Today is my great pleasure and to introduce to this speaker, doctor Susan Anenberg. Susan is associate professor and chair of the Department of Environmental and Occupational Health in the George Washington University and she's also the current director of the DW PAN and Health Initiative Institute and Doctor. August Research focus on the health implications of air pollution and climate change, from both local to global skills.
And we talk a lot about policy implications. Doctor Annenberg is really the true pioneer of making the science of this policy relevant. She serves on the US EPA Science Advisory Board and the Clean Air Act Advisory Committee and the Global air pollution and Health Technical Advisory Group and the National Academy of Sciences Committee to advise the US Global change. She also serves as currently the President of the Jail House section of the American Geophysical Union.
So without first deal, let’s welcome those energy. And for being here today, I really appreciate you taking the time out of your days to be here. So I’m Susan Annenberg from George Washington University, and I will be talking today about linking climate change, air pollution and human health and bridging science to the policy, which is really what I’m very passionate about doing.
let me just say that a lot of the work that I'm going to show today is really standing on the shoulders of giants. This is work that would not be possible without the people who have spent many years detecting associations between air pollutants and health outcomes, developing air pollution exposure datasets that are open and publicly available for others to use. And I appreciate the efforts of many people in this room and contributing to that science. And this really makes the bridging.
00:02:20.410 --> 00:02:22.611 by creating these datasets and associations that others can use.

00:02:22.611 --> 00:02:24.726 But based on the information that we have from Epidemia epidemiology and exposure science,

00:02:24.730 --> 00:02:26.992 we know that air pollution continues to be a leading health risk factor in nearly all countries.

00:02:26.992 --> 00:02:29.158 That’s not the 4th leading environmental risk factor.

00:02:29.158 --> 00:02:30.907 And really indicates that air pollution

00:02:30.910 --> 00:02:32.824 is currently considered to be

00:02:32.824 --> 00:02:34.914 the 4th leading risk factor

00:02:34.914 --> 00:02:36.794 affecting global mortality.

00:02:36.800 --> 00:02:38.520 That’s not the 4th leading environmental risk factor.

00:02:38.520 --> 00:02:40.240 That’s the 4th leading overall risk factor.

00:02:40.300 --> 00:02:41.929 And really indicates that air pollution
needs to be central on the global health

And if you look at the diseases

it is not a small fraction of these diseases

I mean this is a, you know,

40% of chronic obstructive pulmonary disease,

20% of diabetes,

20% of ischemic heart disease and you can

read the rest of the the percentages there.

So this is a preventable risk

factor that it is responsible for.

Millions of premature deaths

globally and a very large,
NOTE Confidence: 0.848036556
00:03:25.600 --> 00:03:29.250 of these diseases around the world.
NOTE Confidence: 0.848036556
00:03:29.250 --> 00:03:31.422 And we also know that climate
NOTE Confidence: 0.848036556
00:03:31.422 --> 00:03:32.870 change worsens air pollution.
NOTE Confidence: 0.848036556
00:03:32.870 --> 00:03:34.895 So climate change is contributing
NOTE Confidence: 0.848036556
00:03:34.895 --> 00:03:36.110 to worsening ozone,
NOTE Confidence: 0.848036556
00:03:36.110 --> 00:03:38.030 increased wildfire smoke,
NOTE Confidence: 0.848036556
00:03:38.030 --> 00:03:39.310 increased dust,
NOTE Confidence: 0.848036556
00:03:39.310 --> 00:03:40.876 worsened allergy conditions,
NOTE Confidence: 0.848036556
00:03:40.876 --> 00:03:42.964 and even potentially impacting
NOTE Confidence: 0.848036556
00:03:42.964 --> 00:03:44.530 airborne infectious diseases,
NOTE Confidence: 0.848036556
00:03:44.530 --> 00:03:46.930 both the spread and the severity
NOTE Confidence: 0.848036556
00:03:46.930 --> 00:03:48.530 of airborne infectious diseases.
NOTE Confidence: 0.848036556
00:03:48.530 --> 00:03:50.745 So air pollution and climate
NOTE Confidence: 0.848036556
00:03:50.745 --> 00:03:52.517 change are highly interlinked.
NOTE Confidence: 0.848036556
00:03:52.520 --> 00:03:54.067 This is just one of the ways
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that they’re interlinked, and we’re going to talk about some of the others.

But climate change is now worsening. Air pollution making it harder for us to protect the air, making it healthy for people to breathe and and.

One of the ways that we one of the most prominent effects of climate change on air pollution is now wildfire smoke.

So I just want to look at some of the recent work that I was a part of looking at PM 2.5, you know, very fine particle concentrations
across the United States, the Eastern US and then the Western US and we see across the the last couple decades for the United States, PM 2.5 concentrations have been declining substantially. That’s a huge public health win and. Is the result of many years of effective regulations under the Clean Air Act in the United States. So PM 2.5 concentrations have been declining substantially and even more substantially in the eastern US, where we have very strong anthropogenic emissions that have been controlled.
from our power plants and our vehicles over the last couple of decades. And we’ve seen this very dramatic decrease.

