Where There's Fire, There's Smoke

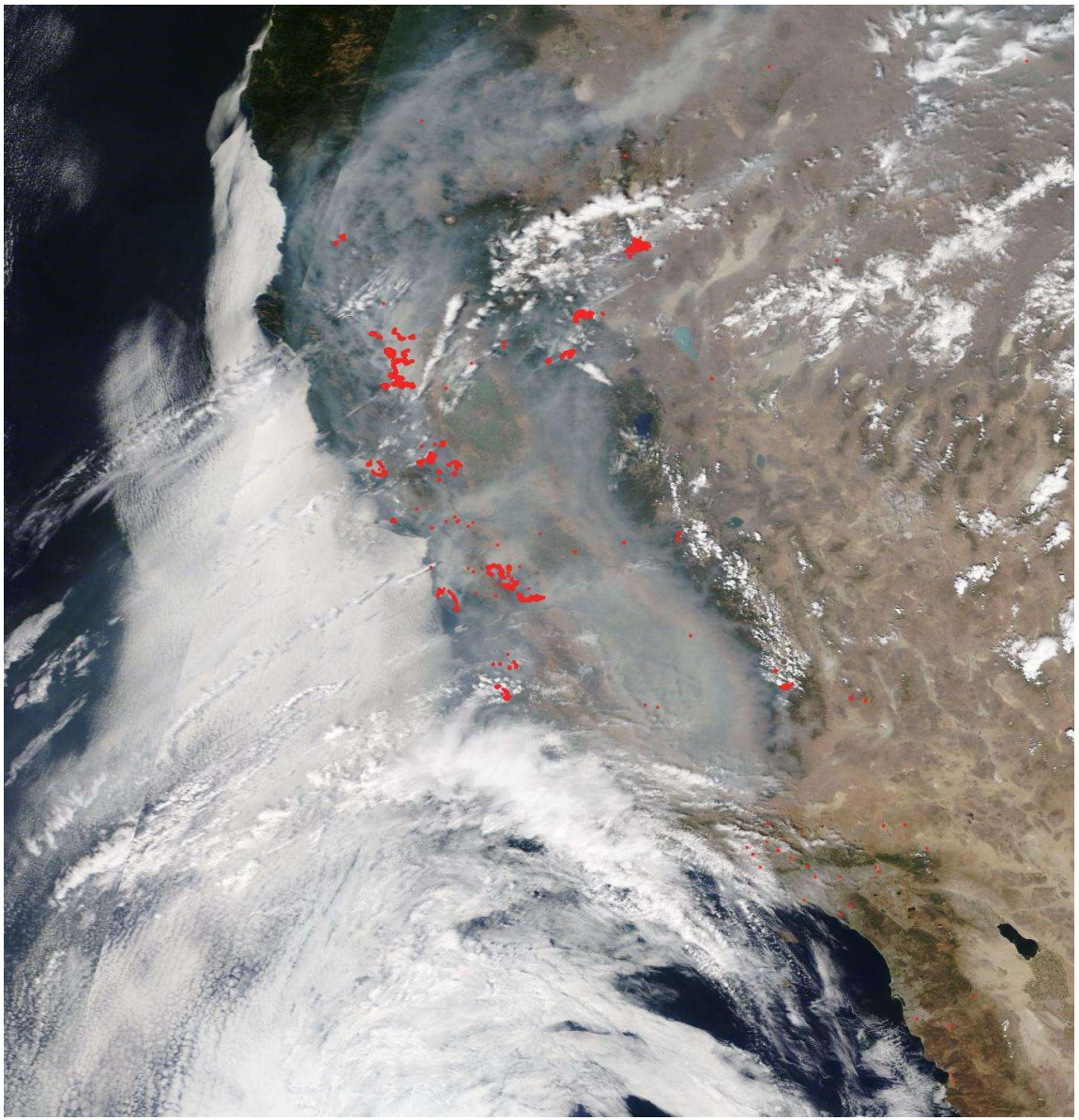
John R. Balmes, MD

University of California,

San Francisco and Berkeley

Camp Fire – Nov. 9, 2018

Aug. 24, 2020



2020 California Wildfires

- **4 of the 5 largest wildfires** in CA history are currently burning in the northern part of the state
  - August Complex Fire: started 8/17/20; 846,898 acres burned; 43% containment as of 9/22/20
- **3,627,010 total acres burned to date in 2020**
  - 7,097 structures damaged or destroyed and at least 26 fatalities as of 9/21/20

