Annual Health Impacts from Wildland Fire Air Pollution in the United States

Session 3A – Focus on the West:
Exposures & Health Impacts from Wildland Fires
HAQAST Utah

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NYU Marron Institute of Urban Management

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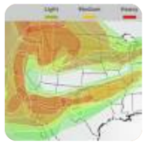
CNN

Smoke from Western wildfires has blown thousands of miles to New York

(CNN) Smoke from severe wildfires raging on the West Coast has blown thousands of miles east, reaching parts of the Midwest, Canada and upstate New York.



Los Angeles Times

2020 California wildfires likely offset years of air quality gains

Nationally, 29 of the top 30 counties with the highest level of particulate pollution that year were in California, researchers found.

https://ecology.wa.gov/Air-Climate/Air-quality/Smoke-fire/Agricultural-burning

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United States Environmental Protection Agency

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Treatment of Air Quality Data Influenced by Exceptional Events (Homepage for Exceptional Events)

Exceptional events are unusual or naturally occurring events that can affect air quality but are not reasonably controllable using techniques that tribal, state or local air agencies may implement in order to attain and maintain the National Ambient Air Quality Standards (NAAQS). Exceptional events may include wildfires, high wind dust events, prescribed fires, stratospheric ozone intrusions, and volcanic and seismic activities.

The Exceptional Events Rule

In September of 2016, the Environmental Protection Agency (EPA) finalized revisions to the Exceptional Events Rule to establish criteria and procedures for use in determining if air quality monitoring data has been influenced by exceptional events. The rule:

- applies to all exceptional event types and all NAAQS,
- ensures that air quality measurements are properly evaluated and characterized with regard to their causes,
- identifies reasonable actions that state, local and tribal air quality agencies should take to address the air quality and public health impacts caused by these types of events,

Exceptional Events Rule Webpage Navigation

- Treatment of Air Quality Data Influenced by Exceptional Events (Homepage for Exceptional Events)
- The Final 2016 Exceptional Events Rule, Supporting Guidance Documents, Updated FAQs, and Other Rule Implementation Resources
- Example Demonstrations and EPA Responses Prepared under the 2016 Exceptional Events Rule
- Federal Register Notices and Other Documents that Informed the Development of the 2016

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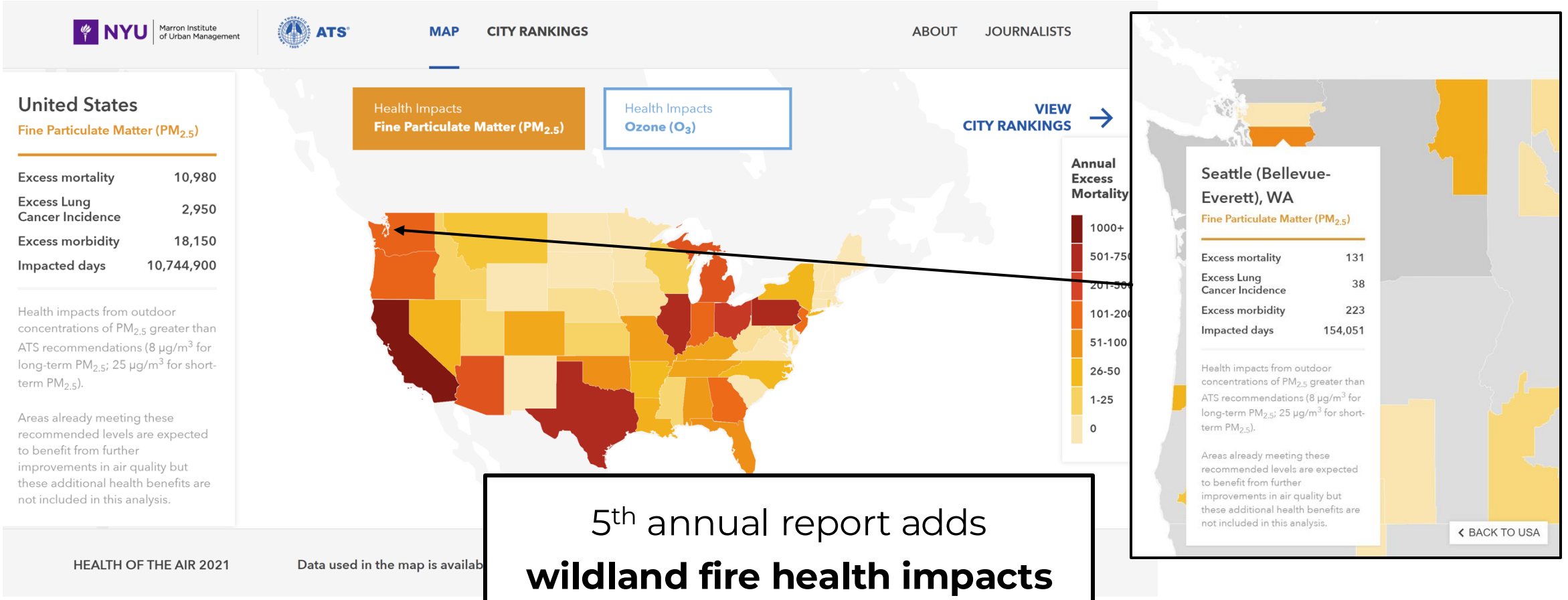
ATS-Marron "Health of the Air" Report