Again, 2.5 crowded Eastern US in the western US, we have a different story here with a lot of interannual variability in those PM 2.5 concentrations in the last 5-10 years, and that’s driven by wildfire smoke. If you draw a line through this very large interannual variability, you see that PM 2.5 concentrations are actually increasing in the Western US, despite the very effective regulations that we have on power plants and industry and vehicles.
And that different disparate picture between the western US and the eastern US is driving what we see here for the US on average, that we actually see that the PM 2.5 concentrations are beginning to flatten out. They’re not declining to the same degree as they have been for the past couple of decades. We’re actually seeing that they’re starting to stagnate in the coming decades. We might actually start to see that they’re starting to rise again. And this makes it more difficult for us to attain our national ambient
air quality standards for PM 2.5 because of this climate induced change and wildfire smoke keeping PM 2.5 concentrations high. I had the honor of working with the US Environmental Protection Agency on their climate change impacts and risk analysis project, their Sierra project. I used to actually work at the EPA from 2010 to 2014, and when I was there, we were starting this project to quantify the different damages of climate change on life in the United States, and that includes air pollution, but it also includes a lot of other
things like labor and extreme temperature mortality and coastal property and roads and back at that time, the only. Estimate of how climate change impacted air pollution and therefore damages through human health in the US was via ozone. air quality was the 4th largest damage of climate change in the United States once valued.
we also think that climate change is influencing. Yea, 2.5 and PM 2.5 has a very strong relationship with premature mortality. So if we were able to quantify the impacts of climate change on PM 2.5, in addition to ozone, we likely would get an A large, potentially a larger number. Back in 2015, climate models were still very uncertain about where the precipitation happens, what’s going to happen to PM 2.5 in different locations.
And that still remains a big uncertainty.

But we do know that climate change is driving.

Quote UN quote natural sources of PM 2.5, which are no longer, I think can no longer be considered fully natural anymore because climate change is impacting them.

So dust exposure in the southwest US, wildfire PM 2.5, which we just talked about.

So I partnered with the EPA and a number of other scientists and we quantified the potential damages of climate change on dust exposure and therefore premature mortality in the US.
and same with wildfire smoke exposure. And we valued that. And we came up with about $47 billion a year from climate induced contributions to dust exposure and its effects on premature mortality and about $25 billion a year for wildfire smoke. And if you add those together with the ozone impact that we had previously quantified, we see that air pollution is one of the largest damages of climate change in the United States. And this is an estimate that I think is likely to grow, I think. We underestimated this impact due to the
methods that were available at the time, so I think this number is likely to get larger. Another reason it’s underestimating the damages of climate change on air pollution is because we can’t just add together the impacts of heat on mortality and the impacts of air pollution on mortality. These actually have synergistic effects. So the total impact of increased heat and increased air pollution is more than the sum of its parts. In the previous slide I just showed you we were only capturing the impact of
each of these risk factors individually, not considering the others. But because we know that there are these synergistic effects, we’re likely missing some of these damages of both heat exposure. And air pollution. And as more research comes out looking at the pollen impacts as well, I think that could be potentially a factor to consider here too. So I talked about how there’s different links between climate change and air pollution. We talked about this one, how climate change can impact air pollution.
Air pollution can also impact climate change. We have short-lived climate pollutants, for example black carbon and methane that contributes to poor air quality and warm the climate. This arrow here is. Sorry should go from climate change to public health. Not that the other association between climate change and air pollution that I want to talk about is how they share the same emission sources. Anytime we burn anything, primarily fossil fuels but also biofuels, we’re releasing both airplanes.
and greenhouse gases.

So if we want to address climate change and air pollution, we should be reducing the amount of fuel that is burned and therefore addressing those emission sources.

What we’ve done so far in the United States by to. Bring down our PM 2.5 levels. We’ve tried to break this arrow between emission sources to air pollution. So we put catalytic converters on our vehicles. We put diesel particulate filters on our trucks, scrubbers on our power plants,
and these have been very effective at reducing the amount of pollution from these emission sources.

But they’ve done nothing to this era here.

We’re still continuing to make greenhouse gases largely unabated, and that climate change is contributing to the air pollution problem.

So if we want to again mitigate both air pollution and climate change.

We need to be burning less stuff, primarily fossil fuels, but also biofuels.

I have focused a lot of my work, especially the most recent years,
on the urban context, and the reason for that is because a lot of cities around the world are experiencing poor air quality. This is just a map of nitrogen dioxide concentrations in the US, but a lot of cities around the world are experiencing much greater levels of pollution than we do in cities in the US, especially in cities in Africa and Asia, which are rapidly growing. These are experiencing rising air pollution levels. They’re also, cities are also experiencing CO2 emissions growth. Right now,
Cities are responsible for about 3/4 of global greenhouse gas emissions, and that’s projected to rise as the world continues to urbanize. We also have very strong health inequality effects. So this is a map of Washington, DC, where I live. And the green colors here show the pediatric asthma emergency department visit rate for 10,000 people. And the red dots show life expectancy. We have about a 20 year life expectancy differential between neighborhoods in the southeast quadrant of the city.
right here versus neighborhoods in the northwest quadrant of the city.
20 year life expectancy differential between people that live about 2 miles away from each other. We also have very dramatic differences in pediatric asthma Ed visit rate as well. So this is just, you know, DC is not unique. We have problems for sure, but we're not unique. Most of the cities across the country are experiencing problems like this and then we have growth growing populations. So right now about half the world’s population lives in urban areas.
That’s expected to grow to about 2/3 by 2050.

And nearly all of that increase is anticipated to happen in African and Asian cities, where, again, pollution levels are also continuing to rise.

So there’s a lot of problems happening simultaneously in the urban context, and if we were to address the way that our cities burn fuel, we likely would be able to get at multiple of these problems.

What we can’t see, we can’t fix. We have to be able to see the pollution in order to fix it.
Right now this is where the monitoring happens for air pollution around the world. You can see most of the monitors are in the US and Europe, and increasingly in China and in India. But much of the world is left uncovered. And even in places that look like they’re densely covered by monitors, like Washington DC, we only have 5 monitors, or looks like 4, but two. We only have 5 monitors for the entire city of Washington DC, so how are we supposed to capture the inequality and pollution levels if we have these?
This is our only source of information? Luckily, we have a new source of information which is Earth observing satellites. So NASA, the European Space Agency and other space agencies around the world have been launching satellites and they are constantly taking pictures about miseric composition. And we can tease out that information and understand what are people exposed to in places that have no monitors. This is a map of what nitrogen dioxide looks like from the Tropo ME sensor on the Sentinel 5P satellite from the European Space Agency.
Um, this map was created by Dan Goldberg and you can see where N2 is the highest and the fact that we have the full geospatial coverage here. So we can get beyond the monitors, we can get beyond the monitors and see what people are exposed to all around the world. So what does satellite data look like? Well, this is a daily snapshot of satellite and O2 Tropo mean No2 nitrogen dioxide that Dan Goldberg created. It’s, this is now available on our website. You can download for every day. It’s automatically putting up this image of No2 concentrations over the US and...
over different regions of the US and you can see there’s a lot of white areas, right? These are where clouds are. So the satellites can’t see through clouds. We’re still limited in that way and there’s also a lot of noise. This is just one snapshot per day. The TROPONE sensor is polar orbiting. That means it goes around the earth and it takes an image of the atmospheric composition at about 1:30 PM everywhere on Earth local time. So just the one snapshot per day, and this is what it produces.
Pretty noisy.

