.

Dr. CRAFT. Sure.

Mr. LAMB. Are you aware of—what were the gas companies able to do after that study took place in order to remedy the situation?

Dr. CRAFT. So the main thing that they were able to do is to replace those leaky pipes, and what we were able to do through our work was to highlight where the leakiest pipes were so that they could prioritize. I don't think anyone expects anyone to go in in a week and replace all of the pipes under an entire city, but if you know where the biggest leaks are, you can prioritize those, go in and address them, and get those reductions. It saves everybody money if we're not leaking natural gas from these pipelines.

Mr. LAMB. And do you think there's anything that we can do here to encourage similar partnerships or larger-scale projects based on the one that you guys did?

Dr. CRAFT. I mean, one thing is that we need to go back and make sure that there are pollution controls from the oil and gas sector generally. Those federal rules have been in place to protect everyone across the country. It would help tremendously to Intermountain West if we could—there are places in Wyoming that never had an ozone exceedance day before some of the oil and gas activity ramped up. So if we put those commonsense pollution controls on that save money, then that helps everybody.

Mr. LAMB. Great. Thank you. Mr. Chairman, I yield back.

Chairman BIGGS. The gentleman yields back.

The Chair recognizes the gentleman from California, Mr. Rohrabacher.

Mr. ROHRABACHER. Thank you very much. I'm trying to catch up. Sorry I'm late but it happens here in Washington. You got five different things you got to do and they're all important. And I think this is an important hearing because we need to be educated about this quite frankly, and I'm not educated about it, so I appreciate you sharing some of your knowledge.

To the whole committee, what percentage of the atmosphere is ozone? What are we talking about here? What percentage of the atmosphere is ozone? We know how much the CO_2 is. We kind of know what methane is. Ozone isn't a percentage of the atmosphere?

Mr. STELLA. That's an interesting question. I think from a holistic value, I'm not sure that that can be answered adequately. I think the measurements that we tend to take are more on a regional and local scale, and so we look at the ambient conditions sort of respective of individual areas.

Mr. ROHRABACHER. So the fact that we may not have a global problem here but we have a problem in places?

Mr. STELLA. Well, I think there is absolutely a global problem, and I think what we're focusing on here today is how that impacts us locally.

Mr. ROHRABACHER. Does anybody else——

Dr. CRAFT. Well, I guess I'll just add. So there are different types of ozone. We have ground-level ozone, and that's the ozone that is harmful. That's why we regulate it across the country. There's also stratospheric ozone, and that actually is protective. It protects us from UV radiation coming from the sun.

Mr. ROHRABACHER. Okay.

So there's good ozone and bad ozone?

Dr. CRAFT. Good ozone and bad ozone. One of the issues in the Intermountain West, which is why it's a challenge, is that in some of these high-elevation places, what happens is there are stratospheric intrusions meaning that some of the ozone, the good ozone that's in the stratosphere, can actually intrude into the troposphere and contribute to some of the ground-level ozone problem.

The other issue with high-elevation areas is that the chemistry of ozone is a little bit different. It sticks around a little bit longer. And that's where you see sort of some of the pollution issues coming in, blowing in from other States and whatnot.

Mr. ROHRABACHER. So we—and I know that's what the subject of the hearing is is we want to focus on what's happening and how it impacts on health in terms of the lower level and that really has very little to do with the higher level of ozones.

Dr. CRAFT. Correct. So we're talking about ground-level ozone here.

Mr. ROHRABACHER. Okay. And you were mentioning how different dealings—and again, I'm an amateur on this. This is not something—I'm happy you're here to tell us about it. There are leaks from oil and gas—and I remember in California we had a huge problem, a health problem, and then we were requiring things on the engines of our cars that cut down ozone. And was that something—was the ozone higher before that and then we made it lower because of that? And did that impact on health?

Dr. CRAFT. So ozone is actually not a primary pollutant. What that means is that ozone is actually formed by different precursors. So what happens is in the presence of heat and sunlight and volatile organic compounds and nitrogen oxides, all of that mixes and there's a chemical reaction that actually forms ozone. That's why it's one of the trickier pollutants to manage because it's not a primary pollutant; it's a secondary pollutant. That's what we call a secondary pollutant.

Mr. ROHRABACHER. Coming from southern California, I can still remember people talking about ozone. Are we healthier? Did we handle that with what we did on our engines? Because I know that cost a lot of money in terms of gas mileage, et cetera, but are we healthier because of that now?

Dr. CRAFT. You are healthier because of that. If you look, there's actually work done in southern California by a prominent researcher Gauderman, who's actually been able to demonstrate the improvement in children's health because of the reduction in air pollution generally. So we know that these controls work and that they lead to better health outcomes.

Mr. ROHRABACHER. Well, we know generally, but I was thinking about ozone and—do we know—does—is there someone else want to jump in on that?

Ms. RATH. Congressman, I'll be glad to say that we appreciate the controls and the impact it's making, particularly in the NOx because in our area the VOC is a very small contributor to our ozone precursors.

I would like to address your question about the oil and gas, and I have to salute the energy companies that operate in the Eagle Ford Shale. Last year, the highest production of oil came out of the Eagle Ford Shale, particularly Karnes County, more than any place else in the world. And the energy companies that are operating in south Texas have made significant investments in technology to really respect people's health and to take those measures to really lower their emissions.

So the emissions from the oil and gas industry in our area is a very small contributor. I certainly can't speak to what's going on in the West, but I want to be very clear that that is not a primary contributor in our area at all.

Mr. ROHRABACHER. Well, what is the primary contributor?

Chairman BIGGS. Unfortunately, the gentleman's time is expired.

Mr. ROHRABACHER. Oh, pardon me.

Chairman BIGGS. Sorry. Sorry, Mr. Rohrabacher.

I now recognize the gentleman from Virginia, Mr. Beyer.

Mr. BEYER. Thank you, Mr. Chairman. Thank you all very much for being with us.

I would like to talk for a minute about the "once in, always in" policy legal history. And, Dr. Craft, EPA's repeal memo claims that the "once in, always in" policy violates the plain language of the Clean Air Act. Was the policy ever challenged in the courts in its 27-year history?

Dr. CRAFT. The policy has been around for roughly a quarter of a century, and as far as I know, it has—actually, I'm not sure about that, whether it's actually been legally challenged.

Mr. BEYER. It was a rhetorical question because at least our evidence shows that it's never been questioned in court. And what's remarkable is that the new EPA Assistant Administrator William Wehrum filed suit against the EPA 31 times when he was in private practice, and he's the primary person behind this memo, and yet he never challenged it as a private citizen either.

You know, the decision to increase hazardous air pollutants, carcinogens, and neurotoxins is completely irresponsible, and this decision is even more reckless today given that we know we can successfully control them with operating control devices, long-range applicable regulations. And it's the responsibility of the EPA to continue to guard the health and human environment against potential harms. And that's why I led a letter with Congresswoman Dingell with 87 cosponsors asking Administrator Pruitt to reinstate these longstanding toxic air pollution protections. And, Mr. Chairman, I ask that this be admitted to the record.

Chairman BIGGS. Without objection.

[The information follows:]*************** COMMITTEE INSERT ***************

Mr. BEYER. Dr. Clark—Dr. Craft rather, there have been cases made well by your three panelists about background radiation or background ozone levels. And one of the—and you've pointed out in the questions from Chairman Smith that in fact EPA, the Clean Air Act, already takes this into consideration. But one of the questions was that a demonstration can only be submitted after three years of the area not meeting the standard. This was for Yuma particularly. Is three years too long?

Dr. CRAFT. The reason—oh, sorry. The reason for that three-year requirement is that they don't—EPA does not want to penalize an area for having sort of a bad year, so what they do is they average the previous three years to account for any anomalies that might exist. So that's the purpose of the 3 years.

I just wanted to go back and mention your "once in, always in" question. One of the things that we've done as an organization is we've gone through to analyze the potential outcome of reversing such a policy. One of the things that can happen is that this policy—this loophole that's been created applies to major sources of hazardous air pollutants under section 112, and it allows these facilities to reclassify themselves as area sources if they dip below the threshold value, which is 10 tons per year for a single hazard air pollutant or 25 tons per year of a combination of hazardous air pollutants, whereas before, once they were classified as major, they had to continue applying those controls regardless of those emissions.