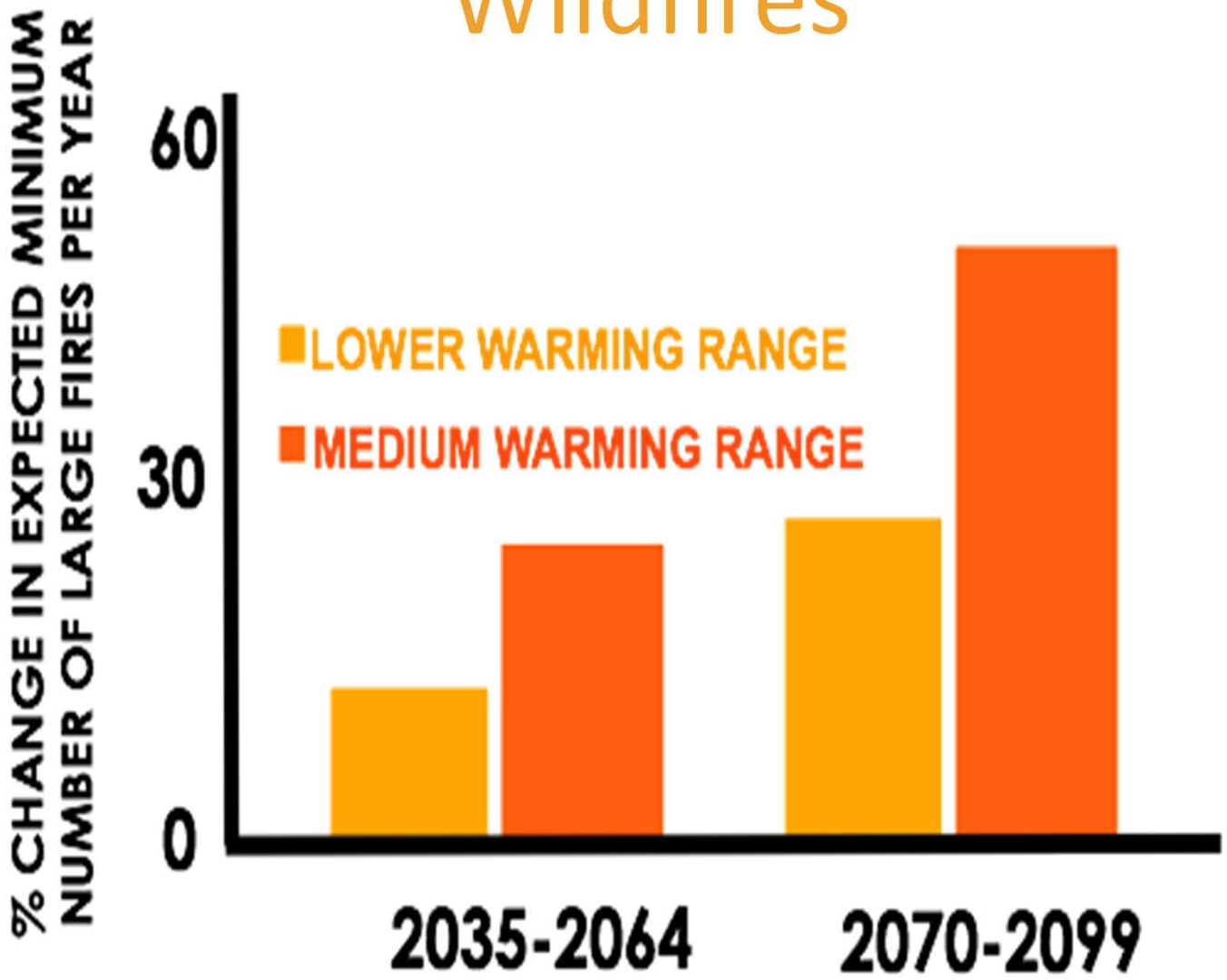
Why Do We Have Bad Wildfire Years?