But when we start to average over longer time periods, we have a lot more data and it starts to look more smooth.

So this is a season of data of N2 concentrations over the US and then the comparison for 2021 to 2019. And again you can get this on our website.

So what we can do with the full geographical coverage of satellite data and increasingly high spatial resolution as well is that we can start to tease out what is happening in all urban areas globally. And there’s about 13,000
Urban areas globally.

So we can use that continuous spatial map that we get from satellite data and integrate and aggregate that up to the urban areas from Veronica Sutherlands and Ross Mohegan and.

Danny Balashov, who have all worked with me, have done this for PM 2.5, for N2 and for ozone. So we now have available on a Nice website as well interactive website the levels of these three pollutants as well as their trends overtime and their contributions to.
the burden of disease in those cities for all 13,000 cities globally. We’ve given the data to the health Effects Institute who runs the state of Global Air project and they have published this report, air quality and health in cities for the first time. Making the data more available for cities around the world to use. And, you know, I think it’s important to note that in most of these, probably the vast majority of these 13,000 cities, there is no air quality monitoring.
So this is the first time that there’s really any estimate of the pollution levels in those cities. They’re likely to be very uncertain, probably wrong in a lot of different ways, but at least it’s a first, you know, first guess at what pollution levels are driven by the observations from these. The other thing we can do with the satellite data, with the continuous coverage, the continuous geospatial coverage from the satellite data,
is that we can get at what is happening within individual cities. And again, we know that cities are experiencing health inequality issues. There’s a long history of science telling us that air pollution levels are inequitably distributed within cities as well. But again, we can’t get that just from the four or five monitors that we have in individual city. So we need to use approaches for
estimating pollution levels between those monitors to understand inequality and air pollution levels. So this is a study led by Maria Castillo, who’s now an urban planning student at MIT. And we partnered with the DC local government, the DC Department of Energy and Environment and the Office of HealthEquity, who had the Volkswagen Diesel gate scandal. Anyone remember in 2015 there Volkswagen vehicles were equipped
with these defeat devices,

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pieces of software that would turn

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the emission control equipment on

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when the vehicle was undergoing

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regulatory testing of emissions and

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then off when they were being driven

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around in real world driving conditions.

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And that was leading to substantially

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higher orders of magnitude higher

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NOx emissions in real world driving conditions than during

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certification testing.

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So there’s a big lawsuit,

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people went to jail and now cities

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have access to settlement funds.

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They can use to direct resources
So the DC government had settlement funds and they came to us and they said, can you help us understand how air pollution is contributing to the health inequality problem in the city so that we might be able to direct these resources to places that are overburdened? So we estimated PM 2.5 attributable mortality using one of those continuous data sets of PM 2.5 in this case from the Washu group led by Randall Martin. And we estimated PM 2.5 mortality rates and. We saw that the highest PM 2.5 mortality rates occurred in the
eastern half of the city, and lower PM 2.5 mortality rates in the western half of the city. And this lined up almost exactly with the map of racial segregation, so the eastern half of the cities primarily black and the western half of the cities primarily white. I know what that noise is. This research was received some interest from NASA and they created this really nice looking map and made it the image of the day on the NASA Earth Observatory, which was really cool.
And because so many people follow the NASA Earth Observatory, if you don’t you should on Instagram or you know, whatever your social media choices. They posted it there and it got picked up by another influential Instagram accounts. Which has hundreds of thousands of followers. So this was a way that our study which was published in an esoteric journal Geo Health was picked up and brought to people who wouldn’t normally read papers of Geo Health. And I know they tell you, you never read the social media.
comments about your work. But you know in a lapse of judgment one day I decided to read those comments and anyone want to take a guess at the most frequent comment of the Washingtonian probs account got when they when they posted? Yes. Thank you for your work. That would be nice. The most frequent comment was done. So you know, I think people know this, people know that air pollution is inequitably distributed. But again, if you don’t show it with data and maps, then it’s difficult to address.
In this case, again, we work directly with the DC local government. So it was a way that they were able to help us design the study to answer the question that they had and then they can use the results to, you know, to determine how they’re using those settlement funds.

Fun Facts on Friday I just recorded a video at NASA studio, then that the lobby of NASA headquarters, a giant screen with me talking about this study.
And they did not tell me my face was going to be up there at the size of my course. So I’m not excited about that. But I’m excited that they are, that they’re highlighting this important work because I really think it does show the value of satellite data and what it can tell us in terms of real world’s problems that we’re experiencing in cities. So that was PM 2.5 and CO2 is a pollutant that a lot of us don’t think that much about. We often think about PM 2.5. That’s the largest contributor to the burden of disease from air pollution, followed by ozone.
And O\textsubscript{2} is a precursor to both PM 2.5 and ozone. So if we want to address those pollutants, we have to know where the No\textsubscript{2} is and control it. It’s also a high resolution tracer for urban traffic in particular it’s associated itself. With asthma development, that’s just not that’s just asthma exacerbation, but new development of asthma among children. And very conveniently it is highly correlated with ground level O\textsubscript{2} from monitors.
for example,