5th annual report adds
wildland fire health impacts

HealthoftheAir.org
Cromar et al. (2022)

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Fire-Specific Air Pollution Model

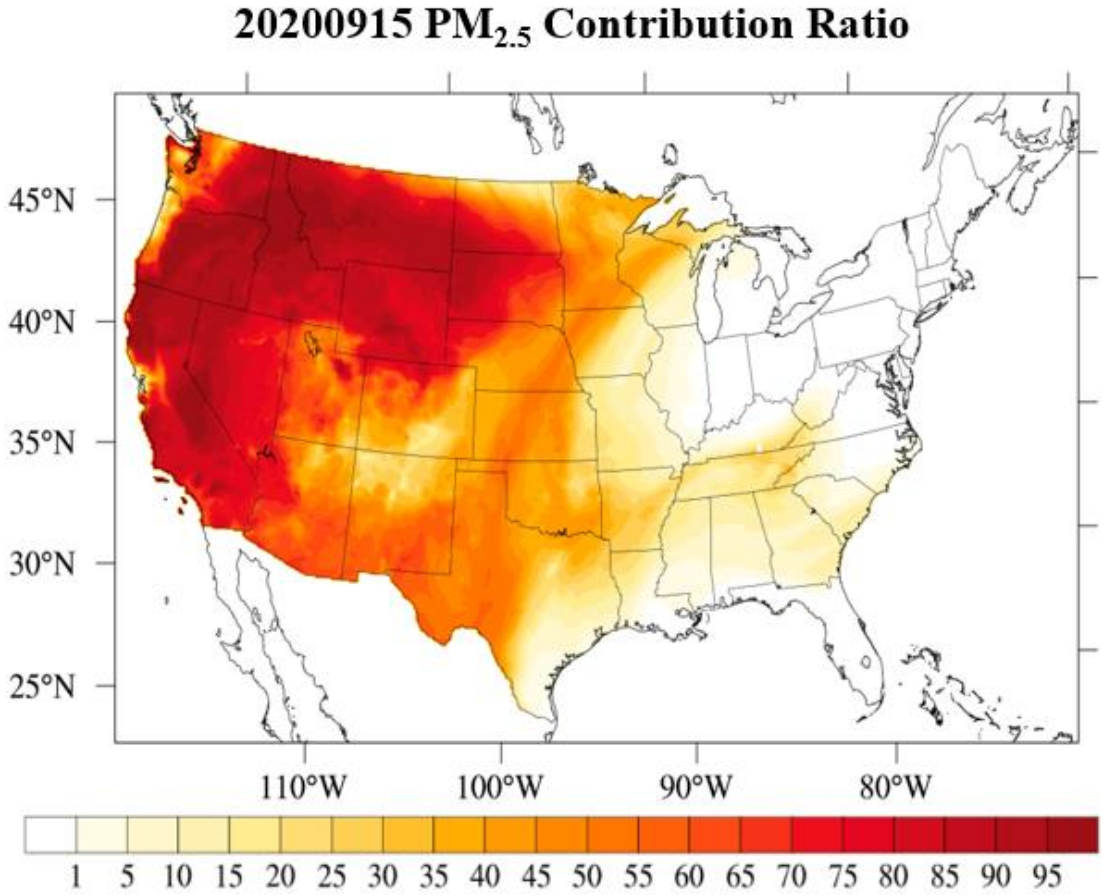
Satellite Observations

Blended MODIS and Visible Infrared Imaging Radiometer Suite (VIIRS) fire detection product

Air Quality Model

Community Multi-Scale Air Quality (CMAQ) simulations

With and without smoke
daily $PM_{2.5}$ & O_3 estimates for 2020



Tong et al. (2022)