Sierra Snowpack

2019 2020

- The wildfire season in California typically ends in October when autumn rains begin
- Years of drought; many dead trees
- Increased growth of vegetation in spring
- Normally dry and very hot summer weather generating lots of new fuel added to dead trees
- Lack of rain in fall

Climate Change and Increase in Wildfires

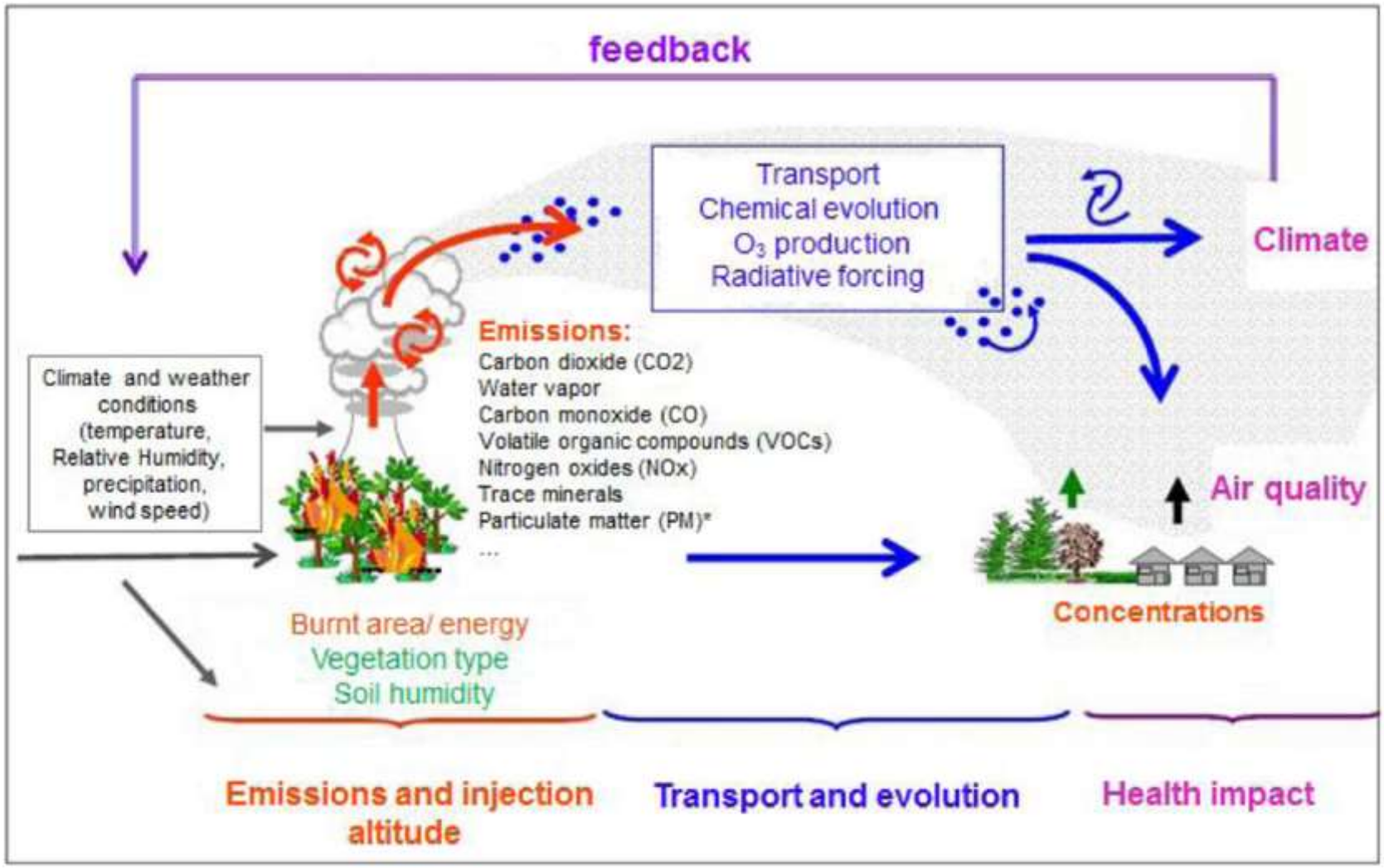


Source of data : Westerling and Bryant, "Climate change and wildfire in and around California: Fire modeling and loss modeling" (2006), *www.climatechange.ca.gov*

Australian Bush Fires

- 31 million acres have burned (16 times what burned in California in 2018
- Fires are in populated areas with more than 2500 homes destroyed
- Poor air quality in Sydney, Melbourne, Canberra, and New Zealand
- Climate-forcing emissions = 9 months from man-made sources