So in this example a source that had been previously classified as a major for lead and other HAPs, if they went down to one ton per year, they could under the new policy stop applying those maximum achievable control technologies and then increase its emissions back to 9 tons per year, still avoiding being classified as a major source. So that is a critical issue.

And actually, in 2017, EPA issued a fact sheet stating that 1.7 million tons of hazardous air pollution was prevented because of that policy, so that's an important issue I just——

Mr. BEYER. Okay.

Dr. CRAFT. —wanted to go back and clarify.

Mr. BEYER. Okay. Thank you. I have one more key issue. Administrator Pruitt on May 9 issued a memo implying that EPA might consider costs when setting NAAQS standards despite settled Supreme Court precedent. The standards must be based on public health. And I don't think I've ever quoted Justice Scalia positively before, but he wrote the unanimous decision from the Court that only public health factors may be considered. And I'd like to submit another letter for the record signed by 71 Members, Mr. Chairman, objecting to this. But I'd love your perspective, Dr. Craft.

Chairman BIGGS. Admitted without objection.

Mr. BEYER. Thank you.

[The information appears in Appendix I]

Dr. CRAFT. Yes, that is totally outside the specific language of the Clean Air Act to require cost to be considered. Costs are considered in another part of—in terms of implementation, not in terms of setting the policy—the scientific standard itself.

Mr. BEYER. Great. Thank you. Mr. Chairman, I yield back.

Chairman BIGGS. The gentleman yields back.

I recognize the gentleman from Texas, Mr. Babin.

Mr. BABIN. Thank you, Mr. Chairman. And thank you, witnesses, for being here.

Mr. Stella, in your testimony you also state that for the areas that have seen elevated levels of ozone over the last ten years, an increase in background ozone is likely to blame. Can you please elaborate how you know this to be true?

Mr. STELLA. Thank you for the question.

Mr. BABIN. Yes, sir.

Mr. STELLA. Specifically, we don't have values that would allow us to interpret how much of the increased international or background contribution is there, but what we do recognize is that when we run our photochemical models and look at our source apportionment studies, which basically tags the input to the model, follows it through time and space, and then we look at the ozone concentrations at each monitor, we're seeing that as anthropogenic emissions are being applied locally in our States, the ozone concentrations are being offset by an increase from this background contribution component. Now, whether or not that's all international anthropogenic or international biogenic is uncertain, but the studies seem to indicate that, based on our source apportionment runs, the relative percentage of the background ozone is increasing compared to the reductions we're seeing from anthropogenic controls domestically.

Mr. BABIN. Okay. Well, you had mentioned modeling. Would you discuss some of the improvements being made to modeling through collaborations like the one between NOAA, NASA, and EPA?

Mr. STELLA. Absolutely. Some of the work that's ongoing at those agencies include looking at the performance evaluation of the models. Are we adequately predicting and projecting levels of background ozone. And so, for example, along the West Coast of the United States where we have a very clean boundary and we can measure ozone as it comes across the Pacific, studies are being conducted with satellites, with ozone sons, with high-elevation monitors, and so we're trying to capture with better accuracy the amounts of emissions that are coming in without a domestic anthropogenic or biogenic influence. And so those are some of the studies that are being conducted, in addition to looking at the air chemistry involved with the ozone formation as it's developed over the oceans, as well as attempting to better understand the impact of wildfires and biogenics, and so looking at the inputs that go into our modeling.

Mr. BABIN. Okay. Thank you. And then, Ms. Rath, reducing ozone emissions can stifle economic development in a region because of the impacts to construction industry and businesses. Do you have any sense of how much it costs for your area to comply with these regulations?

Ms. RATH. Yes, sir. Thank you. As I had mentioned, we had a study that was performed by an economist at St. Mary's University, and he said that with a marginal designation, our eight-county MSA would have costs at a minimal level of $117 million a year up to a maximum of a little over $1 billion a year, so that's the cost annually if we were to go into a marginal status of nonattainment. And then we also have the figures for moderate.

And if I may, Congressman, I would like to say——

Mr. BABIN. Sure.

Ms. RATH. —that we have certainly seen an increase in the foreign transport in our area. In 2015, we were about 29 percent foreign, and it's increased in 2017 to 38 percent foreign. So we're clearly seeing a much larger impact of foreign transport, and it's because of the improvements that we have done locally with the local generation going down, so that percentage that's foreign has certainly increased at least in our area.

Mr. BABIN. Okay. Thank you very much. And then, Mr. Franquist, would you please explain the potential economic impacts on a rural community if it's determined to be in nonattainment for ozone?

Mr. FRANQUIST. Thank you, and good question. Unfortunately, I don't have the same numbers for an area like Yuma. What I can say is, thanks to the good work that Texas has done, we actually scaled a similar economic study for Phoenix's nonattainment area, and that's somewhere in the neighborhood of $80–100 million, again, per year annually.

For a place like Yuma, I think the cost you have to look in is it voided businesses coming into the area? We know that in the Phoenix area we lost four large businesses coming into the nonattainment area just to avoid the offsets and layer requirements. So, unfortunately, I can't give you a dollar sign, but I can say it's significant in terms of job loss or job avoidance.

Mr. BABIN. Yes, so I mean it's definitely an impact.

Mr. FRANQUIST. Correct.

Mr. BABIN. A number of businesses just won't come into that area because of the nonattainment.

Mr. FRANQUIST. That's correct.

Mr. BABIN. Okay. Well, I think my time's expired. Thank you, Mr. Chairman.

Chairman BIGGS. Thank you. The gentleman yields.

And we're going to turn to the gentleman from California, Mr. Takano.

Mr. TAKANO. Thank you, Mr. Chairman.

Dr. Craft, I'm—this probably has been asked, but I want to ask it again. The current law permits mainly health concerns and science to drive ozone standards, is that correct? It's not economic impact, is that correct?

Dr. CRAFT. Correct.

Mr. TAKANO. And that's been—I think Mr. Beyer submitted for the record Supreme Court decisions which reaffirmed that. And I know that even the majority in this House respects the first branch of government, the legislative branch, as the maker of the laws, and it's, I think, inappropriate for the EPA to decide if they're going to use some other criteria to decide the levels of ozone that are permissible in regulation.

Dr. CRAFT. Yes.

Mr. TAKANO. Yes. Are you familiar with the Inland Empire region of southern California and the work of the Southern California Air Quality Management District in improving air quality in my region?

Dr. CRAFT. Yes.

Mr. TAKANO. What can you say about that over the past 20, 30 years?

Dr. CRAFT. I can say that California has been a leader in developing air quality strategies to reduce emissions. California has some unique challenges that don't exist anywhere else in the country, and they have taken that challenge on. It's one of the most innovative, creative States in terms of trying to get those reductions. What California has done with regard to clean car standards is tremendous. We had just this week actually the State of Colorado signing on to California's clean car standards. So California has been a model leader for implementing strategies to reduce pollutants like ozone.

Mr. TAKANO. I can say from my anecdotal personal experience that I experienced as a child in the '60s and '70s frequent days of what we called smog alerts where kids were not allowed to go out and play because—I think it was because of ozone, the ozone layers—levels were so high. And I can remember at night my lungs feeling that burning sensation, and that those days have been reduced greatly. And I think that's in great deal—a part—we can attribute that to the aggressive efforts of the—of the Air Quality Management District in California.

Dr. CRAFT. Absolutely. And I would say that there's still more work to do. If you review the State of the Air 2018, it's estimated that 41 percent of the population of the United States lives in areas that exceed health-based standards for pollutants like ozone and particulate matter.

Mr. TAKANO. And my district in the Inland Empire, we experience high volumes of traffic from trucking and also other mobile sources, but we're seeing an increase of truck traffic as a result of products being shipped to and from logistics centers in my area. If public health were not the primary concern in setting ozone standards, would districts like mine have more to worry about when it comes to air quality and public health?