is a scatter plot created by my colleague Dan Goldberg and Gage Kerr who showed that trouble me No₂ columns. That's the amount of N₂ in the column of air between the satellite and the surface of the Earth. Is highly correlated to N₂ at the ground level monitor monitored by our AQS monitor monitors our air quality system monitors and so this makes it a very convenient pollutant to study. Whereas for PM 2.5, the satellites are monitoring at different quantity, aerosol optical depth and then we need
00:23:05.404 --> 00:23:07.416 to do a bunch of science to convert
00:23:07.416 --> 00:23:09.224 that to ground level PM 2.5 here,
00:23:09.224 --> 00:23:11.030 even if we just took the Tropo
00:23:11.090 --> 00:23:12.110 Vienna 2 columns,
00:23:12.110 --> 00:23:14.476 we have a pretty good sense for
00:23:14.476 --> 00:23:16.857 where the ground level 2 is.
00:23:16.860 --> 00:23:20.060 So around the time that the pandemic hit,
00:23:20.060 --> 00:23:22.440 we had just hired Dr. Gage Kerr as a postdoc and we
00:23:22.440 --> 00:23:25.618 were wondering whether or not we
00:23:25.618 --> 00:23:28.376 could use these troponin data.
00:23:28.376 --> 00:23:30.556 So troponin data started that
00:23:30.560 --> 00:23:32.930 the records started in 2018,
00:23:32.930 --> 00:23:35.300 so it was very new.
00:23:35.300 --> 00:23:36.660 And you know, when the
00:23:36.660 --> 00:23:38.750 And you know, when the
pandemic hit in spring 2020,

Dan Goldberg had been going through these energy readings and looking at different urban areas and seeing how the trends differed in different cities. And we wondered, you know, could we use this data set to explore how No2 changed during the pandemic? There are a lot of people working on air quality changes during the pandemic. Of course, there’s a whole community of people. We actually got on the phone once a month talking about air quality changes during COVID.
further and really leverage the value of the satellite data with that complete geospatial coverage. And one of the, you know, values of that satellite data is the fact that we can look within cities, different subpopulations. Living within cities. So we had no idea whether we could use this data set to explore disparities. And I know two concentrations, but we we thought, let’s just give it a shot, see what happens. Probably we won’t see anything. Well,
it turned out we did see something and it was really striking to me. So prior to the pandemic in 2019, the least white census tracts across the United States had no two concentrations that were about double the concentrations. Again, that’s prior to the pandemic. During the lockdowns in 2020, both the orange dots and the blue dots shifted left, and that indicates that NO2 dropped for both the least white census tracts and the most white census tracts.
Just good thing, you know, we had about 50% fewer passenger vehicles on the road. It’s a good thing that we can observe and O2 just by itself. That was useful to know that we could use this tromi data set to observe that drop in and O2 during the 2020 lockdowns. But, one thing that we found that was really concerning was that during the 2020 lockdowns, then O2 concentrations in the...
least white Census tracts were still about 50% higher than the concentrations and the most white census tracts prior to the pandemic. And this indicates that the disparities in antipollution were so large prior to the pandemic that even about a 50% drop in passenger vehicle traffic was not enough to eliminate those disparities. And that held, that pattern held for nearly all major cities across the US and also held for educational attainment and for income. But really,
that only tells us about exposure.

We're really just concentrations, not even exposure.

It doesn’t tell us about the susceptibility of the population.

That is breathing those concentrations.

So Gage took this a step further and looked at both PNC .5 and N2, and not just the concentrations,

but the health outcomes that are associated with those concentrations.

So he’s comparing PM 2.5 attributable mortality per 100,000 people and that NATO attributable pediatric

asthma incidence rate as well.
And let’s just look at PM 2.5 first. We see that PM 2.5 concentrations are dropping over time for both the most white and the least white census tracks across the United States. This is very similar to the graph I showed you at the beginning, showing that PM concentrations are going down, starting to stagnate a little bit due to those Western US fires. But the disparities persist, as many others have found in the literature as well, for the least weight census tracts.
and then they are for the most white census tracts. And the relative disparity, the relative ratio between blue dots and the orange dots here, is actually rising over time. So the relative disparity is getting worse even though the levels are coming down for both populations subgroups. For No2, on the right hand side here we see that no two and its associated impact on asthma incidents among children is also decreasing over time, again to very successful.
But the disparity is much, much larger than it is for PM 2.5.

In fact, the relative disparity is about 7 1/2, meaning that the most the least white census tracts have values that are about 7 1/2 times larger than the most white census tracts, whereas that value is only 1.3. For PM 2.5 not to diminish 1.3, that’s still 30% larger PM mortality impacts for the least white Census tracts compared to the most white census tracts, but no two exhibits far greater.
disparity than PM 2.5 does.