Wildfire emissions and related health impacts

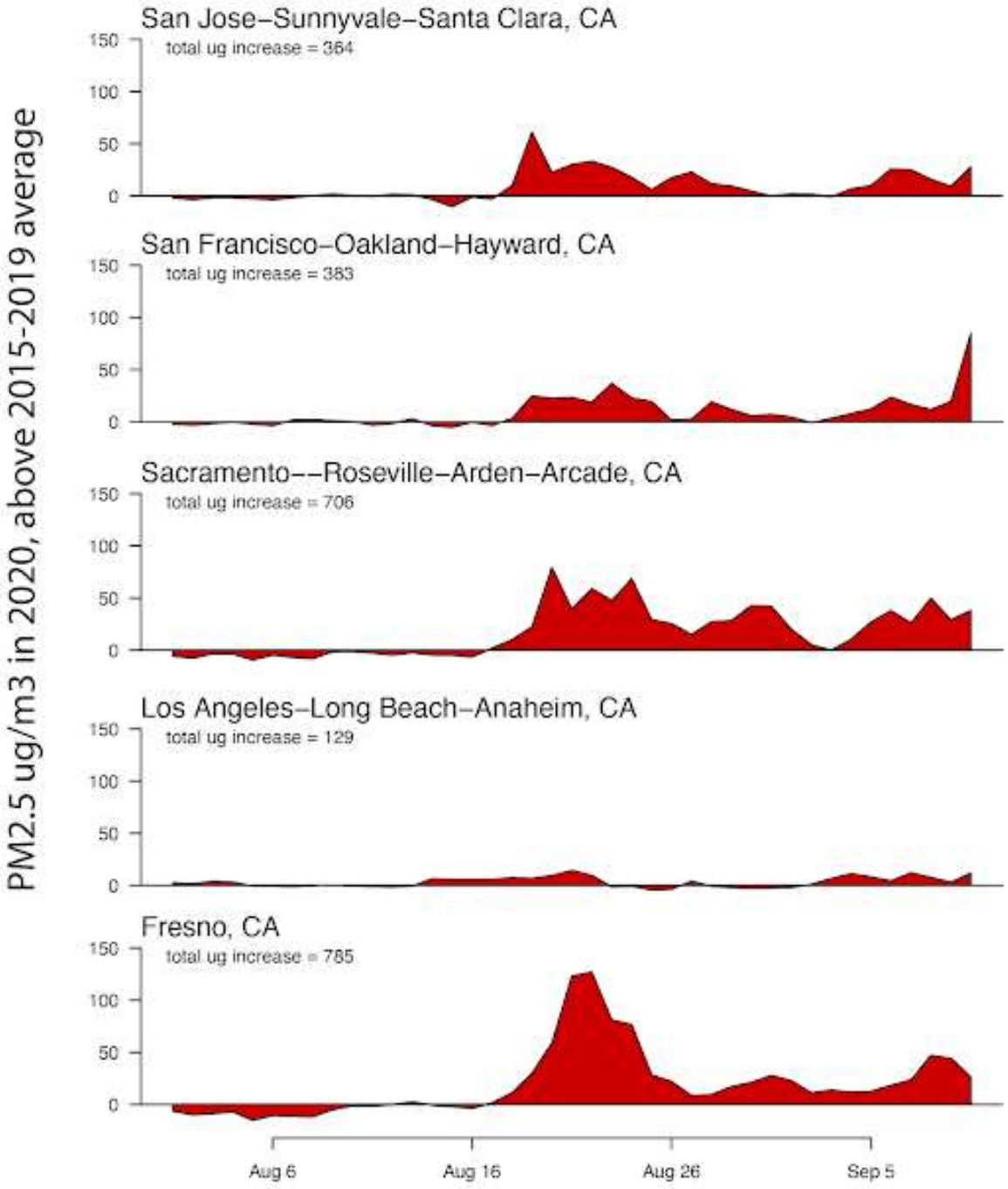


Youssouf et al. Atmospheric Environment 2014;97:239-251

Emissions from Wildfires

Primary air pollutants
- Particulate Matter (PM)
- CO
- NO_2
- Polycyclic aromatic hydrocarbons (PAHs)
- Volatile organic compounds (VOCs)

