

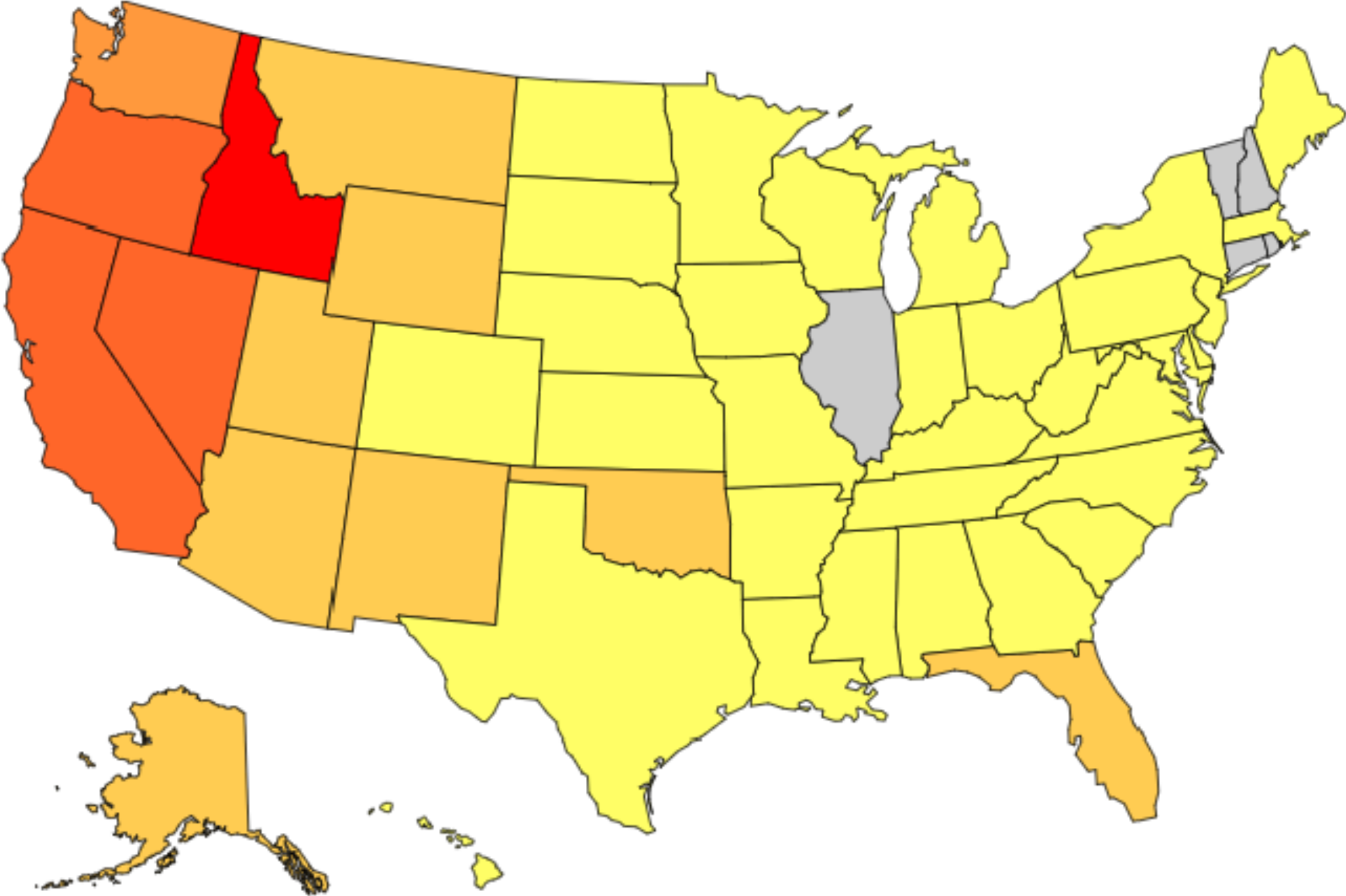
Wildfires and Mental Health

Preliminary Evidence

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Average Annual Burned Acreage by State, 1984–2020