Dr. CRAFT. I think we have to use sound science to establish these polices. We can't use anything else. Using anything else jeopardizes the integrity of the science. That's why we use science. That's why it's so important. We cannot have policy-led science. We need to have science-led policy.

Mr. TAKANO. Thank you very much for that. You know, it's my understanding, Dr. Craft, that the Clean Air Act contains a number of mechanisms that allow EPA to address high background levels of ozone, specifically allows for the exclusion of exceptional events like wildfires and the transport of air pollution from overseas that contributes to higher ozone levels. We talked about the good ozone and bad ozone.

This exceptional-events rule was revised in 2016 to address stakeholder concerns about the rule's clarity and efficiency. Could you share with us how and why these types of mechanisms operate to the benefit of public health?

Dr. CRAFT. Sure. EPA has actually done a lot of work over the last couple of years trying to address tools, getting tools in place to help manage ozone. I have a recent white paper from the agency outlining some of the tools that are available to manage ozone exceedances from things like exceptional events and background ozone. So some of those tools are the exceptional-event exclusions that you mentioned. Small nonattainment area boundaries for sites minimally impacted by nearby sources is another. Rural transport areas is another. And then international transport provisions mentioned here, the 179B, are just a couple of the tools that are in place.

EPA does work hand-in-hand with the States to try to come up with policies that work for those States. It's not—it's under an agreement known as cooperative federalism. We want the Federal Government and the States working hand-in-hand toward the common goal of protecting public health. That's why the EPA is there.

Mr. TAKANO. Mr. Chairman——

Chairman BIGGS. The gentleman's time is expired.

Mr. TAKANO. Thank you.

Chairman BIGGS. Thank you, sir.

I now recognize myself for five minutes for questions.

I want to begin with a statement regarding the memo that's received such attention today. Administrator Pruitt, in his memo on the NAAQS, requested that the Clean Air Scientific Advisory Committee compile data on background ozone. As we've just heard in the testimony, that request is in line with Clean Air Act and its interpretation by the courts, including such cases as American Trucking Associations v. EPA. The Administrator of EPA is permitted by law to consider background ozone in NAAQS implementation.

And with that, Mr. Franquist, Yuma County, bordered by Mexico, bordered by California, a rural county, very few big businesses, very few even medium-sized businesses in it, is it possible for Yuma County to reach attainment even under diligent efforts to offset emissions?

Mr. FRANQUIST. Mr. Chairman, I think it's unlikely, given the sources. When we look at the National Emissions Inventory for volatile organic compounds and NOx, the two precursors for ozone, we're looking at something in the neighborhood of two percent for VOCs and five percent from vehicles—from essentially anthropogenic sources in the Yuma area. So you likely could remove all industrial activities in the Yuma area, but because of the influence of international sources, you would likely still have a challenge of attaining the standard.

Chairman BIGGS. So we hear about the impacts of ozone on health, but we just talked about you could actually eliminate all industrial outputs and still fail to meet the NAAQS requirement levels. So that would further induce poverty into that area. And so what's the health impacts of poverty? What have the studies said about that?

Mr. FRANQUIST. Mr. Chairman, we've referenced a couple today and we've supplied several in the past, but, again, the connection for poverty and ill health is enormous. We know in areas like Yuma when we're 19 percent unemployment, what that does is it adds a burden to healthy foods, access to health care, so it goes hand-in-hand. And so, again, there's numerous academic articles linking public health issues and the economy, and so, again, that's why we don't challenge that ozone in and of itself is a problem. However, when that ozone's coming from somewhere else and the Clean Air Act is designed to impact negatively those local economies, now those impoverished areas have a one-two punch. And so, again, we think it's really valid to begin to look at how the Clean Air Act is designed to protect public health and the environment but to also relieve some of those areas of some of the significant economic impacts that go with the 179B demonstration.

Chairman BIGGS. And, Mr. Stella, in your testimony you discussed a diminishing rate of return on U.S.-controlled programs impacting air quality as the incremental cost of every ton of emissions increases. Can you elaborate on that, please?

Mr. STELLA. Certainly. Thank you for the question. In essence, what we're seeing is that, as a series of controls have already been historically put in place and we see domestic ozone reduced from the anthropogenic sources that we have control over, and an ever-increasing relative contribution of uncontrollable sources, whether or not the international transport or background or stratospheric intrusions and the like. As we try to get each additional ton reduced to improve our air quality, the cost becomes higher and higher, and it's simply because we're not getting the same response out of a reduction of one ton of NOx or VOC, for example, to reduce an equal amount of ozone concentration. And so as we get lower and lower and we see a greater percentage of uncontrollable sources dominate what our ambient conditions are, it's going to cost more to reduce less.

Chairman BIGGS. Thank you. I would like to elaborate on that just for a second. As we see the diminishing return economically, do you see it—is there a diminishing return as far as health conditions and improvement in health as you move from, say, 70 NOx down to 69, for instance?

Mr. STELLA. I'm not sure that that's a question for me, not being my area of expertise, but as a scientist, I would believe that, as you see the ozone levels decreasing, you see improvements in health.

Chairman BIGGS. Is there a statistical—well, you just said it's not your area, so I'm just wondering if there's a statistical diminution, but regardless, we have reached basically the end of our time today. I appreciate all of you for coming and sharing your testimony. I think it's important for us as this allows for a robust discussion, and we need a robust discussion on these issues. And there's a lot of considerations, a lot of variables that we have to take into account.

I appreciate those on both sides of the aisle for being here and participating today, and with that, we're adjourned.

[Whereupon, at 11:43 a.m., the Subcommittee was adjourned.]

Appendix I

ADDITIONAL MATERIAL FOR THE RECORD

LETTER SUBMITTED BY COMMITTEE CHAIRMAN
LAMAR S. SMITH

GOVERNOR GREG ABBOTT

May 11, 2018

The Honorable Scott Pruitt
Administrator
U.S. Environmental Protection Agency
William Jefferson Clinton Building
1200 Pennsylvania Avenue, NW, 1101A
Washington, D.C. 20460

Re: Ozone Designation for the San Antonio Metropolitan Area, EPA-HQ-OAR-2017-0548

Dear Administrator Pruitt:

On February 28, 2018, I urged EPA to designate Bexar County as in attainment of the 2015 National Ambient Air Quality Standard (NAAQS) for ozone. In the alternative, I explained that "under no circumstances should Bexar County receive a designation worse than unclassifiable."[1] On March 19, 2018, you responded that EPA intends "to designate all or portions of Bexar County as, at best, Unclassifiable" and invited me to submit additional information for EPA's consideration.[2] I write to provide that additional information.

EPA should designate Bexar County as "attainment" or, at worst, "unclassifiable" under the 2015 ozone NAAQS. If EPA chooses to designate Bexar County as "nonattainment"—despite the discretion to do otherwise—EPA should at least defer the effective date of that designation until Bexar County has had the opportunity to meet the 2015 NAAQS on its own.

I. EPA Should Exercise Discretion to Designate Bexar County as in Attainment

I previously recommended that EPA designate Bexar County as in attainment of the 2015 ozone NAAQS, and I stand by that recommendation. Bexar County is projected to meet the 2015 NAAQS by 2020 without additional federal intervention. Indeed, Bexar County would have already met that standard if not for foreign emissions that it cannot control.

I appreciate that your March 19 letter acknowledged two important factual underpinnings for my recommendation of attainment. First, EPA acknowledged projections that Bexar County will meet the 2015 ozone NAAQS by 2020. Second, EPA noted that foreign emissions

[1] Letter from Gov. Abbott to Administrator Pruitt (Feb. 28, 2018), https://www.regulations.gov/document?D=EPA-HQ-OAR-2017-0548-0297.
[2] Letter from EPA to Gov. Abbott (Mar. 19, 2018), https://www.epa.gov/sites/production/files/2018-03/documents/san_antonio_naaqs_epa_ltr_3_19_2019.pdf.

adversely affect Bexar County's ozone levels.[3] Unfortunately, the Technical Support Document (TSD) attached to that March 19 letter also contained significant legal and factual errors that underlie the proposed modification to my recommendation. Once those errors are corrected, the propriety of designating Bexar County as in attainment becomes clear.