Secondary air pollutants
- Particulate Matter (PM)
- Ozone

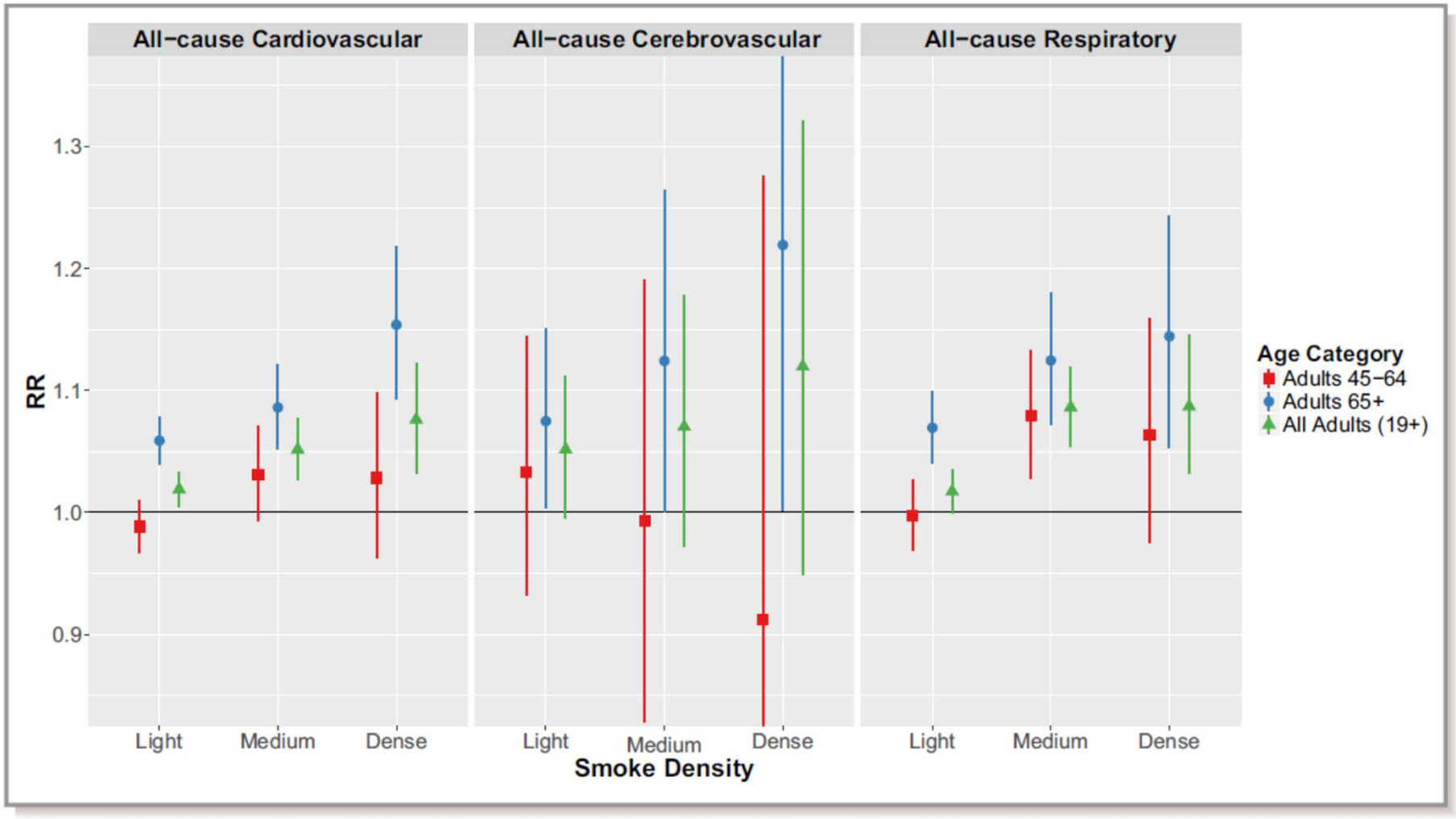

PM2.5 ug/m3 in 2020, above 2015-2019 average
San Jose–Sunnyvale–Santa Clara, CA
total ug increase = 364
San Francisco–Oakland–Hayward, CA
total ug increase = 383
Sacramento––Roseville–Arden–Arcade, CA
total ug increase = 706
Los Angeles–Long Beach–Anaheim, CA
total ug increase = 129
Fresno, CA
total ug increase = 765
150
100
50
0
Aug 6
Aug 16
Aug 26
Sep 5

Acute health impacts of short-term community wildfire smoke exposures

Critical Review of Health Impacts of Wildfire Smoke Exposure

Colleen E. Reid,[1,2] Michael Brauer,[3] Fay H. Johnston,[4,5] Michael Jerrett,[1,6] John R. Balmes,[1,7] and Catherine T. Elliott[3,8]