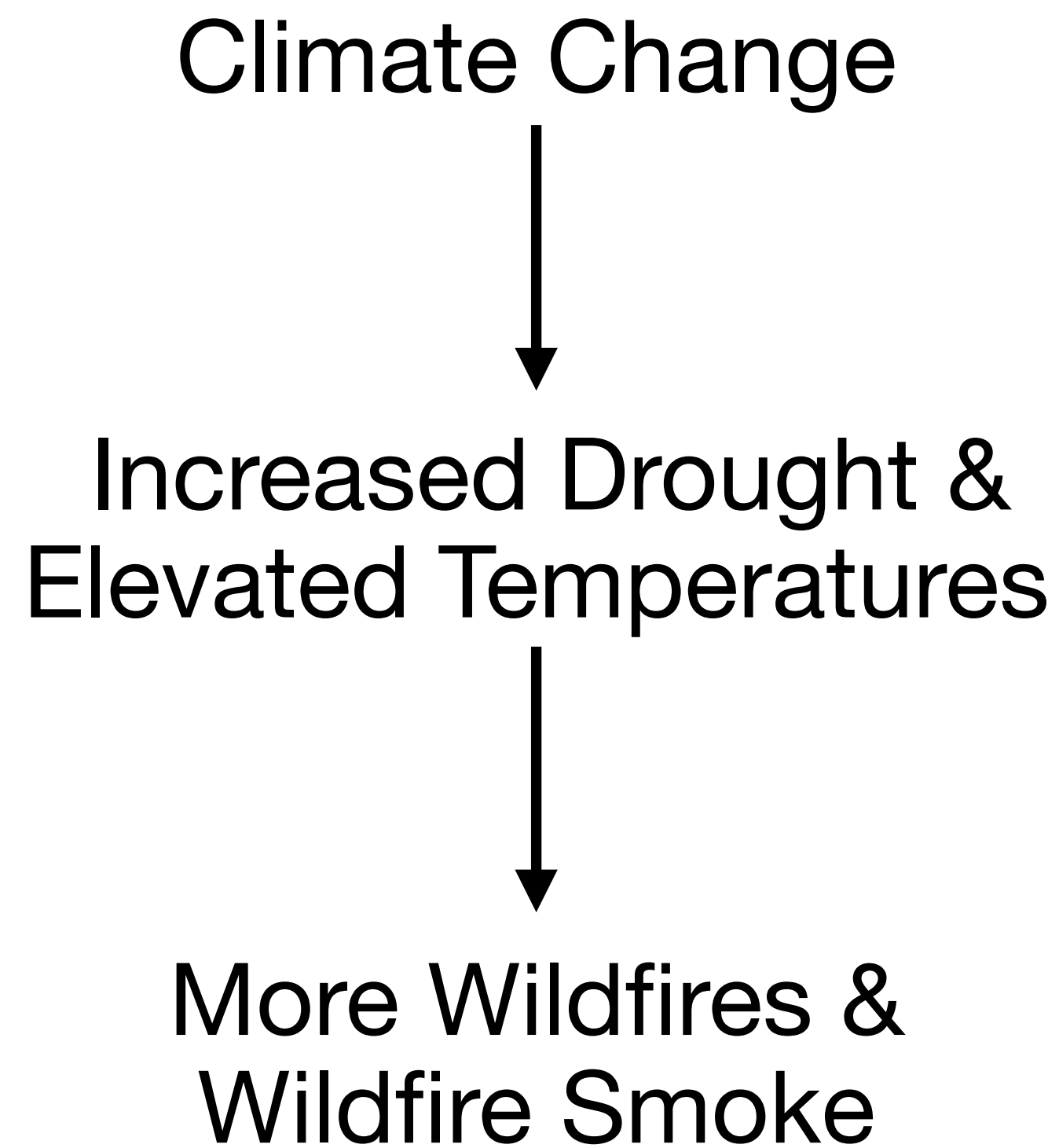
Average annual burned acres per square mile of land area:



States colored light gray did not have any fires that were large enough to be included in this analysis.

Data source: MTBS (Monitoring Trends in Burn Severity). 2022. Direct download. Accessed June 2022. www.mtbs.gov/direct-download.

For more information, visit U.S. EPA's "Climate Change Indicators in the United States" at www.epa.gov/climate-indicators.