A. As a Matter of Law, EPA Has Discretion to Designate Bexar County as In Attainment

The TSD misstates the law. It asserts that "EPA *must* designate as nonattainment any area that violates the NAAQS." TSD at 6 (emphasis added). Elsewhere, the TSD suggests that this result is compelled by Section 107(d) of the Clean Air Act. *See id.* at 2.

That is not true. As I explained in my previous letter, EPA's discretion is recognized in the plain text of the CAA, judicial interpretations of the CAA, and EPA's past practices under the CAA. It would be legally erroneous for EPA to ignore these authorities and to follow instead a nonbinding guidance document issued by the previous Administration.

1. First consider the text of the CAA. Section 107(d) grants EPA significant discretion in making designation decisions. It establishes a two-step process in which Governors make initial recommendations and then the Administrator "make[s] such modifications as the Administrator deems necessary." 42 U.S.C. § 7407(d)(1)(B)(ii). Section 107 "says nothing of what precisely will render a modification 'necessary'" and thus leaves the necessity of modifications to EPA's discretion. *Catawba Cty., N.C. v. EPA*, 571 F.3d 20, 35 (D.C. Cir. 2009).

2. Courts likewise have recognized this discretion when interpreting materially identical language in related sections of the CAA. For example, section 231 of the CAA empowers EPA to regulate emissions from aircraft and requires the Administrator to "issue such regulations with such modifications as he deems necessary." 42 U.S.C. § 7571(a)(3). The D.C. Circuit described this "deems necessary" language, which Section 107 also contains, as an "explicit and extraordinarily broad" delegation of authority. *Nat'l Ass'n of Clean Air Agencies v. EPA*, 489 F.3d 1221, 1229 (D.C. Cir. 2007). "Finding nothing in 'the text or structure of the statute to indicate that the Congress intended to preclude the EPA from considering [factors other than air quality],' [the court] refused 'to infer from congressional silence an intention to preclude the agency from considering factors other than those listed in a statute.'" *Id.* at 1230 (quoting *George E. Warren Corp. v. EPA*, 159 F.3d 616, 623–24 (D.C. Cir. 1998)).

So too here. Section 107 grants EPA broad discretion to consider factors beyond monitoring data, including Bexar County's projected improvements in air quality and the adverse effect of foreign emissions, as the case law cited in my previous letter demonstrated. *See, e.g., Sierra Club v. McCarthy*, No. 13-cv-3953, 2015 WL 889142, at *1 (N.D. Cal. Mar. 2, 2015), *aff'd sub nom. Sierra Club v. North Dakota*, 868 F.3d 1062 (9th Cir. 2017) (recognizing "EPA's

[3] Texas: San Antonio, Intended Area Designations for the 2015 Ozone NAAQS, Technical Support Document at 21, https://www.epa.gov/sites/production/files/2018-03/documents/tx_sanantonio_120d_tsd_draft_3-2018_r6.pdf.

discretion to determine, based on available information, whether an area is in 'attainment' or 'nonattainment' with the [relevant] air quality standard, or whether the area is 'unclassifiable' "). I am aware of no contrary authority.[4]

3. EPA has long used discretion to avoid nonattainment designations. When EPA considers changing an area's previous designation, it exercises discretion regarding whether to redesignate an area as in nonattainment. For example, under the Early Action Compact (EAC) program, EPA agreed to use its discretion to avoid redesignating EAC areas as "nonattainment" in exchange for local governments making voluntary improvements to their air quality:

> [I]n deciding whether to redesignate an EAC area to nonattainment, EPA will consider the factors in section 107(d)(3)(A) of the CAA. If an EAC area continues to meet its compact milestones, EPA believes those factors should weigh in favor of not redesignating the area to nonattainment immediately, but rather waiting to see if the programs the area puts in place will bring it back into attainment.

Early Action Compact Areas With Deferred Effective Dates, 69 Fed. Reg. 23,858, 23,871 (Apr. 30, 2004). In other words, EPA "deem[ed] necessary" a wait-and-see approach for redesignations that allowed areas not meeting the NAAQS to avoid the regulatory burdens of a nonattainment designation while they were making progress toward cleaner air.

EPA should do the same here. That EPA has exercised discretion in the redesignation process under Section 107(d)(3) weighs heavily in favor of exercising discretion in the designation process under Section 107(d)(1) because the two provisions are similar in both text and purpose. *See* 42 U.S.C. § 7407(d)(3)(C) ("[T]he Administrator shall promulgate the redesignation, if any, of the area or portion thereof, submitted by the Governor in accordance with subparagraph (B), making such modifications as the Administrator may deem necessary, in the same manner and under the same procedure as is applicable under clause (ii) of paragraph (1)(B) [the provision at issue here].").

4. Statutory text, court decisions, and EPA's previous actions all make clear that EPA has discretion to designate Bexar County as in attainment. Against those authorities, EPA's March 19 response cited a non-binding policy memorandum, prepared under the previous Administration, suggesting that EPA lacks discretion over designations.

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[4] EPA should also consider that one regulatory monitor and numerous non-regulatory monitors all show that ozone levels in Bexar County satisfy the 2015 NAAQS. Your response asserts that the data "do not meet EPA quality assurance criteria and cannot be used for regulatory purposes," TSD at 21, but it makes no effort to distinguish the multiple recent instances in which EPA has considered similar data. "[W]hen an agency takes inconsistent positions, as [EPA] did here, it must explain its reasoning." *Gulf Power Co. v. FERC*, 983 F.2d 1095, 1101 (D.C. Cir. 1993).

But that unreasoned *ipse dixit* is not the law. The memorandum itself recognizes that "[a]ny guidance contained herein is *not binding* on states, tribes, the public or the EPA."[5] As former Attorneys General, we both know that the previous Administration's legal assertions cannot be taken at face value. For that reason, more than a year ago, President Trump ordered EPA to review existing environmental policies to ensure that they "comply with the law." Presidential Executive Order on Promoting Energy Independence and Economic Growth § 1(e) (Mar. 28, 2017). More recently, the President specifically directed you to "evaluate EPA's existing rules, guidance, memoranda, and other public documents relating to the implementation of NAAQS." Presidential Memorandum for the Administrator of the Environmental Protection Agency § 9 (Apr. 12, 2018). I respectfully urge you to follow the President's lead, independently review EPA's legal authority, and for the reasons outlined above, conclude that EPA has the discretion to designate Bexar County as in attainment.

Failing to recognize and exercise EPA's discretion in this regard would render any nonattainment designation "arbitrary, capricious, an abuse of discretion, or otherwise not in accordance with law." 5 U.S.C. § 706(2)(A). "[A] court 'can compel an official to exercise his discretion where he has obviously failed or refused to do so.'" *NAACP v. Sec'y of Housing & Urban Devel.*, 817 F.2d 149, 160 (1st Cir. 1987) (quoting *Mastrapasqua v. Shaughnessy*, 180 F.2d 999, 1002 (2d Cir. 1950)); *see also United States ex rel. Accardi v. Shaughnessy*, 347 U.S. 260, 268 (1954) ("[W]e object to the Board's alleged failure to exercise its own discretion, contrary to existing valid regulations."); *Bargmann v. Helms*, 715 F.2d 638, 641 (D.C. Cir. 1983) ("[W]e are presented with an agency's refusal to exercise its discretion, based on its belief that it has no power to do otherwise. . . . It is well within the tradition of our review of agency action on petitions for rulemaking to make an independent inquiry into an agency's allegation that it lacks the statutory authority to act.").

B. Foreign Emissions Caused Bexar County to Exceed the 2015 Ozone NAAQS

The TSD also misunderstands the relevant facts. As I explained in my February 28 letter, "[r]ecent photochemical modeling shows that emissions from foreign sources likely contribute 10–24 ppb of ozone to eight-hour ozone concentrations in Bexar County. Without these foreign emissions, Bexar County's ozone levels would be well below the 2015 NAAQS."[6]

1. The TSD downplays the significance of these foreign emissions because they include both man-made and naturally occurring foreign emissions. TSD at 21. The TSD's objection fails for two independent reasons. First, considering all foreign emissions, regardless of cause, is the more relevant analysis. Second, considering man-made foreign emissions alone, as the TSD suggests, does not change the result. In the absence of foreign man-made emissions, Bexar County would have satisfied the 2015 ozone NAAQS.