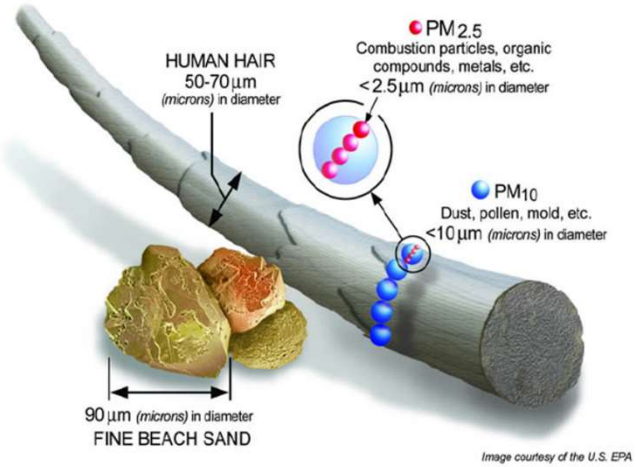
Environ Health Perspect 2016;124:1334–1343



Wettstein Z, Hoshiko S, Cascio WE, Rappold AG et al.
JAHA April 11, 2018

Other Health Outcomes

- Adverse birth outcomes
  - Low birth weight, ? preterm birth
- Mental health
- ? Chronic effects from recurrent exposures based on the $PM_{2.5}$ literature
  - Metabolic outcomes
  - Cognitive decline
  - Child neurodevelopment
  - Decreased lung function
  - Health of pregnant mothers



Wildland Firefighter Health Effects

- Cross-shift changes in lung function, urinary biomarkers of exposure, and blood biomarkers of inflammation
- Pre-post season changes in lung function, airway responsiveness, and airway inflammation
- Do the fire season-associated changes persist?

