Health Effects of Wildfires

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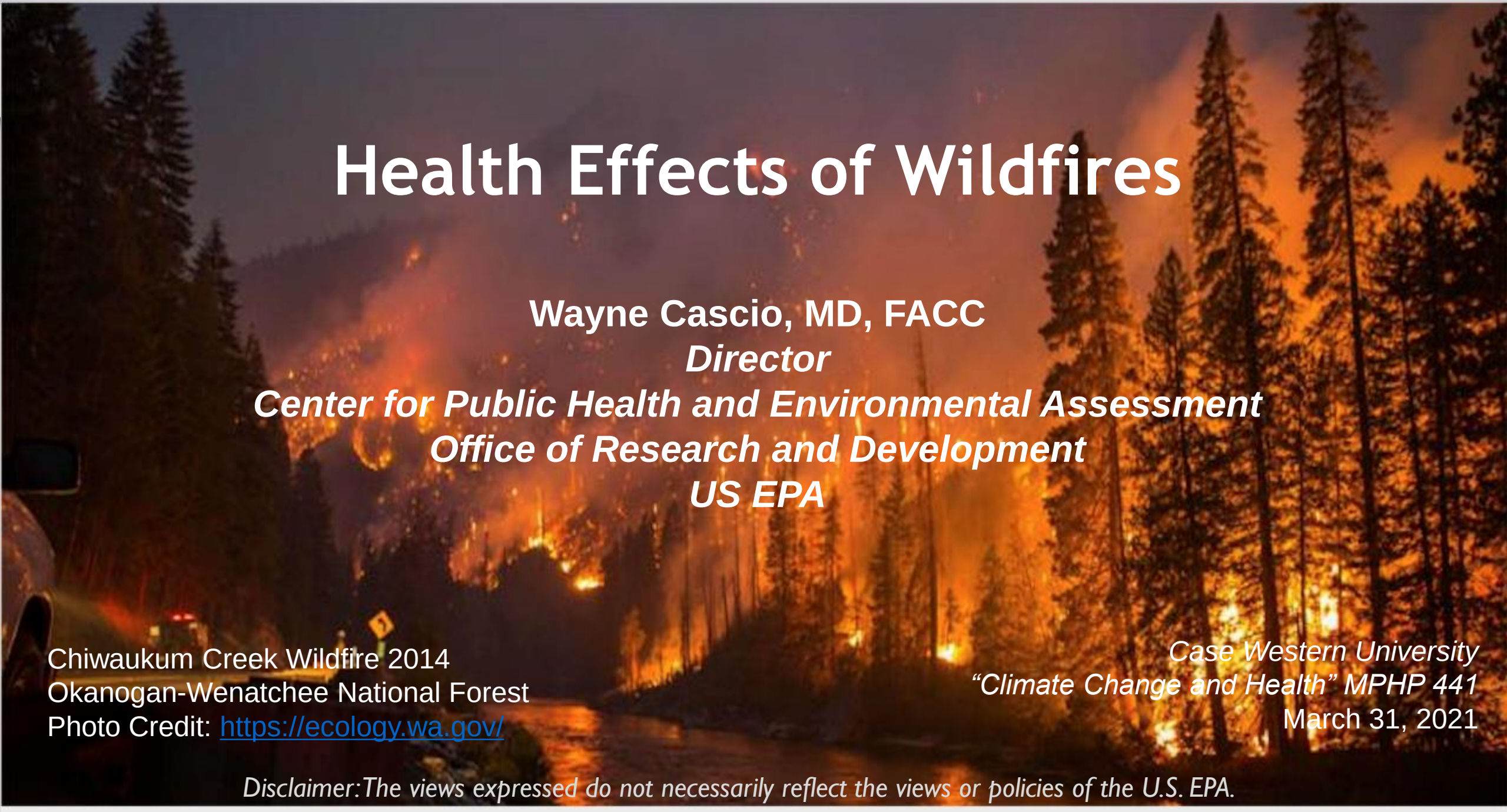
Director
Center for Public Health and Environmental Assessment
Office of Research and Development
US EPA