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[5] Memo. from Acting Assistant Administrator Janet G. McCabe to Regional Administrators re Area Designations for the 2015 Ozone National Ambient Air Quality Standards at 9 (Feb. 25, 2016), https://www.epa.gov/sites/production/files/2016-02/documents/ozone-designations-guidance-2015.pdf (emphasis added).

[6] Letter from Gov. Abbott to Administrator Pruitt at 6 (Feb. 28, 2018), https://www.regulations.gov/document?D=EPA-HQ-OAR-2017-0548-0297.

There is no legitimate reason to punish Bexar County for emissions that it cannot control, regardless of whether those emissions are naturally occurring or man-made. For that reason, EPA has traditionally defined background ozone, which is not subject to regulatory controls, as including *all* foreign emissions as well as naturally-caused domestic emissions.[7] There is no reason to exclude consideration of naturally occurring foreign emissions.

My letter called attention to both the impact of foreign emissions in particular and the problem of background ozone in general. Consideration of total foreign emissions is not too broad; in fact, a broader-still consideration of all background ozone is appropriate. Consistent with EPA's historical understanding of background ozone, EPA should consider that only 49 percent of relevant Bexar County ozone emissions come from domestic man-made sources.[8] In other words, neither EPA nor Bexar County could regulate a majority of the ozone affecting Bexar County.

2. Moreover, the TSD is wrong to suggest that foreign man-made ozone is insignificant. In fact, EPA has previously estimated the effects of foreign man-made emissions on ozone levels, and EPA's own analysis suggests that Bexar County would have met the 2015 ozone NAAQS if not for foreign man-made ozone.

EPA estimated the effect of "global methane emissions related to recent human activity as well as anthropogenic emissions outside of North America" on Bexar County as 8–10 ppb.[9] EPA then noted that the increase in methane was probably responsible for 4–5 ppb of ozone nationwide.[10] That leaves 4–5 ppb that EPA attributed to man-made emissions from outside North America. Of course, that estimate understates total foreign man-made emissions by omitting man-made emissions from Mexico, Canada, and other foreign countries in North America. Because Bexar County exceeded the 2015 ozone NAAQS by only 3 ppb, EPA's own data suggest that it would have met the 2015 ozone NAAQS if foreign man-made emissions had not interfered.

3. Instead of undertaking this analysis, the TSD claims that "the impacts from manmade emissions from Mexico is on the order of less than 1 ppb." TSD at 21. First, that statement is factually incorrect. Only part of Mexico was included within the modeling domain, meaning that Mexican emissions were split between what the model labelled "Mexico" and what

[7] EPA, Implementation of the 2015 Primary Ozone NAAQS: Issues Associated with Background Ozone at 2 (Dec. 30, 2015), https://www.epa.gov/sites/production/files/2016-03/documents/whitepaper-bgo3-final.pdf; *see also* Presidential Memorandum for the Administrator of the Environmental Protection Agency (Apr. 12, 2018) (defining ozone "background levels" as the "levels associated with natural sources or emissions originating outside of the United States").
[8] *Id.* at 22 (Table 2a).
[9] EPA, Policy Assessment for the Review of the Ozone National Ambient Air Quality Standards (Aug. 2014) at 2A-29, https://www3.epa.gov/ttn/naaqs/standards/ozone/data/20140829pa.pdf (estimating 6–15 ppb for the United States as a whole and noting that 8–10 ppb was the "most frequent bin"); *id.* at 2A-31, Figure 8b (showing Bexar County as 8–10 ppb).
[10] *Id.* at 2A-29.

the model labelled "Boundary conditions/International."[11] As a result, the TSD's estimate is too low. Second, the TSD's focus on Mexico, to the exclusion of all other foreign sources, cannot be squared with the President's recent order that EPA "not limit its considerations to emissions emanating from Mexico or Canada, but rather consider[ ], where appropriate, emissions that may emanate from any location outside the United States." Presidential Memorandum for the Administrator of the Environmental Protection Agency § 4(b) (Apr. 12, 2018). The TSD's Mexico-only analysis, in addition to being wrong, is irrelevant.

In short, Bexar County would have already met the 2015 ozone NAAQS if it did not have to contend with foreign emissions. EPA's preliminary conclusion to the contrary was premised on a fundamental misunderstanding of the data.

II. Alternatively, EPA Should Designate Bexar County as Unclassifiable

EPA is considering whether to withdraw the 2015 NAAQS. In fact, EPA has used that potential withdrawal to justify staying a challenge to the lawfulness of the 2015 NAAQS. *See* Respondent EPA's Third Status Report, Doc. No. 1711911, *Murray Energy Corp., et al. v. EPA*, No. 15-1385 (D.C. Cir. Jan. 8, 2018) (consolidated with 15-1392, 15-1490, 15-1491 & 15-1494). As I previously explained in my February 28 letter, EPA should not proceed with designations while the fate of the 2015 NAAQS is still uncertain.

Legal uncertainty surrounding the 2015 NAAQS counsels in favor of, at worst, an unclassifiable designation. Because EPA cannot give effect to an unlawful rule, "available information" is insufficient to establish the 2015 NAAQS as "the national primary or secondary ambient air quality standard" for purposes of Section 107, much less can "available information" show that Bexar County "is not meeting" that standard. 42 U.S.C. § 7407(d)(1)(A)(iii).

In addition, considerable factual uncertainty means that Bexar County "cannot be classified [as nonattainment] on the basis of available information." *Id.* As has been recently reported, a coal-fired power plant in Bexar County is planning to cease operations by the end of this year.[12] Because this plant is upwind of the relevant monitors, its suspension of operations is likely to significantly improve ozone levels. While such a major change is pending, a nonattainment designation based on soon-to-be-out-of-date information would be unreasonable. *See, e.g., Permian Basin Petrol. Ass'n v. Dep't of the Interior*, 127 F. Supp. 3d 700, 716–17 (W.D. Tex. 2015) (failure to consider "updated . . . numbers" was arbitrary and capricious

[11] Letter from Gov. Abbott to Administrator Pruitt at App'x C, pp.1–2 (Feb. 28, 2018), https://www.regulations.gov/document?D=EPA-HQ-OAR-2017-0548-0297. Moreover, the TSD erroneously claims that the modeling cited in my previous letter inappropriately includes ozone "generated from emissions within the US and recirculated into the domain." TSD at 21. As the Texas Commission on Environmental Quality has explained, because the modeling boundary "is at least 200 miles away from any continental U.S. border," it is likely "that emissions and ozone outside this boundary did not originate within the continental United States." Letter from Gov. Abbott to Administrator Pruitt at App'x C, p.1 (Feb. 28, 2018), https://www.regulations.gov/document?D=EPA-HQ-OAR-2017-0548-0297. Similarly, the impact of Hawaiian and Alaskan emissions is likely negligible.

[12] U.S. Energy Information Administration, Natural Gas Weekly Update (Mar. 14, 2018), https://www.eia.gov/naturalgas/weekly/archivenew_ngwu/2018/03_15/ ("Units 1 and 2 at the 840-MW JT Deely coal-fired plant are planned for retirement by the end of this year.").

because "reliance on out-of-date or incomplete information may render the analysis of effects speculative and uncertain" (quoting *City of Dallas v. Hall*, 562 F.3d 712, 720 (5th Cir. 2009))); *Sierra Club v. Babbitt*, 15 F. Supp. 2d 1274, 1284 (S.D. Ala. 1998) (agency finding was "arbitrary and capricious" due to reliance "on insufficient, inadequate, and out of date data").

Under no circumstances should Bexar County receive a designation worse than unclassifiable.

III. EPA Should Defer the Effective Date of Any Nonattainment Designation

If, contrary to my recommendation, EPA chooses to designate Bexar County as in nonattainment, EPA should at least defer the effective date of that designation.

In the past, EPA has deferred effective dates for nonattainment designations when localities have demonstrated a willingness and an ability to improve their air quality without additional federal intervention. Through the EAC program discussed above, EPA deferred the effective date of nonattainment designations in exchange for local governments agreeing to clean their air more quickly than the CAA would otherwise require.