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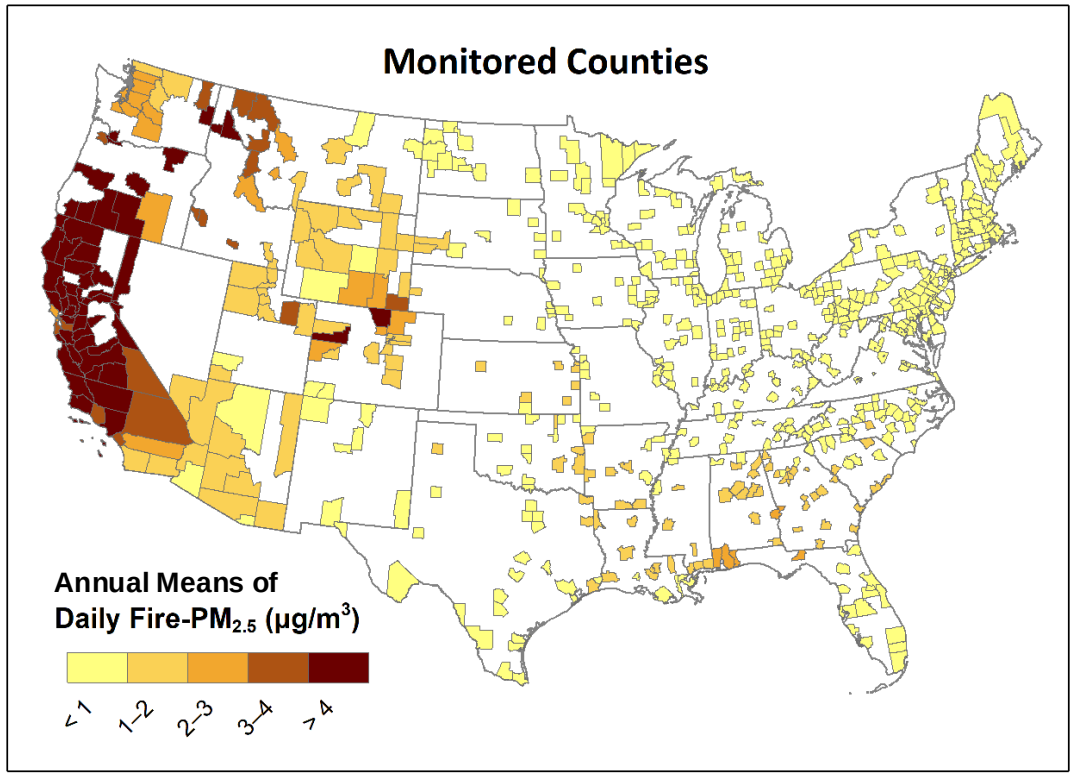

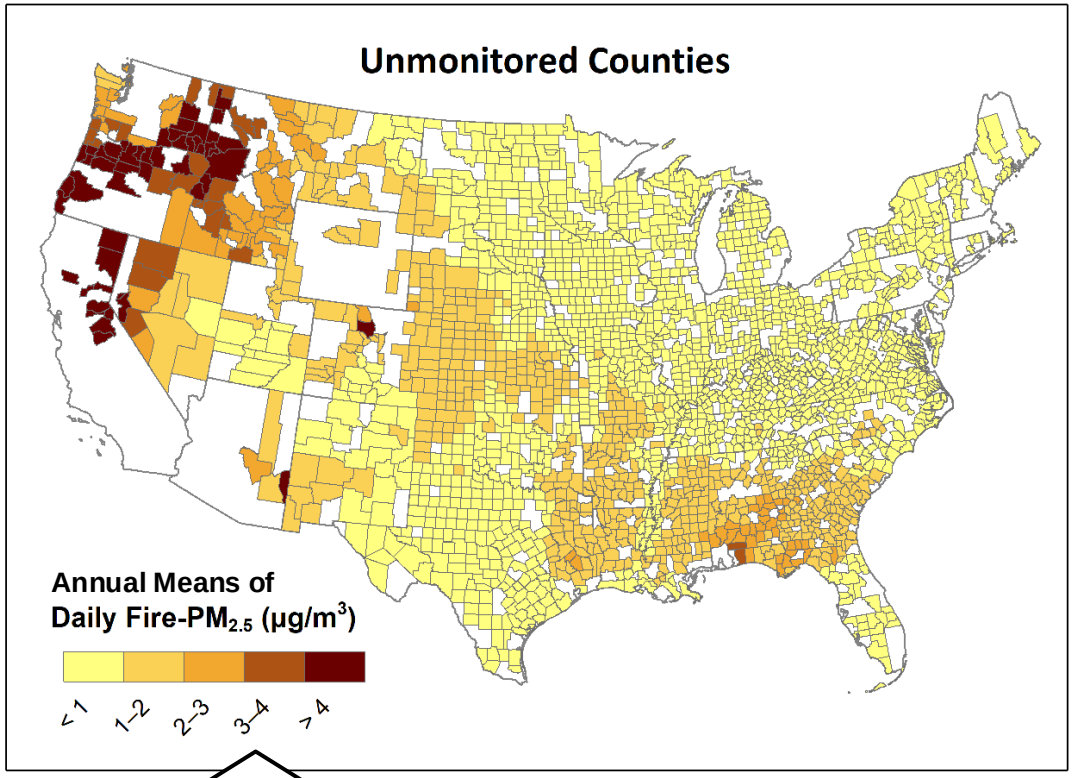

Air quality standards (for context):