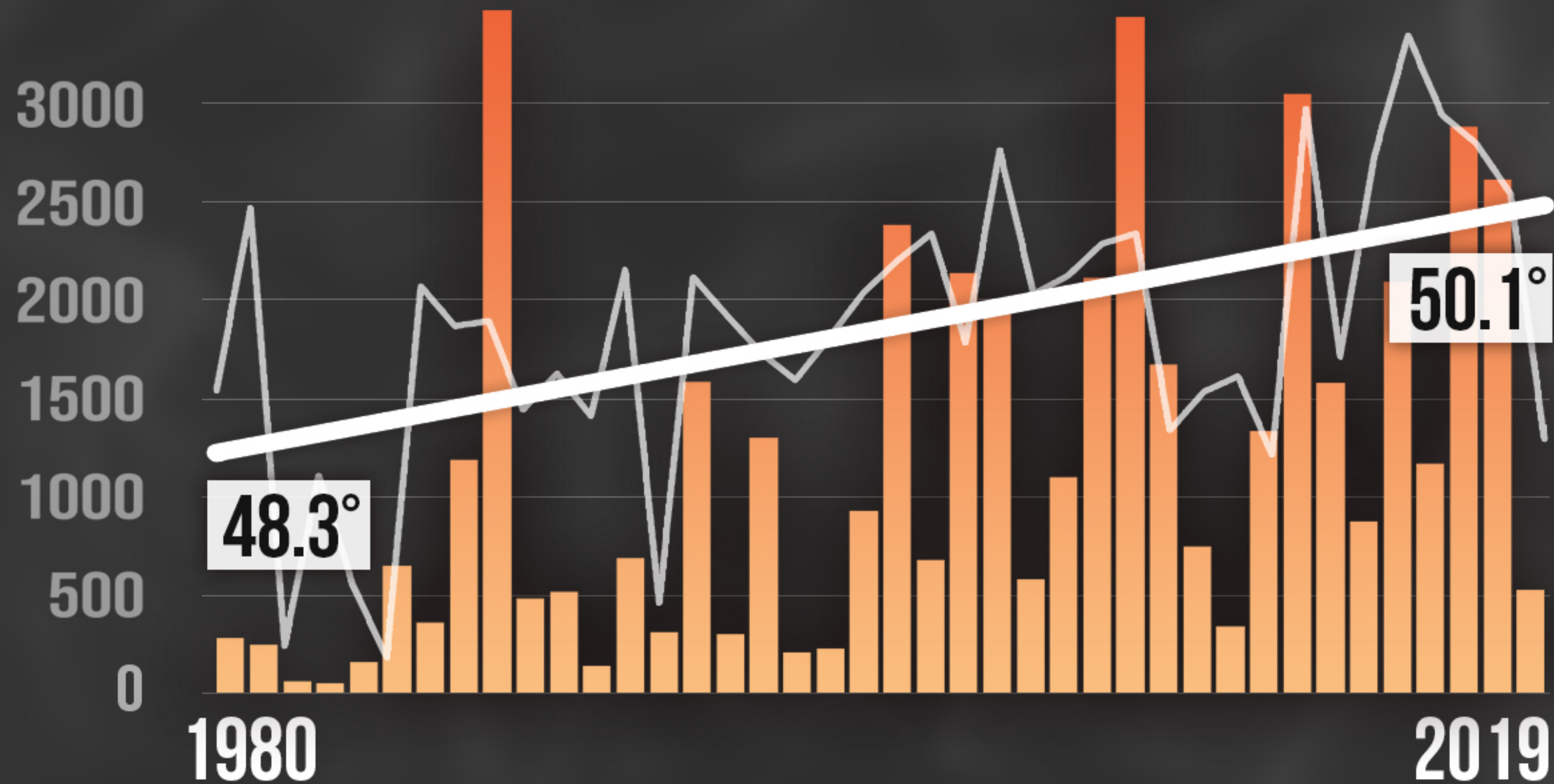


(Liu et al., 2016; Mansoor et al., 2022)

HOTTER YEARS, HIGHER FIRE RISK

ACRES BURNED ACROSS WESTERN STATES

(THOUSANDS OF ACRES)



Total acres burned in the west calculated by summing acres burned across 11 states: AZ, CA, CO, ID, MT, NV, NM, OR, UT, WA, & WY. Avg annual temps (1980-2019) calculated by averaging temps across same states. Source: National Fire & Aviation Management FAMWEB Data Warehouse & NOAA/NCEI's Climate at a Glance

Introduction

- Wildfires are understudied.
 - Some evidence that floods are associated with worse mental health (Fernandez et al., 2015; Raker et al., 2019)
 - Evidence that PM_{2.5}, outside of the context of wildfires, is associated with worse mental health (Braithwaite et al., 2019)
 - Various mechanisms: trauma, physiological, isolation, ...
- What is impact of wildfires on mental health?