Contents lists available at ScienceDirect

Environmental Research

journal homepage: www.elsevier.com/locate/envres

Wildland firefighter smoke exposure and risk of lung cancer and cardiovascular disease mortality

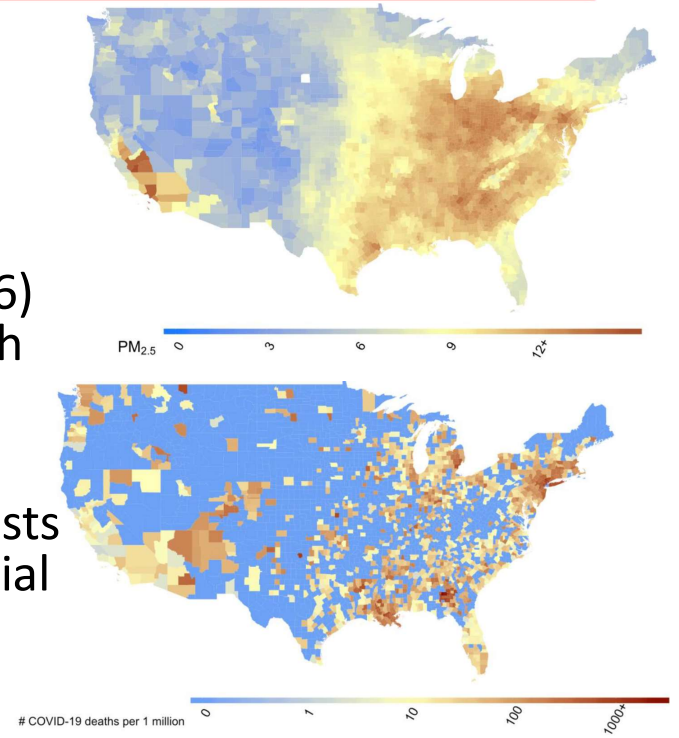
Kathleen M. Navarro[a], Michael T. Kleinman[b], Chris E. Mackay[c], Timothy E. Reinhardt[d], John R. Balmes[e], George A. Broyles[f], Roger D. Ottmar[g], Luke P. Naher[h], Joseph W. Domitrovich[i,*]

- Estimated the daily dose of wildfire smoke $PM_{2.5}$
- The daily dose for firefighters working 98 days per year of $PM_{2.5}$ ranged from 0.30 mg to 1.49 mg
- For career durations (5–25 years), wildland firefighters had an estimated increased risk of lung CA (8 percent to 43 percent) and CVD (16 percent to 30 percent) mortality

Environ Res 2019;173:462-468

Exposure to air pollution and COVID-19 mortality in the United States: A nationwide cross-sectional study

- Examined county-level long-term $PM_{2.5}$ and Covid-19 mortality in 3,000 U.S. counties(~ 98% of the population)
- A 1 $\mu g/m^3$ higher in $PM_{2.5}$ (averaged for 2000 to 2016) associated with an 8% increase in the COVID-19 death rate (95% CI 2%, 15%)
- *April 24, 2020 revision:* data until April 22, 2020, adjusts for timing of the epidemic's spread, timing of the social distancing policies and population age distribution