WHO: 5 µg/m^3

ATS: 8 µg/m^3

U.S. EPA: 12 µg/m^3

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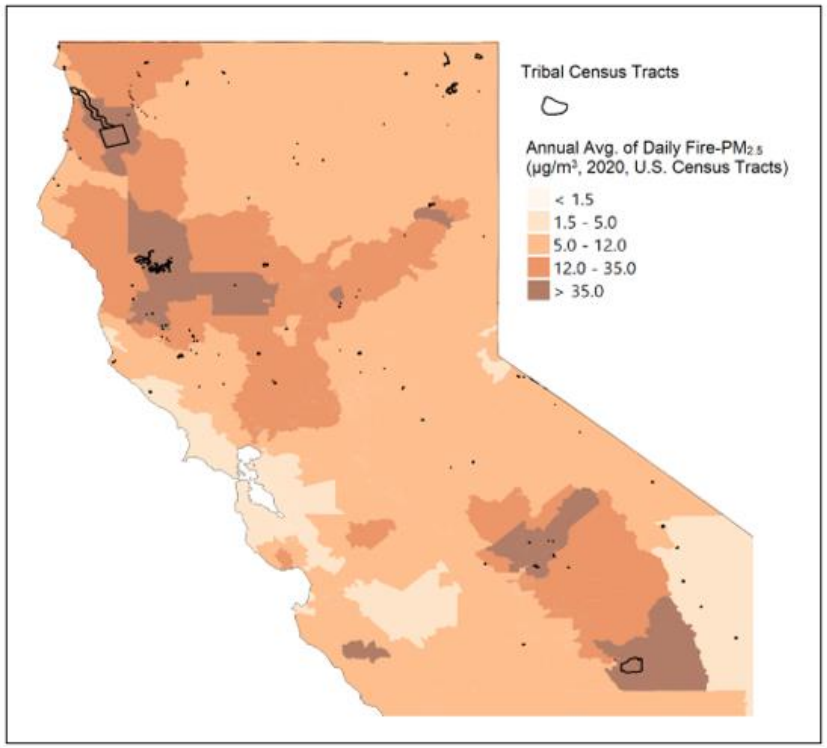
Region	No. Census Tracts (% of total)		2020 Annual Average Fire $PM_{2.5}$					
			Daily Mean (µg/m³)		Highest Daily Mean (µg/m³)		Percent of Total $PM_{2.5}$	
	National	Tribal	National	Tribal	National	Tribal	National	Tribal
Midwest	17,021 (24%)	93 (19%)	0.6	0.6	11.9	18.8	6%	8%
Northeast	13,494 (19%)	29 (6%)	0.3	0.2	8.4	3.9	3%	2%
South	26,201 (36%)	33 (7%)	0.8	1.0	15.5	25.8	7%	9%
West	15,568 (22%)	337 (68%)	4.1	5.2	274.1	357.3	11%	14%
Total	72,284 (100%)	492 (100%)	1.4	3.7	69.0	250.2	7%	12%

Regional comparison of fire $PM_{2.5}$ exposures in tribal vs. federal census tracts in the U.S. (2020). Highest daily mean corresponds to the highest annual daily mean in each group of census tracts.



Locations of tribal census tracts relative to U.S. census tract annual fire-$PM_{2.5}$ levels in Northern California (2020).

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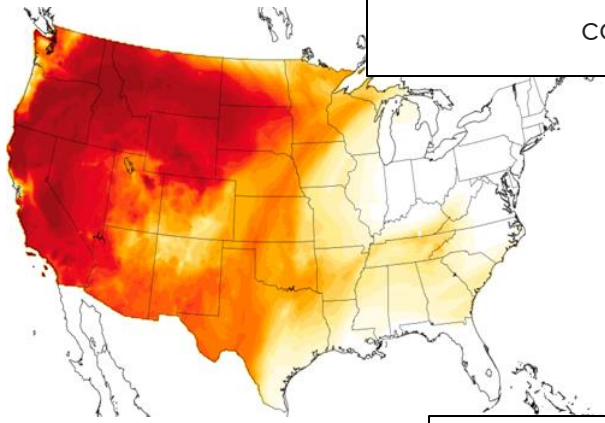
Quantifying health impacts from fire-specific PM2.5 & O_3

Fire-only pollution (2020)

Daily (24-h mean for $PM_{2.5}$, 8-h max for O_3), county-aggregated



Tong et al. (2022)

Baseline health incidence (2019)

mortality
lung cancer incidence
cardiovascular & respiratory HA/ED visits
respiratory disease incidence
adverse birth outcomes (**new**)
work & school loss days
respiratory symptoms

EPA standard health functions (BenMAP)
& functions from meta-analyses (R)

Health impacts associated with fire-only pollution

Annual, county-level

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Table 4a. National annual health impacts from total wildland fire $PM_{2.5}$ (2019). All counties in the contiguous U.S. as available in the Tong et al. (2020) model were included in this analysis (N = 3,107). Suppressed low counts of adverse birth outcomes resulted in a smaller subset of counties assessed for this endpoint (N = 573).