Now, all of this that I've just showed you is based on one exposure concentration data set per analysis. And there's a lot of people working on a lot of different concentration data sets, both PMC .5 and NO2, and we don't know which one is the best. People are using different methods, they're using different approaches, and we wanted to know how much of the result that I just showed is actually driven by features.
00:28:29.181 --> 00:28:31.682 of the one data set that we used as
NOTE Confidence: 0.855744011666667
00:28:31.682 --> 00:28:33.818 opposed to other datasets where we
NOTE Confidence: 0.855744011666667
00:28:33.818 --> 00:28:36.318 find this across multiple datasets.
NOTE Confidence: 0.855744011666667
00:28:36.320 --> 00:28:40.540 So gauge is now comparing No2 disparities
NOTE Confidence: 0.855744011666667
00:28:40.540 --> 00:28:43.434 for four population subgroups using
NOTE Confidence: 0.855744011666667
00:28:43.434 --> 00:28:45.678 the EPA air quality system regulatory
NOTE Confidence: 0.855744011666667
00:28:45.678 --> 00:28:48.138 monitors on the left hand side here.
NOTE Confidence: 0.855744011666667
00:28:48.140 --> 00:28:50.975 For the 10 most populous cities in the US,
NOTE Confidence: 0.855744011666667
00:28:50.980 --> 00:28:53.122 the numbers on the right show the
NOTE Confidence: 0.855744011666667
00:28:53.122 --> 00:28:55.038 number of monitors in those cities.
NOTE Confidence: 0.855744011666667
00:28:55.040 --> 00:28:56.360 And we see a pattern that’s
NOTE Confidence: 0.855744011666667
00:28:56.360 --> 00:28:57.800 kind of all over the place,
NOTE Confidence: 0.855744011666667
00:28:57.800 --> 00:28:59.212 in fact no pattern.
NOTE Confidence: 0.855744011666667
00:28:59.212 --> 00:29:01.405 So this these air quality system
NOTE Confidence: 0.855744011666667
00:29:01.405 --> 00:29:03.530 monitors are not able basically
NOTE Confidence: 0.855744011666667
00:29:03.530 --> 00:29:05.584 to capture the disparities that
we think exist and that a lot of other studies have found to exist. When we use a land use regression model for nitrogen dioxide, which uses statistical approaches to approximate No2 concentrations at pretty high resolution across the entire continental US, we see a stronger pattern pop out here. So for every major city we have the the lowest No2 concentrations in the non Hispanic white population and higher concentrations among the Hispanic, Asian and black populations.
The ordering differs by city, but it’s very similar to what we find using just the troponin No2 columns. So this is the land use regression model. Approximates surface level and O2 concentrations. The Tropome data is No2 columns that are more directly from the satellite and we see a very similar pattern here. We see that for both the non Hispanic white population has the lowest No2 concentrations. For some cities we see that. Ordering of the population subgroups is very similar, so in Philadelphia the ordering is very similar.
In other cities we see differences, but nevertheless there’s much closer consistency between the land use regression data set and the troponin data set compared with the monitor data set. It’s really not surprising. I mean the monitor data set was not intended to be used for this purpose and we’re really was intended to monitor regional average pollution and not neighborhood scale pollution that differs within cities. So that was for No2. That would really LED us to wonder, OK,
Well the data set that you use for N2 has a big impact on the estimated disparities.

What about for PM 2.5, which is a prudent that doesn’t vary as much spatially as an O2 does, and the two has a very short atmospheric lifetime, it stays pretty close to the mission source. PM 2.5 has a lot more emission sources. A lot of it is secondarily formed in the atmosphere. It lives longer in the atmosphere, so it spreads out and sort of smooth spatially. So we but there’s a lot of attention on PM 2.5,
right, the Justice 40 initiative of this current administration. This is a new initiative that is aimed at 40% of the benefits. Of federal investments going to disadvantaged communities, the data set they’re using to do that, to identify communities as disadvantaged as a 12 kilometer spatial resolution for PM 2.5. That’s this CMAC model monitor fusion data set. That’s the one that’s used in EJ screen. It’s used in a lot of EPA regulatory
support documents and now it’s used in the climate and economic justice screening tool suggest that is used for the Justice 40 initiative.

So we wondered, if we used a different high resolution data set that’s now available from the scientific community, would that lead to differences in which communities are flagged as disadvantaged in the Justice 40 initiative?

So we’re now comparing. The CMAC Model monitor fusion data set at 12 kilometer spatial resolution with the the data set I talked about earlier from the Washu team,
the bins unclear at all data set that
fuses satellites with a geophysical model.
And then there’s a new data set led
by Haresh mini that’s available at 50
meter resolution within cities and
1 kilometer resolution outside of cities.
And you can see just looking
at the spatial resolution,
the spatial distribution
in Los Angeles at the top,
Chicago in the middle and Phoenix
in the middle and Phoenix
on the bottom. These datasets,
they look somewhat similar in terms
of their being a BLOB over the city.
But once you start to look a little bit
closely, they really differ in terms of which neighborhoods are popping out at having the highest concentrations.

This is still a work in progress, but this is led by Doctor Tess Carter, who just recently finished her PhD at MIT.

And I just want to point your attention to the top few rows here, which show all census tracts, urban tracts and rural tracks across the US. On the left hand side here is that comparing the most non Hispanic white populations to the least. Then on the right hand side is most Hispanic versus least Hispanic.
And we see for each of these three datasets the CMAC Fusion, the vans angular .01 is that spatial resolution and then a mini, all three of these data sets are very consistent in what they show for at those geographies. And it's very similar to for each region. The absolute magnitude of the values of the PM 2.5 concentrations differ, but the disparities, the patterns and disparity are similar. This is on a regional average basis.
is that on a regional average basis,

NOTE Confidence: 0.878951873333333

this EMAC data set not so bad for estimating those disparities.

NOTE Confidence: 0.878951873333333

And you can imagine why that might be.

NOTE Confidence: 0.878951873333333

For PM 2.5,

NOTE Confidence: 0.878951873333333

we have two things happening simultaneously.

NOTE Confidence: 0.878951873333333

We have regional PM 2.5 concentrations.

NOTE Confidence: 0.878951873333333

PM is sort of higher in California and the southwest US than it is in other parts of the US and we have that happening at the same time as regional sorting of populations.

NOTE Confidence: 0.878951873333333

There’s a very large Hispanic population, for example,

NOTE Confidence: 0.878951873333333

in California and the southwest.
breathing those high PPM concentrations in that same region. So that’s sort of regional nature of both population sorting as well as pollution. That’s one effect. The second effect is what’s happening in urban areas. PM 2.5 has some intra urban spatial variability, or so the literature tells us. And that, you know, driven by anthropogenic sources within cities could be contributing to differences in neighborhood scale.
pollution levels within cities. So this maybe is actually not that surprising that this lines up pretty well regardless of the data set because the spatial resolution of data set doesn’t matter that much for that regional effect, that first effect I was describing. But for the intra urban effects, the 12 core meter data set is not going to be able to capture those intra urban variability. So what do we see within cities? We see something different so. In the top 10 most populated cities across the US.
One thing is consistent and that the non Hispanic white population has the lowest PM 2.5 concentration in all three of these datasets.