Data

1. NASA Fire Points

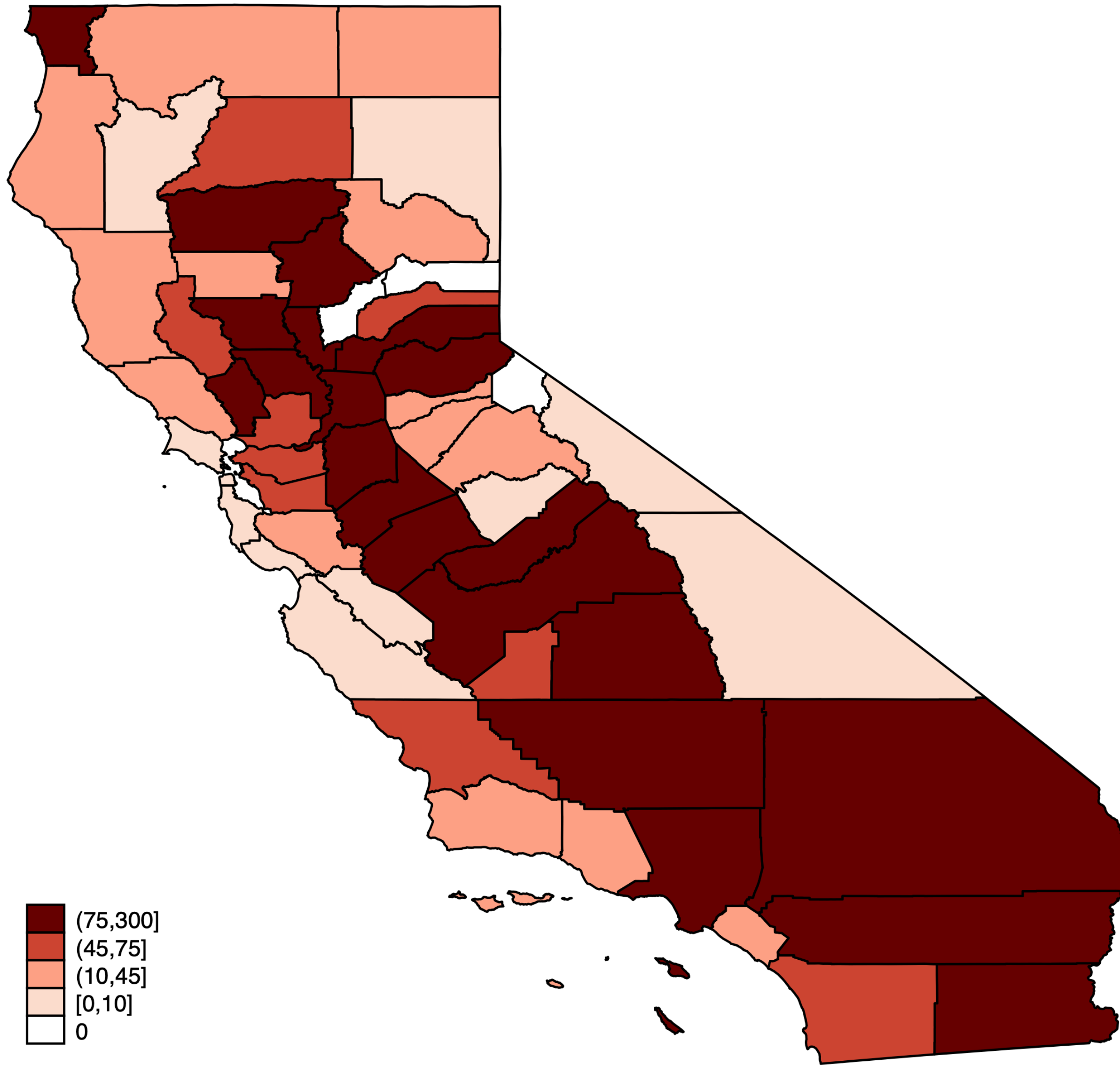
- Publicly available wildfire data from the Geostationary Operational Environmental Satellite (GOES) Products Server of the NOAA Satellite and Information Service
- Coordinates of fire points, shape files of smoke polygons, start and end dates/times
- 2003-2021