Health Endpoint	Annual health impacts attributable to **wildland fire $PM_{2.5}$** (95% CI)
Mortality [a]	
All-Cause (Di et al. 2017)	28,000 (27,300–28,700)
All-Cause (Turner et al. 2016)	39,700 (26,700–52,200)
All-Cause (Chen et al. 2021)[b]	4,080 (242–7,890)
Lung Cancer Diagnosis	5,910 (3,080–8,600)
Morbidity	
Emergency Room Visits, Respiratory	13,250 (2,680–26,930)
Hospital Admissions, Neurological	7,060 (5,310–8,600)
Hospital Admissions, Respiratory	400 (20–760)
New Onset Asthma & Hay Fever/Rhinitis	395,560 (112,760–582,240)
Adversely Impacted Days	
Acute Respiratory Symptoms	14,040,000 (11,800,000–16,200,000)
Asthma Symptoms (Albuterol use)	7,310,000 (-4,330,000–16,100,000)
Work Loss Days	2,550,000 (2,190,000–2,880,000)
Adverse Birth Outcomes	
Low Birth Weight	2,570 (1,500–3,740)
Preterm Birth	4,330 (2,200–6,730)

[a] Individual study results are reported for mortality impacts due to key differences in their methodologies

[b] Wildfire-specific concentration-response function

Wildland Fire $PM_{2.5}$ National Annual Health Impacts

Contiguous U.S. wildland fire $PM_{2.5}$ exposures associated with approximately:

- **28,000 mortalities (middle estimate)**
- **6,000 lung cancer diagnoses**
- **400,000 major morbidities**
- **24 billion impacted days**
- **7,000 birth outcomes**

Fire-specific, short-term only impacts concentration-response function:
4,000 mortalities (low estimate)

Cromar et al. (2023, in press)

Table 4b. National annual health impacts from total wildland fire ozone (2019). All counties in the contiguous U.S. as available in the Tong et al. (2020) model were included in this analysis (N = 3,106). Suppressed low counts of adverse birth outcomes resulted in a smaller subset of counties assessed for this endpoint (N = 573).

Health Endpoint	Annual health impacts attributable to **wildland fire O_3** (95% CI)
Mortality [a]	
All-Cause (Katsouyanni et al. 2009)	828 (295–1,340)
Respiratory (Turner et al. 2016)	973 (675–1,260)
Morbidity	
Emergency Room Visits, Respiratory	3,180 (670–6,850)
Hospital Admissions, Respiratory	130 (-30–280)
New Onset Asthma & Hay Fever/Rhinitis	55,260 (28,460–74,480)
Adversely Impacted Days	
Acute Respiratory Symptoms	941,000 (379,000–1,480,000)
Asthma Symptoms	1,920,000 (-245,000–3,910,000)
School Loss Days	692,000 (-102,000–1,390,000)
Adverse Birth Outcomes	
Low Birth Weight	320 (40–610)
Preterm Birth	90 (0–180)

[a] Individual study results are reported for mortality impacts due to key differences in their methodologies

Wildland Fire O_3 Annual National Health Impacts

About 2-3% of fire $PM_{2.5}$ impacts

Conditions near fires constrain ozone formation

Cromar et al. (2023, in press)