So we see a lot of the dark blue color left of 1. One is the average the the mean PM 2.5 concentration for the entire population. The non Hispanic white population has lower than average concentrations for every one of these major cities in all of the datasets but the ordering. Of the other population subgroups really varies quite a bit depending on the data set and that again is driven.
by the spatial distribution of the concentrations in the input datasets. I want to point out a couple other things. The CMAC Fusion data set, that 12 kilometer data set that’s being used by the Justice 40 initiative team right now that has the least variability between population subgroups. And again not surprising, this is 12 kilometer datasets not capturing that heterogeneity. But we definitely see that play out or we have the the narrowest range here for I just picked up Philadelphia here for Chicago and for New York. But then there’s really interesting
things that happen.

So New York, Chicago,
and Phoenix all show pretty different effects here,
where in New York we have the same ranking of population subgroups in terms of their PM 2.5 concentration for both of the two high resolution datasets, but not in the CMAC Fusion data set.

In Chicago,
we hardly get much variation at all in any of the three datasets.

And then in Phoenix,
all three of the data sets, including CMAC, the CMAC Fusion data set,
do have similar disparities across these population subgroups. So we’re still trying to dig into each of these cities and understand why they’re showing these different patterns. I’m really excited about the future because the satellite data we have available right now, these this polar orbiting satellite data, that’s a major improvement over what we had. what we had before, which is no satellite data, but we are now launching geostationary satellites which are going to hover over the US as the earth spins.
It’ll always be taking measurements over the US so Tempo is launching in April and that will be a geostationary satellite measuring atmospheric composition. Really excited about that. And then Noah is working on Geo EXO, which is an operational satellite intended to launch in the early twenty-thirties. And there’s so many stages of explaining why this is important. So they asked us to help them explain why this is important for air quality management and for public health.
So we’ve been really happy to be working with them and showing them the value of satellite data for managing air quality and for public health. And this is work led by Doctor Kate Odell, who is quantifying the number of four air quality alert days across the US that you would get if you had a geostationary Satellite which is taking measurements across all hours of the daylight versus if you only had that one snapshot from a polar orbiting satellite at 1:30 PM and she’s showing that the number of air quality alert days is much much higher for the Geo case.
00:38:57.570 --> 00:38:59.026 that’s the Geo stationary

00:38:59.026 --> 00:39:00.846 case versus the Leo case.

00:39:00.850 --> 00:39:02.380 Leo stands for low Earth orbit,

00:39:02.380 --> 00:39:05.428 which is the polar orbiting satellites.

00:39:05.430 --> 00:39:08.174 And we wanted to look at the disparities

00:39:08.174 --> 00:39:10.929 in the populations that are receiving

00:39:10.929 --> 00:39:13.414 receiving these air quality alerts

00:39:13.414 --> 00:39:16.218 if we had the geostationary data

00:39:16.218 --> 00:39:18.448 versus the polar orbiting data.

00:39:18.450 --> 00:39:21.124 And she finds that actually you know

00:39:21.124 --> 00:39:23.430 while the magnitude differs overall,

00:39:23.430 --> 00:39:26.670 the pattern of who, what you know the,

00:39:26.670 --> 00:39:28.614 the population sub categories

00:39:28.614 --> 00:39:31.044 experiencing these poor air quality

00:39:31.044 --> 00:39:33.474 alert days is actually pretty

NOTE Confidence: 0.867879225333333
similar depending regardless of the.

Geostationary or the polar orbiting satellite?

Really quickly, I want to go back to the framing of climate change, because again, air pollution and climate change come from the same sources. Anytime we burn fossil fuels and we burn biofuels, or releasing both air pollutants and greenhouse gases, we want to solve a lot of the problems that I just talked about. We could be burning less fuel and also be gaining by reducing CO2 emissions.
So I have been able to partner for the last few years with C-40 cities as well as a variety of other partners who had been. Planning, the largest worldwide effort for cities to undertake urban climate action planning. And these are cities that have committed to very deep decarbonization and creating ambitious plans for reducing greenhouse gases. And we help them understand not just their greenhouse gas reduction, but now understand also the reduction
00:40:33.210 --> 00:40:36.218 of PM 2.5 that they would get from
NOTE Confidence: 0.867879225333333
00:40:36.218 --> 00:40:37.804 taking those ambitious actions
NOTE Confidence: 0.867879225333333
00:40:37.804 --> 00:40:39.636 to reduce greenhouse gases.
NOTE Confidence: 0.867879225333333
00:40:39.640 --> 00:40:41.248 This is the framework that we
NOTE Confidence: 0.867879225333333
00:40:41.248 --> 00:40:42.052 did this within,
NOTE Confidence: 0.867879225333333
00:40:42.060 --> 00:40:43.770 and we implemented this in six
NOTE Confidence: 0.867879225333333
00:40:43.770 --> 00:40:45.280 pilot cities around the world.
NOTE Confidence: 0.867879225333333
00:40:45.280 --> 00:40:47.476 And I just want to show two of the
NOTE Confidence: 0.867879225333333
00:40:47.476 --> 00:40:48.916 examples of these are actually
NOTE Confidence: 0.867879225333333
00:40:48.916 --> 00:40:51.029 graphs that are now in these cities
NOTE Confidence: 0.867879225333333
00:40:51.029 --> 00:40:53.141 climate action plans for the first
NOTE Confidence: 0.867879225333333
00:40:53.141 --> 00:40:55.180 time integrating air quality into
NOTE Confidence: 0.867879225333333
00:40:55.180 --> 00:40:57.140 their climate action planning.
NOTE Confidence: 0.867879225333333
00:40:57.140 --> 00:41:00.556 So Buenos Aires saw their PM 2.5
NOTE Confidence: 0.867879225333333
00:41:00.556 --> 00:41:02.946 concentrations go down from about
NOTE Confidence: 0.867879225333333
00:41:02.946 --> 00:41:05.261 12 micrograms per meter cubed
00:41:05.261 --> 00:41:07.559 in 2050 to around 8,

00:41:07.560 --> 00:41:09.310 which was under the World Health Organization.