Data

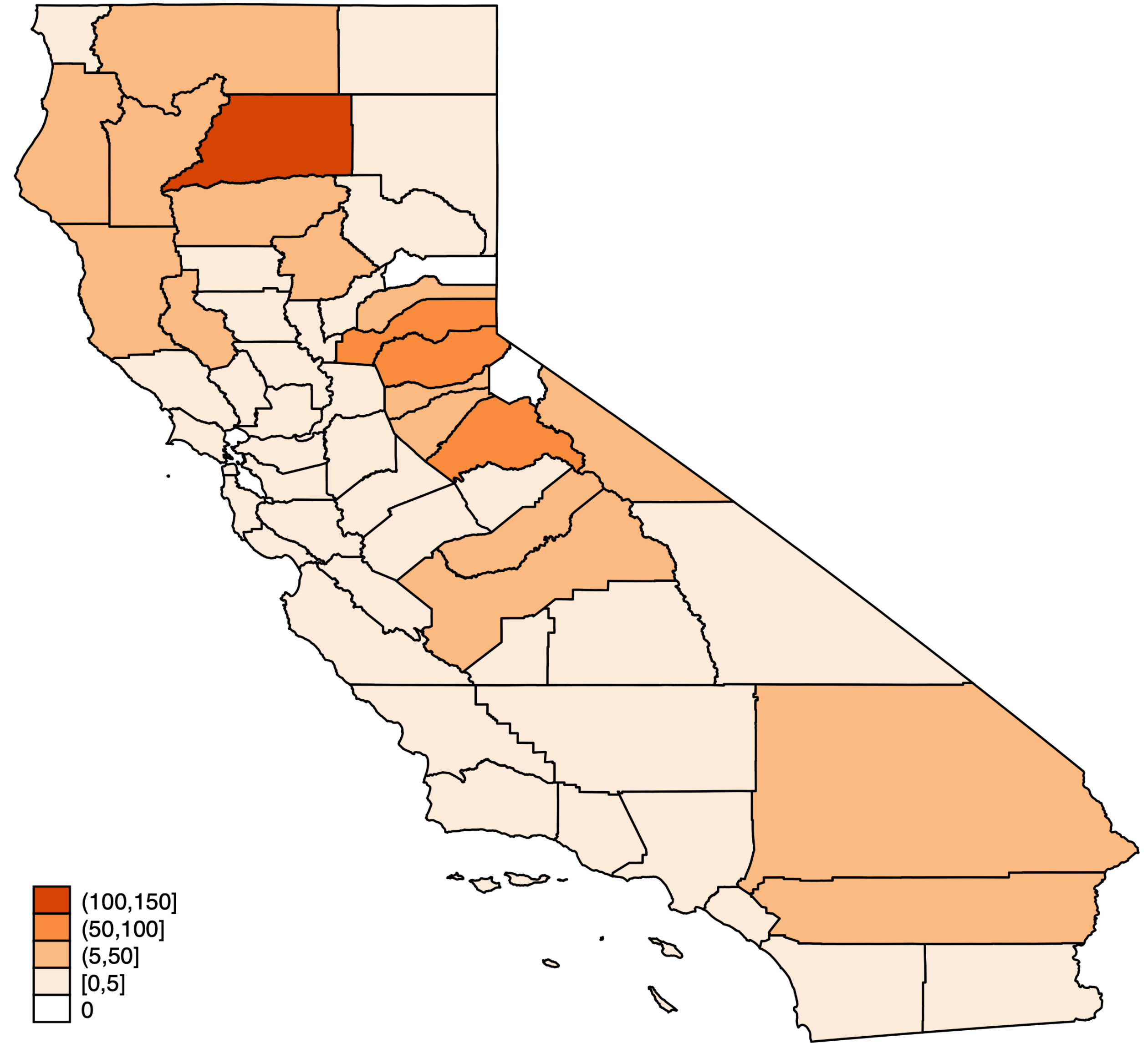
2. Wildfire-driven PM_{2.5}

- Publicly available wildfire data from Childs et al. (2022)
- Various ground, satellite, and reanalysis data -> machine learning model to generate estimates of wildfire smoke-driven PM_{2.5} concentrations
- Daily, 10km-square estimates for US
- 2006-2020