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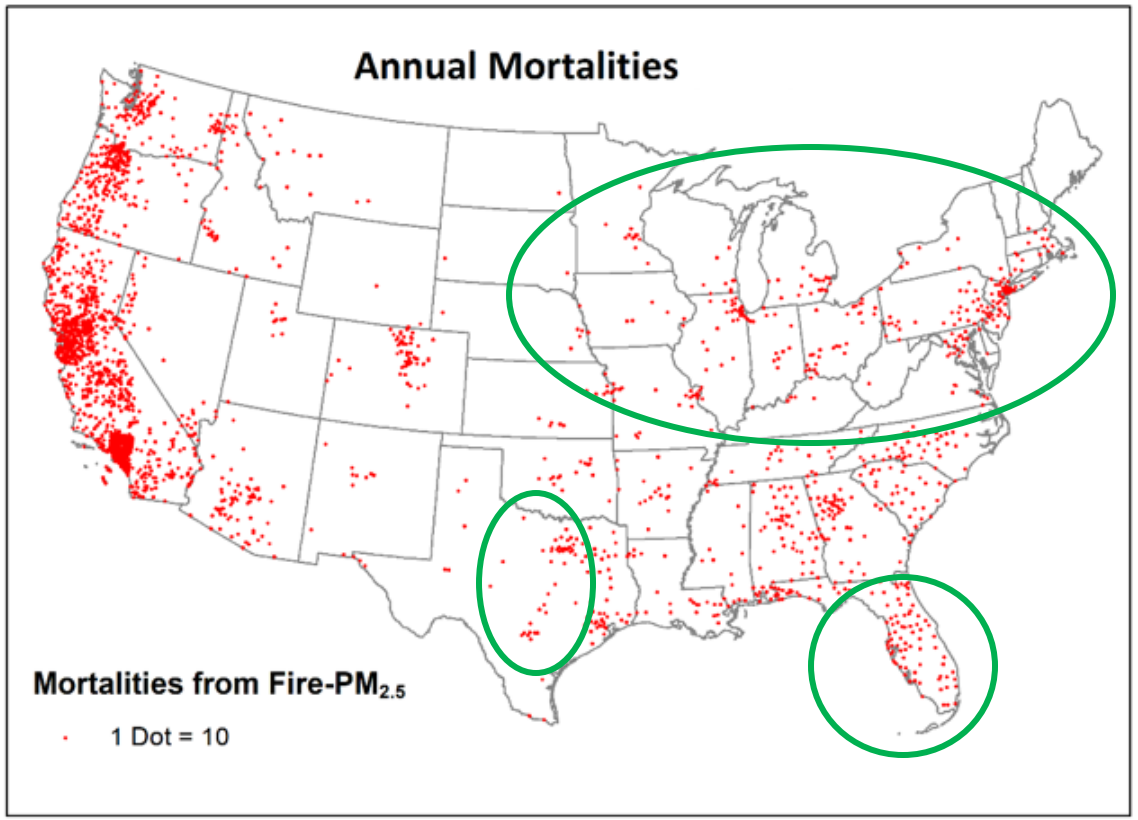

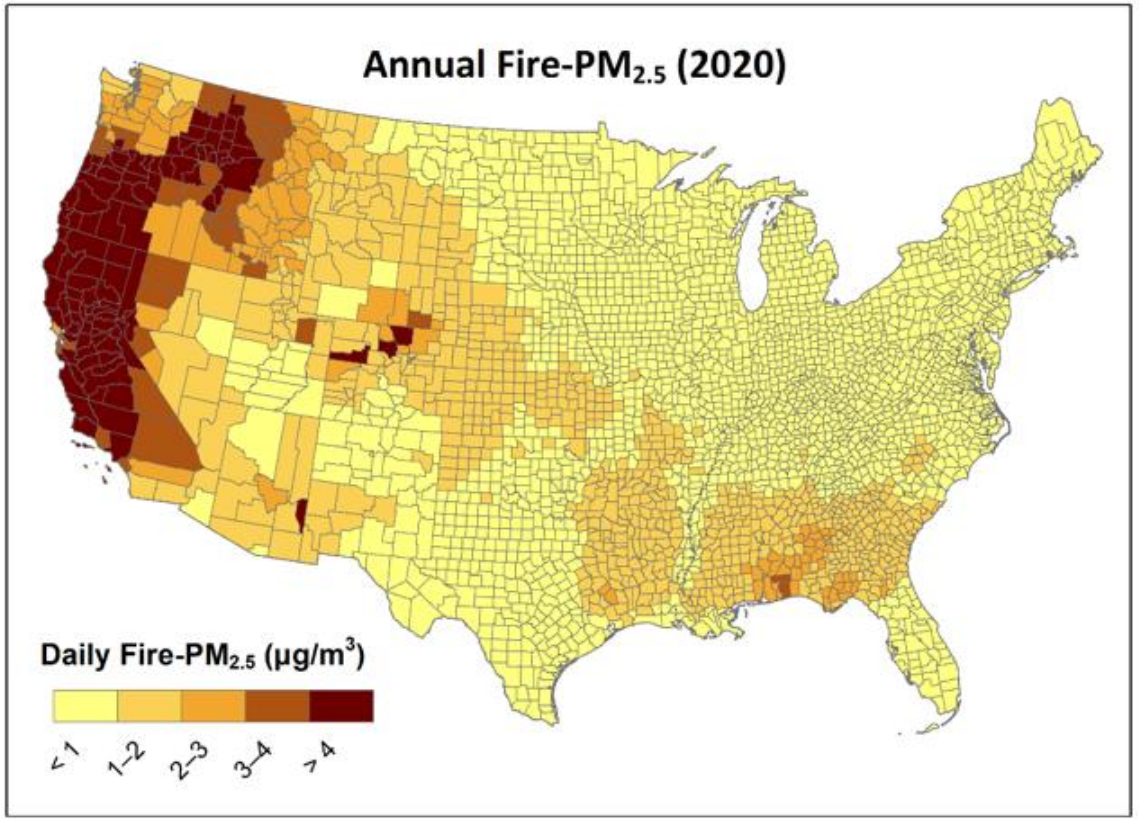

Comparing county-level exposures (2020) and mortalities associated with wildland fire $PM_{2.5}$

Cromar et al. (2023, in press)