00:41:10.010 --> 00:41:11.634 Headline at the time we did this analysis,

00:41:11.640 --> 00:41:14.056 but it’s now over the W 1 because

00:41:14.056 --> 00:41:15.630 that would has been reduced.

00:41:15.630 --> 00:41:17.730 And then Johannesburg took a bit of a different approach here where

00:41:17.730 --> 00:41:22.216 they looked at each type of action

00:41:22.286 --> 00:41:24.463 they could implement and they they

00:41:24.463 --> 00:41:26.641 looked at the percent of total

00:41:26.641 --> 00:41:28.125 PPM concentration reduction from

00:41:28.125 --> 00:41:29.770 that action versus the percent

00:41:29.770 --> 00:41:31.780 of total CO2 emission reductions.

00:41:31.780 --> 00:41:34.636 And the one that achieved the
The greatest dual benefit was a mode shift from on road vehicles. We’re now helping them understand CO2 emissions a little bit more. So right now, each city is developing its own urban inventory of CO2 emissions, and that has advantages, strengths and weaknesses. The scientific community is very hard at work developing gridded CO2 emission data sets as well based on satellite observations of light at night and other data sources. And so we’re looking at whether or
not the self reported inventories

from the cities match what we think

might be happening in the scientific

And this is work led by Doctor Doyon

on where he’s comparing the GPC

inventory that’s the self reported

inventory versus a very widely used.

Um, globally gridded emissions inventory

called Edgar and he sees that the there,

called Edgar and he sees that the there,

sorry, in this other one is,

is ODC, as well as the different

grid CO2 emissions data set.

They want it pretty well.

This is actually better than I might
have expected prior to this project,

but he sees a lot more scatter outside

of the US and Europe and a lot more

consistency in US and European cities.

So just to conclude that climate

change is worsening air pollution,

which is already a leading factor

for global health around the world.

We have now access to data that we

that’s completely unprecedented,

these novel geospatial datasets they’re

increasingly capable of providing.

Information about pollution

levels everywhere in the world

with full geospatial coverage,

high temporal frequency and in some cases
now building long temporal trends too.

Some of these, some of these satellites have been flying for years and that’s enabled us to do a lot of different things.

I just talked today about air pollution levels globally and at 13,000 cities, as well as intra urban disparities.

But people are using these satellite data sets and all kinds of unique and very useful ways like spotting wildfire, smoke and dust storms.

And you know, I really think that this
improved information,

if we integrate this into our environmental management techniques,

including policy development,

we can achieve multiple societal improvements simultaneously.

I’ve been really fortunate to be in a position now where I can be training the next generation to be using data sets like this, and there’s new ways of doing environmental health that are now possible. So bringing that in, bringing in systems approaches and an equity and justice lens in addition to engaging multidisciplinary
00:44:23.775 --> 00:44:26.009 teams and diverse partners,

00:44:26.010 --> 00:44:27.949 I talked about some of the partners

00:44:27.949 --> 00:44:29.503 I've worked with including C-40

00:44:29.503 --> 00:44:31.439 cities and the DC government.

00:44:31.439 --> 00:44:33.977 That's just sort of scratching the

00:44:33.977 --> 00:44:36.590 surface that if you work directly

00:44:36.590 --> 00:44:38.705 with these action oriented partners

00:44:38.710 --> 00:44:40.666 from the beginning of a project,

00:44:40.670 --> 00:44:42.650 you can actually design a project

00:44:42.650 --> 00:44:44.959 to achieve the needs that they have.

00:44:44.960 --> 00:44:46.880 To improve life for people.

00:44:46.880 --> 00:44:47.960 And, you know,

00:44:47.960 --> 00:44:49.400 leveraging novel geospatial datasets

00:44:49.400 --> 00:44:51.119 is not something that I was,

00:44:51.120 --> 00:44:51.670 you know,
well, actually I was trained to use novel geospatial datasets that were novel at the time that I did my training, which is before satellites. But you know, a lot of people in the field didn’t have that, don’t yet have that training and something that we can bring into public health more frequently. There’s a lot of communities of practice to plug into as well. We’ve developed the climate and Health Institute at GW. We just are now completing a NASA
supported team called satellite data for environmental justice that brought together a lot of people that were using satellite data for this purpose and a plug to shameless plug to get involved in the AGU health community, which you know includes a lot of people who are using these big geospatial datasets to answer environmental health problems. Very excited that Doctor Chen is part of that community as well. So that’s it for me. Just wanted to acknowledge a lot of support and again reiterate
that without open data sets none of this would have been possible.

So thank you to the data set developers. Thank you.

I think it takes around 5 to 10 minutes for Q&A, so if you do have a question please.

Sure. Thank you so much for stopping. It’s really interesting.

I know that one of the major concerns amongst environmental justice communities with datasets such as EJ screen is that they’re not specific enough that they don’t get down to that really granular level of. Look, fenceline impacts umm.
And I’m curious how, when working with large datasets from satellites such as troponin, which only takes about once a day measurement, you can also bring in those qualitative data points from environmental justice communities on the ground to our experiencing air pollution impacts. I love that question because it really shows the value not just in this kind of quantitative data work that I do, but in the lived experience as well. And we’ve we’ve run into this multiple projects and I just couldn’t.
agree more with that because.

As I showed the we still have disagreement between several of the high resolution datasets that we're looking at.

I mean they are better I think than the course resolution data set.