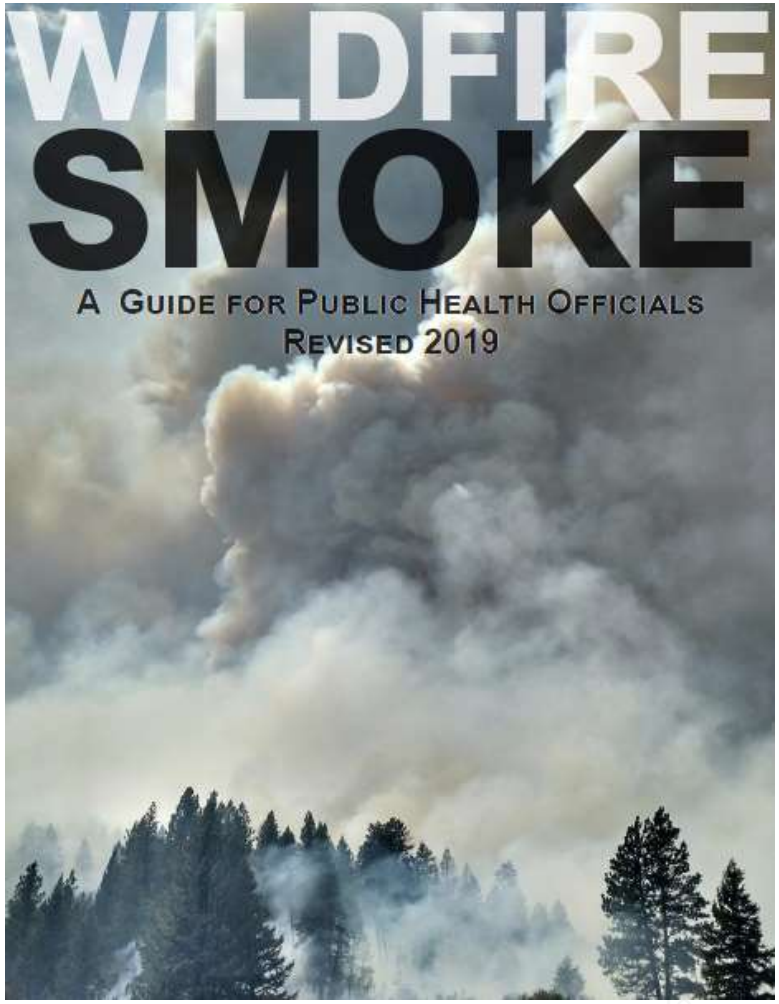
Wu et al. medRxiv 2020.

COVID-19 and Wildfires in 2020

- Worst wildfire season in CA history
- Prescribed burns?
- Can evacuations be done safely?
- How do we fight wildland fires?
- How do we protect the public?

Public Health Response

Improved planning and readiness on the part of the public health infrastructure and health care providers are necessary to reduce morbidity and mortality due to wildland fire smoke exposure



Public Education

- Stay indoors with windows closed – shelter-in-place
- Building and room filtration
- Respiratory protective gear
  - Outdoor workers
  - General public
  - Persons with heart and lung disease
  - Children

CalOSHA Emergency Standard

- If feasible, provide an enclosed location with filtered air so that employee exposure to $PM_{2.5}$ is less than an AQI of 151
- Provide N95 respirators if employers cannot reduce workers' exposure to $PM_{2.5}$ to an AQI of 150 or lower.

Fire suppression has increased fuel availability

Increased Development - Wildland Urban Interface

Prevention

- Most of the U.S. Forest Service wildfire budget goes to suppression activities, leaving precious little for necessary forest-maintenance activities.
  - The 2013 Rim Fire started in Yosemite but mostly burned in the Stanislaus National Forest – why?
- Dead trees and excessive undergrowth need to be removed from our forests
- Communities near National Forests resist prescribed burns

Community Protection

- At-risk communities can do more to prepare for wildfires
  - Bulldoze fuel breaks around neighborhoods
  - Install new smoke-detection cameras and sensors
  - Remove vegetation around homes
  - Improve escape routes in subdivisions
  - Train residents in initial fire suppression methods (i.e., watering down roofs)

Summary

- The duration of the wildfire season is longer and catastrophic wildfires are increasing in frequency due to climate change
- Acute respiratory effects are well documented, but new studies suggest acute cardiovascular effects
- Long-term effects of high and/or recurrent exposures need further study
- Need to invest heavily in forest management and community resilience
- Risk of COVID-19 may be increased by wildfire smoke and complicates wildland firefighting

Thank you