Number of Days with Fire Point in County, 2016



Number of Days with PM2.5 exceeding 35ug/m3, 2016



Data

3. NielsenIQ Health Data

- NielsenIQ's Annual Ailments, Health, and Wellness Survey, via the Kilts Center for Marketing Data at the University of Chicago Booth School of Business (paid subscription)
- Nationally representative sample of ~50,000 households per year (~5,000 Californian households per year)
- Select all the condition(s) that anyone in their household, including themselves, has experienced during the past 6 months from a predetermined list. One condition includes "Depression/Anxiety. Average 14.6% of household-year observations.
- Socio-demographics
- 2011-2017

Data

Bringing it all together

- Restrict (for now) to California
- Match households to wildfire data at zip code level
- Since NielsenIQ data annual, assess impact of prior-year wildfire treatment on survey-year depression/anxiety.

Treatment Variables

Constructed at the zip code, year level

Treatment	Definition	Mean	Std. Dev.
Fire	Indicator for whether there was ever a wildfire in the household's zipcode during the prior calendar year.	22.4%	
Smoke	Indicator for whether there was ever wildfire-related smoke in the household's zipcode during the prior calendar year.	47.6%	
Days PM_{2.5} >35µg	The number of days predicted PM _{2.5} exceeded 35µg/m ³ in the household's zipcode over the prior calendar year. (Generally unhealthy, especially for sensitive groups)	0.050	0.55 Max 23
Days PM_{2.5} >50µg	The number of days predicted PM _{2.5} exceeded 50µg/m ³ in the household's zipcode over the prior calendar year. (Prolonged exposure can lead to serious health issues)	0.023	0.35 Max 16
Days PM_{2.5} >100µg	The number of days predicted PM _{2.5} exceeded 100µg/m ³ in the household's zipcode over the prior calendar year.	0.002	0.08 Max 6

Empirical Model

Using MLE, estimate a logit and probit model with 2-way fixed effects

$$y_{hct} = \beta wildfire_{ht-1} + X'_{ht}\gamma + yr_t + f_c + \varepsilon_{hct}$$

y_{hct} indicator for whether a household in county c reports depression/anxiety in year t