But if you're, let's say you're looking at a map of Houston and you've got our land use regression data set of N2 and then the tricomi data set of two and you live in an area which is high in one data set and not in the other, what then? And you know where that is the reality we are in right now,
we’re in this messy space of data sets. Not matching at that granular scale and I just think it shows the limitation of what we can do with a, you know, one-size-fits-all approach you consistent across the US. We need to bring in people’s lived experience and understanding of the local sources affecting their community for this datasets to be improved. How we do that, I think let’s like. Get creative, right? I mean, we could bring in story maps of people’s life experiences,
you know, there’s a lot of ways it’s, it’s not even just about, community monitoring, which can be quite helpful. And, you know, we’re rapidly expanding that in the US right now, but, you know. You have people going out and writing about their experiences, taking videos of their experience. So I think that’s sort of community contributed, qualitative approach has a lot of value. Yes, just make sure there’s any students have a question for us.
Is there a hand over there?

Umm, so my question or this, first of all, thank you for the fabulous presentation. I greatly enjoyed it.

My question, slash comment is about environmental disparity. So I you know, a lot of times we see more and more and more beautiful, more and more detailed maps. However, if we could press a button today that made exposure equal across the world, first of all, we press it. Second of all, environmental disparities would still exist because people
respond differently to health.

So my comment to you my question. Is. What are your thoughts on this? Because I have had. Like when I talk with communities, 99 to 100% of them talk about exposure without talking about the fact that and it is a fact that we know that people respond differently. And to what degree do you think environmental health disparities should be? Are there may be some environmental disparities not incorporated into the world’s most perfect exposure map? The way they agreed to you that we have very focused on pollution levels,
and the same pollution level can cause dramatically different impacts for different populations.

I showed that map of Washington, DC and the high PM 2.5 mortality rate on the eastern half and the low PM 2.5 mortality rate on the western half. That actually comes from a pretty consistent PM 2.5 concentration for the entire city, but vastly different mortality rates.

The Southeast Quadrant has had no hospital. GW Building went out. I’m very happy that that’s happening.
But no hospital, so no access to healthcare. This is the same, you know, in cities all around the country and around the world that there’s, you know, social determinants of health are a major, Doctor Diamond exposure and I think in terms of addressing it, I mean we have like I said, the there’s this time and economic justice screening tools being used now for the Justice 40 initiative.
We have EJ screen to show where these disadvantaged communities are in a nationwide basis. Some are not accounting for those that increase susceptibility, increase mortality rates, higher mortality rates, higher health outcome rates. The Cbest tool right now is. Includes poverty and one additional indicator. So that could be PM 2.5 and EJ. Screen has an index. I think if we were to use more of like that index approach that brings in poverty,
brings in health and some of these other social determinants of health in addition to the pollution exposure, we can start to identify not just who is experiencing bad pollution, but who is most impacted by that bad. Thank you.

Any idea what’s causing the differences in disparities between cities? I’m originally from Chicago. The expressways run through black and brown neighborhoods, which is true everywhere. But disparities there, both knocks and five were fairly modest compared to the other cities.
That’s it’s such a great question. And we now have a big project with an environmental Defense fund to dig into Chicago specifically to understand that because Chicago does have a whole lot of trucking that is coming through the city. And as you say it is associated geographically with with with black and Hispanic populations. There is no some other major roads that are more in wealthier whiter neighborhoods like Lakeshore. Drive going going north. So when you take like an urban average.
It also very much depends on learning.

It very much depends on how you define what the city is.

Are you looking just at Chicago, the entire county, entire MSA?

And actually we've seen that the disparities flipped depending on how you define their opinion.

More details coming soon at Chicago, so that's an interesting one.

Thank you so much for the fascinating part.

You showed that by racial, ethnic exposure and O 2:00 PM, but how does that change over time?

Is there any like convergence
NOTE Confidence: 0.84271500875
00:52:53.325 --> 00:52:54.294 across those groups?
NOTE Confidence: 0.639273194
00:52:55.860 --> 00:52:58.079 They have to share share the slides
NOTE Confidence: 0.639273194
00:52:58.079 --> 00:52:59.745 but the the project that I showed
NOTE Confidence: 0.639273194
00:52:59.745 --> 00:53:01.621 that had the PM on the left hand side
NOTE Confidence: 0.639273194
00:53:01.621 --> 00:53:03.369 and the No2 on the right hand side
NOTE Confidence: 0.639273194
00:53:03.369 --> 00:53:04.851 that showed PM mortality rates and
NOTE Confidence: 0.639273194
00:53:04.851 --> 00:53:06.646 then No2 attributable asthma rates.
NOTE Confidence: 0.639273194
00:53:06.646 --> 00:53:08.806 Those do show trends overtime
NOTE Confidence: 0.639273194
00:53:08.806 --> 00:53:10.791 and the concentrations for both
NOTE Confidence: 0.639273194
00:53:10.791 --> 00:53:13.828 PM and NS are going down for all
NOTE Confidence: 0.639273194
00:53:13.828 --> 00:53:15.880 population subgroups really great.
NOTE Confidence: 0.639273194
00:53:15.880 --> 00:53:17.664 But the relative disparities
NOTE Confidence: 0.639273194
00:53:17.664 --> 00:53:19.894 are increasing for both parents
NOTE Confidence: 0.639273194
00:53:19.894 --> 00:53:22.298 because of the like the the changes
NOTE Confidence: 0.639273194
00:53:22.298 --> 00:53:24.280 in that that overall magnitude.
NOTE Confidence: 0.639273194

101
So the. That’s this one.

Thank you.

So the overtime, the PM concentrations have come down approximately the same amount for all population subgroups and that leads to an increased. Then for N2 this doesn’t really look like it, but these orange dots are going down as well. Much greater energy reductions for the least white communities, but still we see rising ratios of disparity relative disparities.

Thank you. The reason I ask this is...
From the population migration and point of view is very mixed picture. The data shows that it’s more segregation across cities unless so within cities in many parts of America. So that’s interesting. We only looked at the temporal trends and the pollution levels, not where people are living, so that would be an interesting question to look into. Uh, we do have a comment online, but I think it’s more like suggestion we can look at and thank you all for coming because
we have a class right office.

So we have to end today.

Thank you all and thanks.