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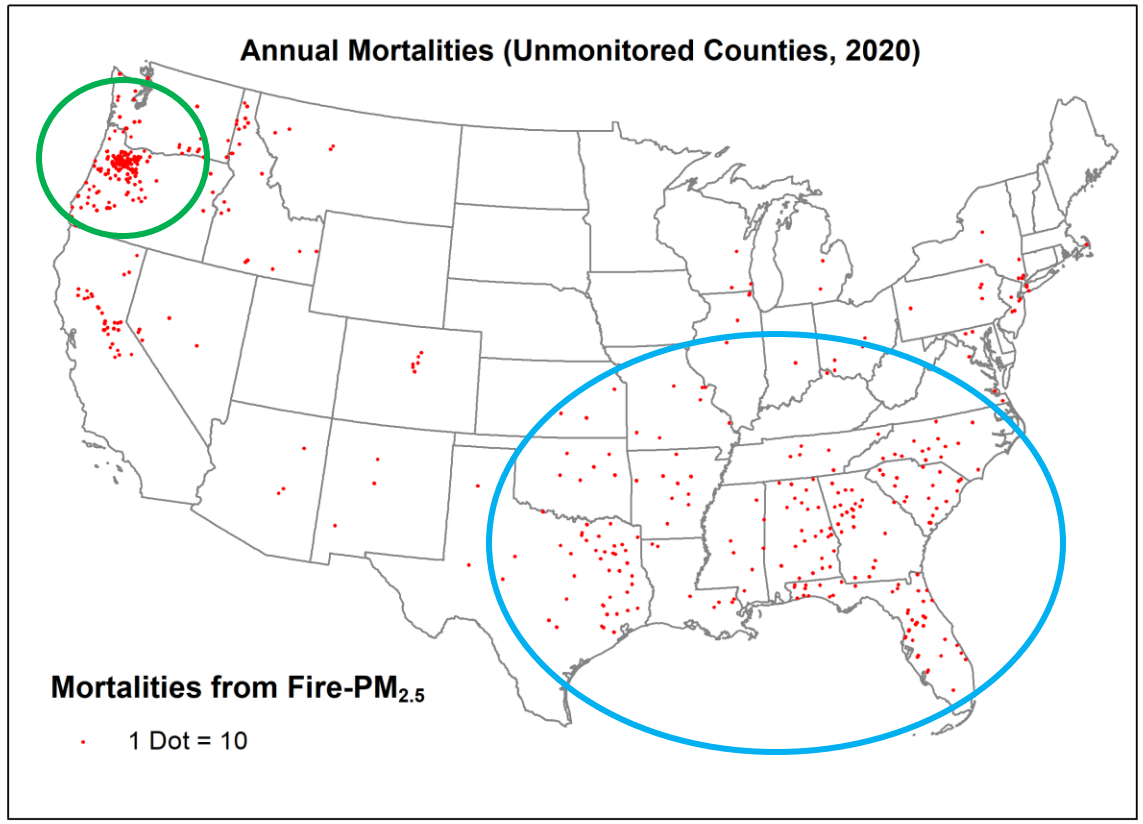

Rank	Unmonitored County Name	Annual mortalities (2020) associated with wildfire $PM_{2.5}$
1	Clackamas, OR	305 (297–312)
2	Marion, OR	287 (279–294)
3	Douglas, OR	132 (129–136)
4	Linn, OR	125 (122–128)
5	Deschutes, OR	78 (76–80)
6	El Dorado, CA	76 (74–78)
7	Glenn, CA	68 (66–69)
8	Kootenai, ID	56 (55–58)
9	Benton, WA	46 (45–47)
10	Jefferson, CO	45 (44–47)
11	Tuolumne, CA	44 (43–45)
12	Coos, OR	39 (38–40)
13	Jefferson, OR	39 (38–40)
14	Marion, FL	35 (34–36)
15	Santa Rosa, FL	35 (34–36)
16	Montgomery, TX	35 (34–36)
17	Yuba, CA	34 (33–35)
18	Curry, OR	32 (31–33)
19	Lincoln, OR	29 (28–29)
20	Cowlitz, WA	29 (29–30)
21	Pasco, FL	27 (26–28)
22	Benton, OR	27 (26–28)
23	Collin, TX	27 (26–27)
24	Amador, CA	26 (26–27)
25	Okaloosa, FL	26 (25–27)

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Local-level health impacts from fire pollution