Such a deferral would be a mutually beneficial solution that advances cooperative federalism, which you have rightly described as "key to maintaining clean air."[13] First, and most important, citizens get cleaner air more quickly with fewer economic drawbacks. Second, States and localities avoid the bureaucratic nightmares that follow from nonattainment designations and maintain "primary responsibility for assuring air quality." 42 U.S.C. § 7407(a). Third, EPA is able to meet its legal obligation to "promulgate the designations . . . as expeditiously as practicable" while advancing the CAA's goal of clean air. *Id.* § 7407(d)(1)(B)(i).

For these reasons, EPA has consistently reaffirmed the legality of deferring the effective date of a nonattainment designation. *See* Final 8-Hour Ozone National Ambient Air Quality Standards Designations for the Early Action Compact Areas, 73 Fed. Reg. 17,897, 17,899 (Apr. 2, 2008); Extension of the Deferred Effective Date for 8-Hour Ozone National Ambient Air Quality Standards for Early Action Compact Areas, 70 Fed. Reg. 50,988, 50,992 (Aug. 29, 2005); Air Quality Designations and Classifications for the 8-Hour Ozone National Ambient Air Quality Standards; Early Action Compact Areas With Deferred Effective Dates, 69 Fed. Reg. 23,858, 23,869–70 (Apr. 30, 2004).

As your response acknowledged, Bexar County is projected to meet the 2015 ozone NAAQS by 2020 without additional federal intervention.[14] Local leaders are eager to clean their

[13] EPA News Release, EPA Advances Cooperative Federalism through Designation Process for Sulfur Dioxide and Ozone Standards (Dec. 22, 2017), https://www.epa.gov/newsreleases/epa-advances-cooperative-federalism-through-designation-process-sulfur-dioxide-and.

[14] Moreover, EPA itself has projected that all three of Bexar County's regulatory monitors will be well below 70 ppb, even in the absence of additional local actions, by 2025. EPA Regulatory Impact Analysis of the Final Revisions to the National Ambient Air Quality Standards for Ground-Level Ozone at 2A-61 (Sept. 2015), https://www.epa.gov/sites/production/files/2016-02/documents/20151001ria.pdf.

air and have already implemented many successful reforms to do so. Deferring the effective date of any nonattainment designation would provide local leaders with the regulatory flexibility necessary for efficient reduction of Bexar County's ozone levels.

In fact, EPA and Bexar County have successfully used a deferred effective date to spur air quality improvements before. Under the EAC program, Bexar County "agreed to reduce ground-level ozone pollution earlier than the CAA would require" and then "successfully attained" the 1997 ozone standard. TSD at 5 n.10. As a result, Bexar County "was ultimately designated as attainment." TSD at 20 n.20. Bexar County's history of success with deferred effective dates strongly supports a similar approach for the 2015 ozone NAAQS.

* * *

In its March 19 letter, EPA committed to "implementing the [NAAQS] using a common sense approach that improves air quality and minimizes the burden on state and local governments." No common-sense approach could support immediately burdening Bexar County with the regulatory consequences of an effective nonattainment designation. I therefore reiterate my recommendation that Bexar County should be designated as in attainment of the 2015 ozone NAAQS.

Sincerely,

Greg Abbott
Governor

cc: Senator John Cornyn
Senator Ted Cruz
Congressman Will Hurd
Congressman Beto O'Rourke
Congressman Joaquin Castro
Congressman Henry Cuellar
Congressman Lloyd Doggett
Congressman Lamar Smith
Congressman Mike Conaway
Congressman Roger Williams
Anne Idsal, EPA Administrator for Region 6
Bryan W. Shaw, Chairman of TCEQ
Richard Hyde, Executive Director of TCEQ

DOCUMENTS SUBMITTED BY REPRESENTATIVE SUZANNE BONAMICI

Allergy & Asthma Network | Alliance of Nurses for Healthy Environments | American Academy of Pediatrics DEDICATED TO THE HEALTH OF ALL CHILDREN | AMERICAN LUNG ASSOCIATION | APHA AMERICAN PUBLIC HEALTH ASSOCIATION For science. For action. For health. | Children's Environmental Health Network | Health Care Without Harm | NACCHO National Association of County & City Health Officials | Trust for America's Health WWW.HEALTHYAMERICANS.ORG

June 21, 2018

U.S. House Committee on Science, Space, & Technology
Subcommittee on Environment

Dear Chairman Biggs, Ranking Member Bonamici, and members of the Subcommittee on Environment of the House Committee on Science, Space, & Technology:

The undersigned public health, medical and nursing organizations strongly support the full implementation and enforcement of the Clean Air Act's protections from ozone pollution, including the 2015 standard. Ensuring the cleanup of ozone pollution is critical to protecting public health.

In 2015, our organizations strongly urged the U.S. Environmental Protection Agency (EPA) to update the National Ambient Air Quality Standard (NAAQS) for ozone to a level that protected human health, including for children, people with lung disease, and others who are at greater risk of health harms. The finalization of the 2015 ozone standard was an important step toward ensuring healthy air, with projected benefits of 230,000 childhood asthma attacks and 160,000 missed days of school prevented every year by 2025.

These benefits will not be realized without full implementation and enforcement. Our organizations are committed to ensuring that EPA work with communities in nonattainment for the 2015 ozone standards to make real pollution reductions, including with strong New Source Review requirements and without excessive exemptions of unhealthy ozone days.

The Clean Air Act requires that the NAAQS be set at the level necessary to protect human health, including for vulnerable populations, with an adequate margin of safety. In a unanimous decision in 2001, the U.S. Supreme Court underlined that the sole basis for setting the standard was the protection of public health. However, in a May 2018 memo, EPA Administrator Scott Pruitt called for the incorporation of other considerations that are clearly not applicable under the Supreme Court decision, such as potential economic and energy impacts, into the standard-setting process.

These considerations are not consistent with the statutory requirements in the Clean Air Act and could lead to standards that are not requiste to protect public health with an adequate margin of safety.

The memo further called for background ozone levels to be taken into account in setting the standard itself, an unnecessary request since the levels of background ozone have been discussed throughly in the last two reviews of the standard. These reviews examine ozone from all sources, as the human body needs protection from ozone regardless of the source.

Future ozone and other NAAQS must continue to be based solely on what the health science shows is necessary to protect human health. The law already allows economic considerations to be taken into account when the standard is being implemented, but they have no bearing on the scientific question of how much ozone is safe to breathe. Even background ozone is already addressed in implementation; days when background ozone is excessive can be treated as exceptional events that do not affect meeting the standard.

Our organizations oppose the changes proposed under EPA's memo, coupled with the agency's proposal to restrict the science it considers in its decisionmaking to exclude seminal health studies. Those changes will likely result in inadequate health protections from ozone pollution and other pollutants. EPA must follow the law and fully implement and enforce the 2015 ozone standards, and set any future standards based solely on what the best health science shows is necessary to protect the health of the communities we serve. We call upon this subcommittee to oppose any changes to these policies and procedures at EPA that would put public health at risk by blocking, weakening or delaying the cleanup of ozone pollution.

Sincerely,

Allergy & Asthma Network
Alliance of Nurses for Healthy Environments
American Academy of Pediatrics
American Lung Association
American Public Health Association
Children's Environmental Health Network
Health Care Without Harm
National Association of County and City Health Officials
Trust for America's Health

GLOBALSTRATEGYGROUP
LEAD THE WAY™

TO American Lung Association
FROM Andrew Baumann and Maura Farrell, Global Strategy Group
DATE April 23, 2018
RE POLL RESULTS: Voters Overwhelmingly Support Stricter Limits on Smog

Last month, the American Lung Association released a memo indicating voters' wide opposition to any efforts to weaken the stronger fuel efficiency standards put in place by the previous administration. As noted in the previous memo, our research also indicated that voters overwhelmingly support the Environmental Protection Agency (EPA) enforcing stricter limits on air pollution.