$wildfire_{ht-1}$ one of five treatment measures from prior year

X'_{ht} vector of household characteristics

yr_t year fixed effects

f_c county fixed effects

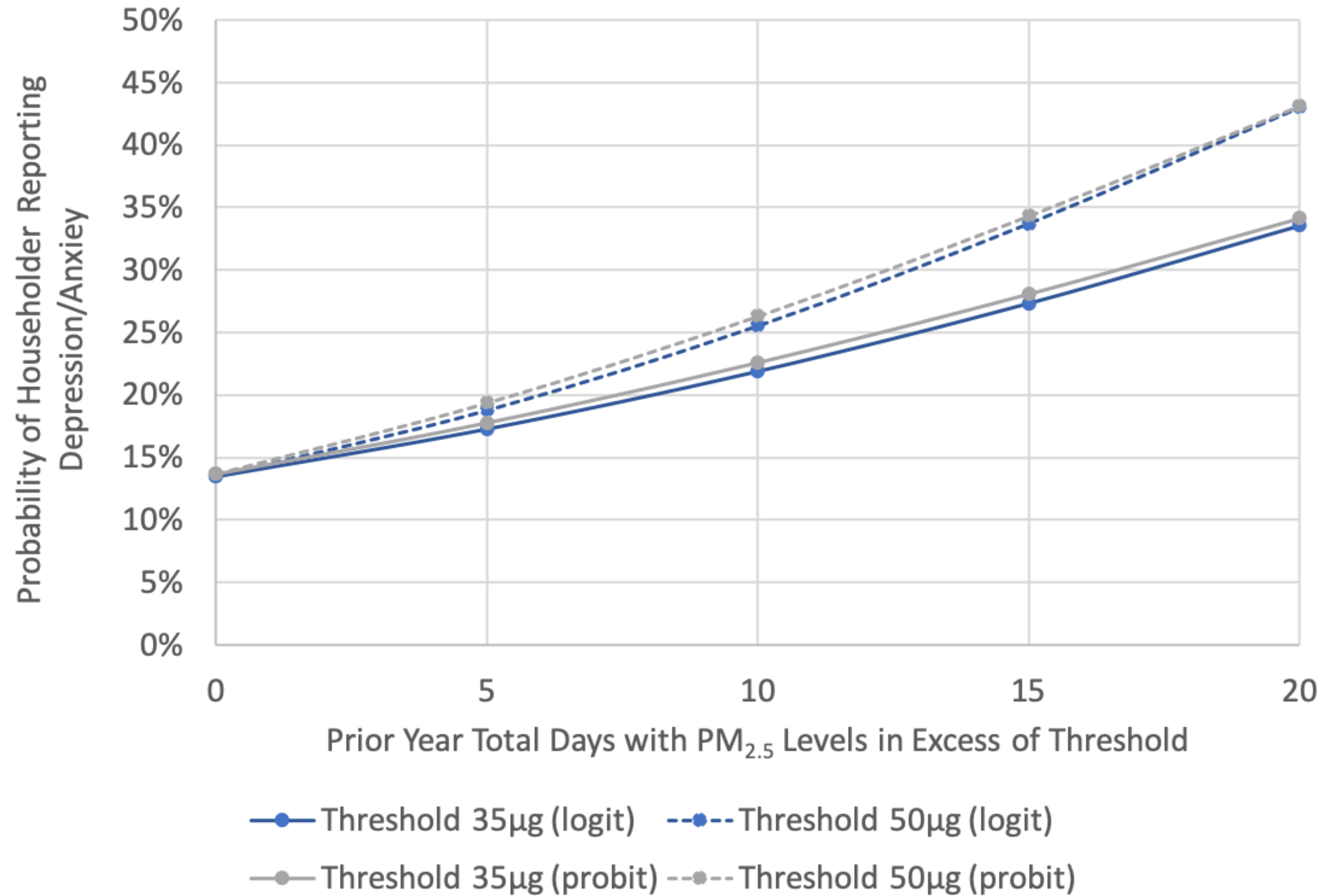
- Logit: $logit(P_{depression_t}) = \log\left(\frac{y_{hct}}{1-y_{hct}}\right)$, where $P_{depression_t}$ is probability that household reports depression anxiety in a given year
- Probit: $\beta wildfire_{ht-1}$ taken to be z-value of a normal distribution
- β : coefficient of interest to be estimated

Results

Column	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Model Specification	Logit	Logit	Logit	Logit	Logit	Probit	Probit	Probit	Probit	Probit
Fire	0.014 (0.060)					0.009 (0.033)				
Smoke		0.045 (0.052)					0.026 (0.028)			
Days PM2.5>35ug			0.0588** (0.025)					0.0343** (0.014)		
Days PM2.5>50ug				0.0788** (0.035)					0.0461** (0.021)	
Days PM2.5>100ug					0.148 (0.131)					0.081 (0.078)

Each column represents a separately-estimated specification. The dependent variable is household-reported depression/anxiety the following calendar year. All specifications include household characteristics (income, household size, age, education level, race/ethnicity, and marital status of household head), and year and county fixed effects. Shown are the estimated coefficients (i.e., β) on the respective treatment variable. Robust standard errors in parentheses are clustered at the county level. There are 19,922 household-year observations. Akaike and Bayesian information criteria for the Probit specifications are somewhat smaller than for the Logit specifications, indicating slightly better model fit. *** p<0.01, ** p<0.05, * p<0.1.

Results



Probabilities are estimated holding all other variables at their mean values across the sample. All predicted probabilities are significant at the 1% level.

Discussion & Conclusion

- Detect increase in probability of depression/anxiety resulting from wildfire *smoke* exposure, but not proximity to the actual fires.
- Exposure to 10 days of elevated PM_{2.5} levels nearly doubles a household's probability of experiencing depression/anxiety the following year.
 - Having experienced 5, 10, or 15 days with PM_{2.5} levels above 35µg/m³ is associated with probabilities of 17%, 22%, and 28% of depression/anxiety (vs. baseline ~13.5%).
 - Having experienced 5, 10, or 15 days with PM_{2.5} levels above 50µg/m³ is associated with probabilities of 19%, 26%, and 34%.
- Ongoing work to collect more data and refine analysis (more outcome variables, higher geographic resolution, etc...)

Thank You! Questions?

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