State	County	2020 Annual Fire $PM_{2.5}$		Annual Health Impacts Attributable to Wildland Fire $PM_{2.5}$ (95% CI)			
		Daily Mean ($\mu g/m^3$)	Percent of Total $PM_{2.5}$	Mortalities	Adverse Birth Outcomes	Morbidity Events	Adversely Impacted Days
Alabama		1.72	19%	360 (318–403)	94 (47–153)	3,988 (944–6,200)	254,352 (116,398–384,982)
	Autauga	1.94	21%	8 (8–9)	—	101 (24–160)	6,421 (2,865–9,768)
	Baldwin	2.21	25%	46 (41–52)	6 (3–11)	404 (90–630)	25,468 (11,749–38,358)
	Barbour	2.19	24%	6 (5–6)	—	44 (10–71)	3,249 (1,531–4,865)
	Bibb	1.52	16%	2 (2–3)	—	25 (5–40)	1,976 (998–2,907)
	Blount	1.09	13%	6 (5–6)	—	56 (13–88)	3,626 (1,621–5,541)
	Bullock	2.25	25%	1 (1–1)	—	18 (4–28)	1,330 (590–2,027)
	Butler	2.58	27%	4 (4–5)	—	43 (10–69)	2,729 (1,160–4,195)
	Calhoun	1.35	15%	16 (14–18)	2 (0–3)	133 (33–207)	8,559 (3,963–12,890)
	Chambers	2.51	26%	8 (7–10)	—	66 (15–104)	4,418 (2,025–6,637)
	Cherokee	1.21	13%	3 (3–4)	—	23 (6–37)	1,683 (824–2,499)
	Chilton	1.71	19%	6 (5–6)	—	69 (16–108)	4,377 (1,911–6,714)
	Choctaw	1.81	20%	2 (2–2)	—	17 (3–27)	1,219 (571–1,833)
	Clarke	2.35	25%	7 (5–7)	—	46 (10–73)	3,089 (1,436–4,641)
	Clay	1.57	19%	2 (2–3)	—	15 (3–24)	1,123 (525–1,691)
	Cleburne	1.68	19%	2 (2–2)	—	20 (4–32)	1,327 (582–2,008)
	Coffee	2.20	24%	10 (9–11)	—	96 (24–153)	6,217 (2,799–9,427)

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Cromar et al. (2023, in press)

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Funding

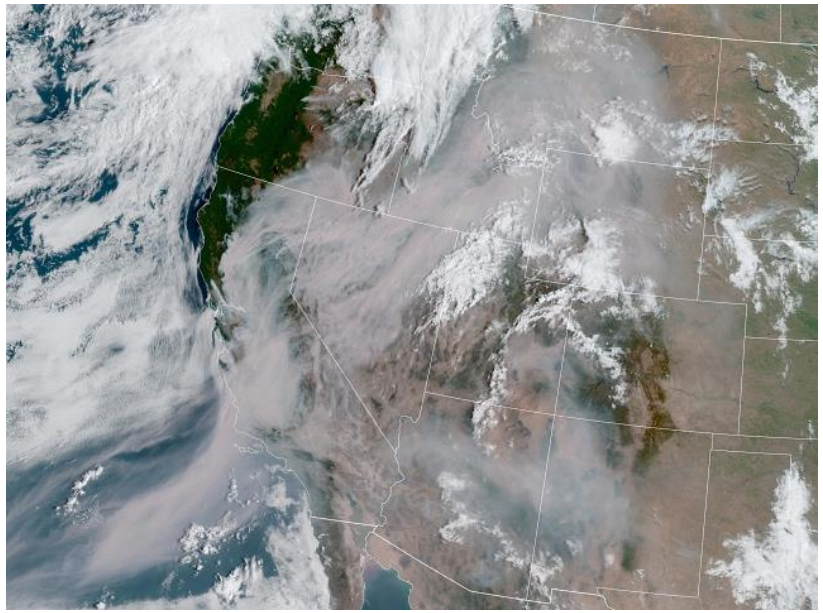
NASA Rapid Response

Team

Daniel Tong & Yunyao Li, George Mason University

Julia Gohlke, Environmental Defense Fund

Gary Ewart, American Thoracic Society



References

Burke M, Driscoll A, Heft-Neal S, Xue J, Burney J, Wara M. The changing risk and burden of wildfire in the United States. *Proc Natl Acad Sci U S A* 2021; 118: 1-6.

Cromar KR, Gladson LA, Gohlke J, Li Y, Tong D, Ewart G, 2023. Adverse Health Impacts of Outdoor Air Pollution, including from Wildland Fires, in the United States: "Health of the Air," 2018-2020. *Annals of the American Thoracic Society.* Manuscript in press.

O'Dell, K.; Bilsback, K.; Ford, B.; Martenies, S.E.; Magzamen, S.; Fischer, E.V.; Pierce, J.R. Estimated Mortality and Morbidity Attributable to Smoke Plumes in the United States: Not Just a Western US Problem. Geohealth 2021, 5, e2021GH000457, doi:10.1029/2021GH000457.

Tong, D.; Li, Y.; Zhang, X.; Li, F.; Kondragunta, S.; Kahn, R.; Saylor, R.; Baklanov, A. (2022). Impacts of 2020 Western Wildfires on Air Quality Exceedances. In Proceedings of the HAQAST Update 22, 2022