When asked specifically about their support for enforcing the EPA's 2015 updated standards which placed stricter limits on the amount of smog that power plants, oil refineries, and other industrial facilities release, voters across party and demographic lines overwhelmingly support enforcing the 2015 standards. This support also holds up against scrutiny: when voters hear a balanced simulated debate, including strong arguments attacking the proposed new smog standards that reflect the language being used by their opponents, two thirds of voters continue to support enforcing these standards.

Key findings from Global Strategy Group's recent nationwide poll of registered voters are as follows:

KEY FINDINGS

Voters' overwhelmingly support clean air laws and clean air enforcement agencies. Voters nationwide are broadly favorable towards the Clean Air Act (65% favorable/10% unfavorable) and the EPA (59% favorable/26% unfavorable). Voters also support the EPA's efforts to enforce stricter limits on air pollution more broadly by a margin of almost four to one (74% support/19% oppose, including 48% who strongly support).

In keeping with voters' strong support for clean air policies, voters also intensely support the Environmental Protection Agency enforcing stricter limits on smog. A broad majority of voters (75%) support the idea of the Environmental Protection Agency enforcing its updated stricter limits on smog. Notably, a majority (56%) of voters *strongly* support the enforcement of the EPA's stricter limits on smog. Less than a fifth of voters (18%) oppose the stricter limits.

Support for stricter limits on smog outweighs opposition among Democrats, Republicans, and independent voters alike. Nearly all Democrats support enforcing the stricter limits (94% support/4% oppose), independent voters support enforcing the limits by more than five-to-one (77% support/15% oppose), and more

Support for the EPA Enforcing Stricter Limits on Smog		
Support	Oppose	
75%	18%	TOTAL
68	25	Men
81	12	Women
82	11	18-44
71	22	45-64
68	23	65+
72	20	White
85	12	Non-white
49	39	Republican
77	15	Independent
94	4	Democrat
76	20	Non-college
75	16	College
72	17	Northeast
72	21	Midwest
75	18	South
82	16	West
66	22	Parents

Republicans support (49%) than oppose (39%) enforcing the limits. Support for enforcing the 2015 limits is wide across the board and transcends the various demographic and regional groupings in the survey, including gender, age, education, and race.

Support remains high even after voters hear arguments from both sides, including an argument from opponents of stricter smog standards that stresses the potentially negative economic and workforce-related ramifications of enforcing stronger smog standards. Support for the EPA enforcing stricter smog limits starts out extremely high (75% support) and remains very robust following statements from both sides (66% support). After the debate, not only do two-thirds of voters express support, nearly half of voters express strong support for enforcing these stricter standards.

Support for Enforcing EPA's Stricter Limits on Smog

As you may know, in 2015, the Environmental Protection Agency updated air pollution standards to place stricter limits on the amount of smog that power plants, oil refineries, and other industrial facilities can release. Now, the EPA is considering if it will enforce these stricter limits on smog. Do you support or oppose the Environmental Protection Agency enforcing these stricter limits on smog?

Some people say that, according to scientists, enforcing these updated standards will prevent hundreds of premature deaths and hundreds of thousands of additional asthma attacks among children **every year by holding polluters accountable for their actions. If the EPA fails to enforce these standards, they would be giving power plants a free pass to pollute and threaten the health of our children.**

Other people say that, according to economists, enforcing these new regulations will not improve air quality any faster, but they will hurt the economy by imposing unrealistic requirements on virtually every part of the nation. **These will be the most expensive regulations in American history, costing billions of dollars a year, raising electricity bills on families by hundreds of dollars, and placing millions of American jobs at risk**

METHODOLOGY

Global Strategy Group conducted a telephone survey from March 13th to 15th, 2018 among 800 registered voters nationwide. The margin of error is +/- 3.5% at the 95% confidence level and the margin of error for subgroups is greater.

DOCUMENTS SUBMITTED BY REPRESENTATIVE DONALD S. BEYER JR.

Congress of the United States
Washington, DC 20515

April 25, 2018

The Honorable Scott Pruitt
Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, N.W.
Washington, D.C. 20460

Dear Administrator Pruitt:

We are concerned regarding the health and environmental consequences of a January 25, 2018, Environmental Protection Agency (EPA) memo, which dramatically weakens protections against toxic air pollution by withdrawing the long standing "once in, always in" (OIAI) policy.

As you know, the Clean Air Act requires EPA to limit emissions of hazardous air pollutants (HAPs), including many known to cause cancer, harm development in children, and kill. The lengthy list includes mercury, arsenic, formaldehyde, benzene, asbestos, chlorine, cyanide, and lead.

In the Clean Air Act amendments of 1990, Congress made major changes to the way EPA regulates these toxic emissions because the agency had regulated only seven HAPs in the preceding 20 years. Congress acted out of deep concern that Americans were dying of cancer and facing other serious adverse health effects as a result of exposure to industrial HAPs. Congress was quite prescriptive in its direction to the agency: we required EPA to issue rules limiting emissions of 189 toxic HAPs, from all categories of "major sources" of these pollutants. The law requires the "maximum degree of reduction in [HAP] emissions ... including a prohibition on such emissions, where achievable." Sources must employ "maximum achievable control technology" or "MACT" to reduce HAP emissions to levels that the top-performing sources in an industry sector already meet. Congressional concern with these carcinogens and neurotoxins was so great that the law also contains *additional* safeguards: periodic reviews for control technology updates; residual cancer risk authorities; strict compliance directives; and anti-backsliding provisions.

From 1995 until this year, sources emitting HAPs were required to meet MACT standards if, on the date that the MACT standard went into effect, they had the potential to emit 10 tons of any one HAP or 25 tons of any combination of HAPs, annually ("10/25 ton per year threshold"). To ensure major sources kept those protections in place, EPA implemented what became known as the "once in, always in" policy, requiring major sources to continue to meet HAP emission limits based on MACT, even as they lowered and maintained emissions at or below MACT limits. EPA recognized that, without this policy, polluting sources could curtail use of MACT and increase their HAP emissions substantially above MACT-based emission limits, all the way up to the 10/25 ton per year threshold.

On January 25, without providing any notice to the public or opportunity for comment on its step, EPA reversed this decades-old understanding. In a four-page memorandum, EPA announced that sources currently complying with MACT air toxics standards now have the option of getting out of all MACT requirements if their emissions are below the 10/25 ton per year threshold. EPA will permit this even if sources are currently subject to one or more MACT standards that reduces HAPs emissions well below that threshold, and even if that means sources may *increase* their hazardous emissions significantly *and increase* the health hazards to Americans in neighboring communities.

This is not the first time EPA has tried to weaken protections against toxic air pollution so radically. When EPA proposed to take this same step more than 10 years ago, the agency's own regional offices expressed concern that the proposal would allow HAPs to increase, and "would be detrimental to the environment and undermine the intent of the MACT program."[1] The regional offices further argued that many plants would take the opportunity to use the less stringent requirements, and "the cost of the increased [HAP] emissions would be borne by the communities surrounding the sources."[2] An EPA political appointee claimed at the time that industry would be motivated to be good neighbors and not increase emissions. However, after Congress inquired pointedly, this claim was revealed this to be little more than speculation, with no basis in fact.[3] Thanks to the concerns raised during the open and transparent rulemaking process, EPA did not make the mistake of finalizing a proposal that would have jeopardized the health and welfare of the American public.

Now, the current EPA has decided to re-litigate the past, purporting to authorize through mere guidance the approach of the failed 2007 proposed rule, and granting immediate permission to industries to increase HAPs substantially. What's more, we now have a snapshot of the potential toxic impacts this policy would have on communities near, and downwind from, the thousands of major sources subject to MACT.

Last month, the Environmental Integrity Project released a brief analysis of the current HAP emissions of 12 major sources in the Midwest, and their potential emission increases without longstanding protections from HAPs. Combined, these facilities released over 121,000 pounds of HAPs annually in 2016, including neurotoxins like lead and carcinogens like benzene. Without the safeguards preserved in EPA's 1995 policy, the report found that "the total emissions from these major sources could more than quadruple to a total of 540,000 pounds a year, because the new exemption allows such facilities to save money by cutting back on their pollution controls."[4] Furthermore, the report highlighted the danger in relying on corporations to report their emissions to prove their HAP emissions are below the 10/25 ton per year threshold

[1] Memorandum to EPA Office of Air Quality Planning and Standards from EPA Regional Offices, *Regional Comments on Draft OIAI Policy Revisions*, at 3 (Dec. 13, 2005).
[2] Memorandum to EPA Office of Air Quality Planning and Standards from EPA Regional Offices, *Regional Comments on Draft OIAI Policy Revisions*, at 3-4 (Dec. 13, 2005).
[3] Letter from Chairman John D. Dingell, Committee on Energy and Commerce, to William Wehrum, Acting Assistant Administrator, EPA Office of Air and Radiation (Feb. 23, 2007); Response Letter from William Wehrum, Acting Assistant Administrator, EPA Office of Air and Radiation, to Chairman John D. Dingell, Committee on Energy and Commerce (Mar. 30, 2007).
[4] Environmental Integrity Project, *Toxic Shell Game: EPA Reversal Opens Door to More Hazardous Air Pollution* (Mar. 26, 2018) (www.environmentalintegrity.org/wp-content/uploads/2017/02/Toxic-Shell-Game.pdf).

and will remain there. The report noted major sources "seldom actually measure their hazardous emissions" on their own volition, so monitoring requirements were created in scores of MACT standards to keep them honest. But EPA's reversal of an essential protection against toxic air pollution would allow industrial emitters to no longer meet the monitoring, recordkeeping, or reporting requirements in MACT standards. This is in addition to letting polluting facilities evade the emission limits that protect Americans from increased HAPs.[5]

The Environmental Defense Fund released a second report assessing the toxic air pollution impacts on the Houston-Galveston region from EPA's new loophole, focusing on at least 18 potentially eligible facilities.[6] The report found that if all these facilities took advantage of the loophole to the maximum extent allowed by EPA's January rollback, the "total annual emissions of hazardous air pollutants from these facilities would increase by almost 146 percent over 2014 levels, to a total of 900,000 pounds."[7] Moreover, the report identified eight more facilities that appear eligible for the loophole; adding these facilities would increase emissions by 400,000 more pounds. EPA's new loophole would allow a total increase of an astonishing 1.3 million pounds of HAPs from just these 26 industrial facilities in the Houston-Galveston region.[8]

We share the serious concerns of those who opposed past attempts to undermine legal protections against HAP increases. The Environmental Integrity Project and Environmental Defense Fund analyses make our concerns far more pressing. This alarming information demands your immediate attention.

The American public needs and deserves clean air and protection from hazardous air pollution. This is a matter of critical human health and safety. We ask you to reverse your decision to rescind the "once in, always in" policy, in order to safeguard future generations from harmful air pollutants. Thank you in advance for considering this timely and important request.

Sincerely,

DEBBIE DINGELL
Member of Congress

DONALD S. BEYER JR.
Member of Congress

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[5] Environmental Integrity Project, *Toxic Shell Game: EPA Reversal Opens Door to More Hazardous Air Pollution* (Mar. 26, 2018) (www.environmentalintegrity.org/wp-content/uploads/2017/02/Toxic-Shell-Game.pdf).
[6] Environmental Defense Fund, *Pruitt's New Air Toxics Loophole: An Assessment of Potential Air Pollution Impacts in the Houston-Galveston Region* (Apr. 10, 2018) (www.edf.org/sites/default/files/documents/OIAI-Houston%20case%20study%20FINAL.pdf).
[7] *Id.*, at 2.
[8] *Id.*

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ZOE LOFGREN
Member of Congress

Congress of the United States
Washington, DC 20515

June 14, 2018

The Honorable E. Scott Pruitt
Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, N.W.
Washington, D.C. 20460

Dear Administrator Pruitt:

We are deeply concerned with your May 9th memorandum regarding future National Ambient Air Quality Standards (NAAQS) reviews and standard setting.

Section 109(b)(1) of the Clean Air Act directs EPA to establish "ambient air quality standards the attainment and maintenance of which in the judgment of the Administrator, based on such criteria and allowing an adequate margin of safety, are requisite to protect the public health." Health is the sole criterion for setting the primary standard. Yet your memo invites that criterion to include economic costs.

Your memo specifically asks the Clean Air Scientific Advisory Committee (CASAC) to consider "adverse social, economic, or energy effects related to NAAQS" during the standard-setting process. Currently, cost considerations inform implementation of the health standards, but not their establishment. The Supreme Court unanimously confirmed this point in *Whitman v. American Trucking Associations*, 531 U.S. 457 (2001), ruling that EPA may not consider implementation costs in setting NAAQS.

The health-based NAAQS have driven lifesaving air pollution cleanup for decades. According to EPA's own analysis, from 1970 to 2015, aggregate national emissions of the six criteria pollutants dropped an average of 70 percent – even as GDP grew by 246 percent. The agency also found that steps taken under the Clean Air Act, including implementing and enforcing the NAAQS, will prevent 230,000 premature deaths in the year 2020 alone. The work of the Clean Air Act and the NAAQS is far from finished, as more than four in ten Americans still live in areas where levels of ozone or particle pollution make the air unhealthy to breathe.

Allowing the consideration of factors other than health in setting future NAAQS would not only result in inadequate standards that would cause undue harm to the health of millions of Americans, it would also set a dangerous precedent for setting EPA standards. Your memo calls for the expedited review of two pollutants, particulate matter and ozone, which have the potential to aggravate asthma, increase the severity of chronic lung diseases, damage the lungs, cause cardiovascular harm, and even cause death. Emerging research shows links to additional health harms. Those at increased risk include children, seniors, pregnant women, people with chronic lung and heart disease, people who work or exercise outdoors, people of color, and lower-income communities. Weakening these public health and clean air standards to help industry will not eliminate costs, it will merely shift them to communities, workers, and children, and increase the cost of medical care for those affected.

Using the CASAC as the vehicle to make this change is also very concerning given your decision to bar scientists that receive agency funding from acting on advisory boards. This action diminishes the input from the world's best scientists and we fear it will advantage the economic arguments of industry to the detriment of public health. It is clear from the Clean Air Act's text, "allowing an adequate margin of safety," that the intent of Congress is to err on the side of caution to protect human and environmental health. Any leniency to ozone and particulate matter NAAQS as a favor to industry resulting from these reviews will only endanger health and the intent of the Act.

There is a highly problematic, internal contradiction at the heart of your memorandum and your charge to CASAC. In describing the controlling legal precedent, your memo claims that "adverse public health… effects" from attaining a standard are "relevant to the standard-setting process." The memo then uses ellipses to omit that the other impacts related to implementation of the standard, may be considered only after that standard has been set: namely economic impacts, energy effects, etc. that may result from various attainment strategies. Despite this, your memo's 'charge questions' to CASAC asks them to "advise the Administrator of any adverse public health, welfare, social, economic, or energy effects which may result from various strategies for attainment and maintenance of such NAAQS" *during the standard-setting process.* This charge question to CASAC contradicts the memo's recognition of the restrictions in the controlling Supreme Court decision. The memo notes that your charge may "elicit information which is not relevant to the standard-setting process, but provides important policy context for the public, co-regulators, and EPA." CASAC must only consider adverse public health effects--from the air pollutant itself--that are relevant to the standard-setting process, during that process. CASAC should not consider alleged health effects related to attainment strategies, and CASAC certainly must not consider economic or energy effects allegedly resulting from those implementation strategies, during any health standard-setting process.

Your memo's stratagem—formally directing CASAC to consider non-health factors during the standard-setting process, before final standards are adopted—is highly objectionable. We, therefore, urge you to withdraw the improper charge to CASAC at once, and to make clear that CASAC—and EPA—will remain focused exclusively on the adverse public health effects that the Clean Air Act and a unanimous Supreme Court confirm are the only relevant statutory considerations during the health standard-setting processes.

The Clean Air Act has been an overwhelming success for the health of Americans. We urge you not to backslide on that legacy.

Sincerely,

Donald S. Beyer Jr.
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Marcy Kaptur
Member of Congress

Gerald E. Connolly
Member of Congress

Nanette Barragán
Member of Congress

Diana DeGette
Member of Congress

Jerry McNerney
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