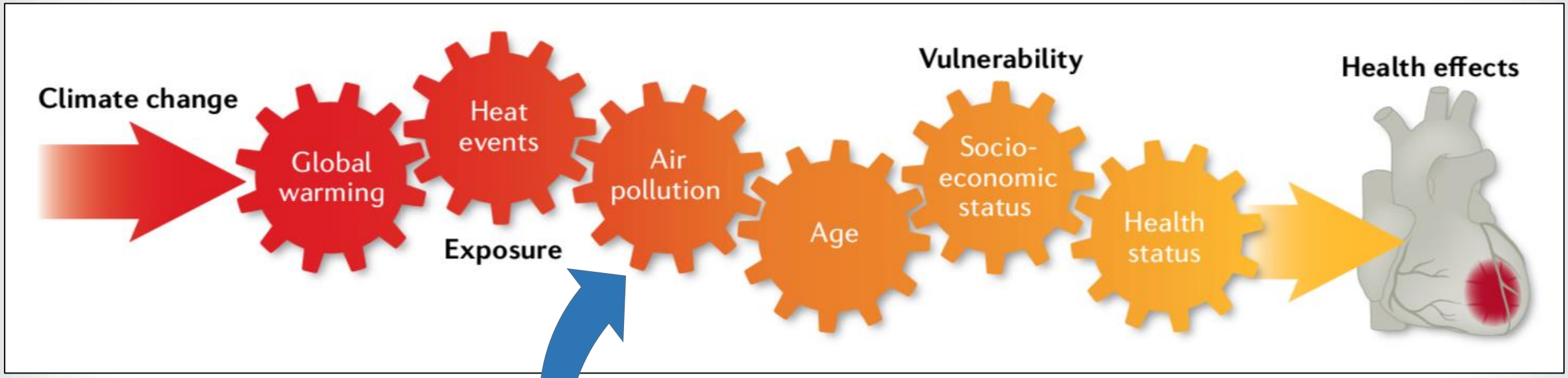


Chiwaukum Creek Wildfire 2014
Okanogan-Wenatchee National Forest
Photo Credit: https://ecology.wa.gov/

Case Western University
"Climate Change and Health" MPHP 441
March 31, 2021

Disclaimer: The views expressed do not necessarily reflect the views or policies of the U.S. EPA.

Factors contributing to the health risks of climate change

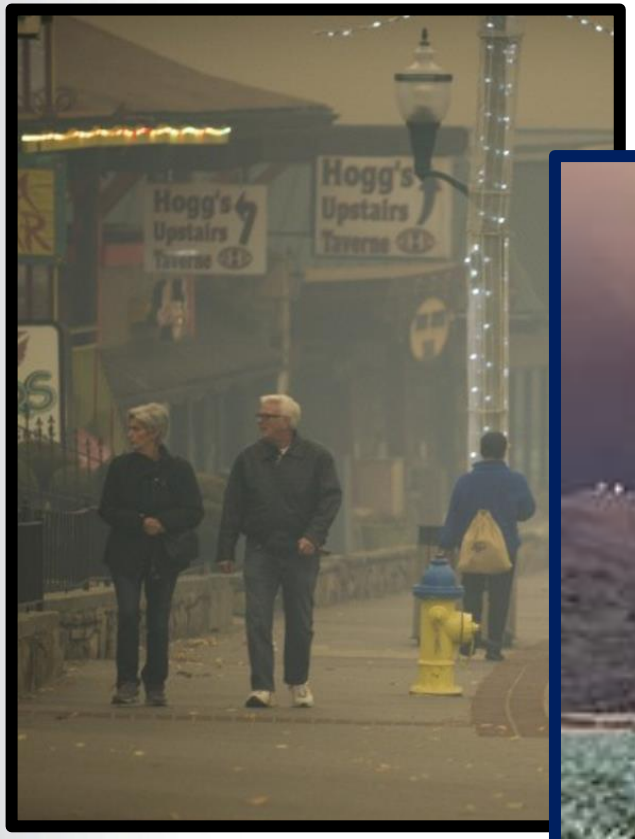


Peters A and Schneider A.
Cardiovascular Risks of Climate Change
Nature 18:2, 2021

Wildfire Smoke

Wildland Fires & Their Emissions

Rural & Urban Community Public Health Concern



Brianna Paciorka, Knoxville News Sentinel

Stephanie Rodriquez, Courtesy of CAUSE

Wildland Fire Definition and Statistics

Current Definitions: (Fire Executive Council 2009)

Wildland fire — any non-structure fire that occurs in the wildland. Includes both wildfires and prescribed fires.

Wildfire — unplanned ignitions or prescribed fires that are declared wildfires.

Prescribed fires — planned ignitions to meet specific objectives.

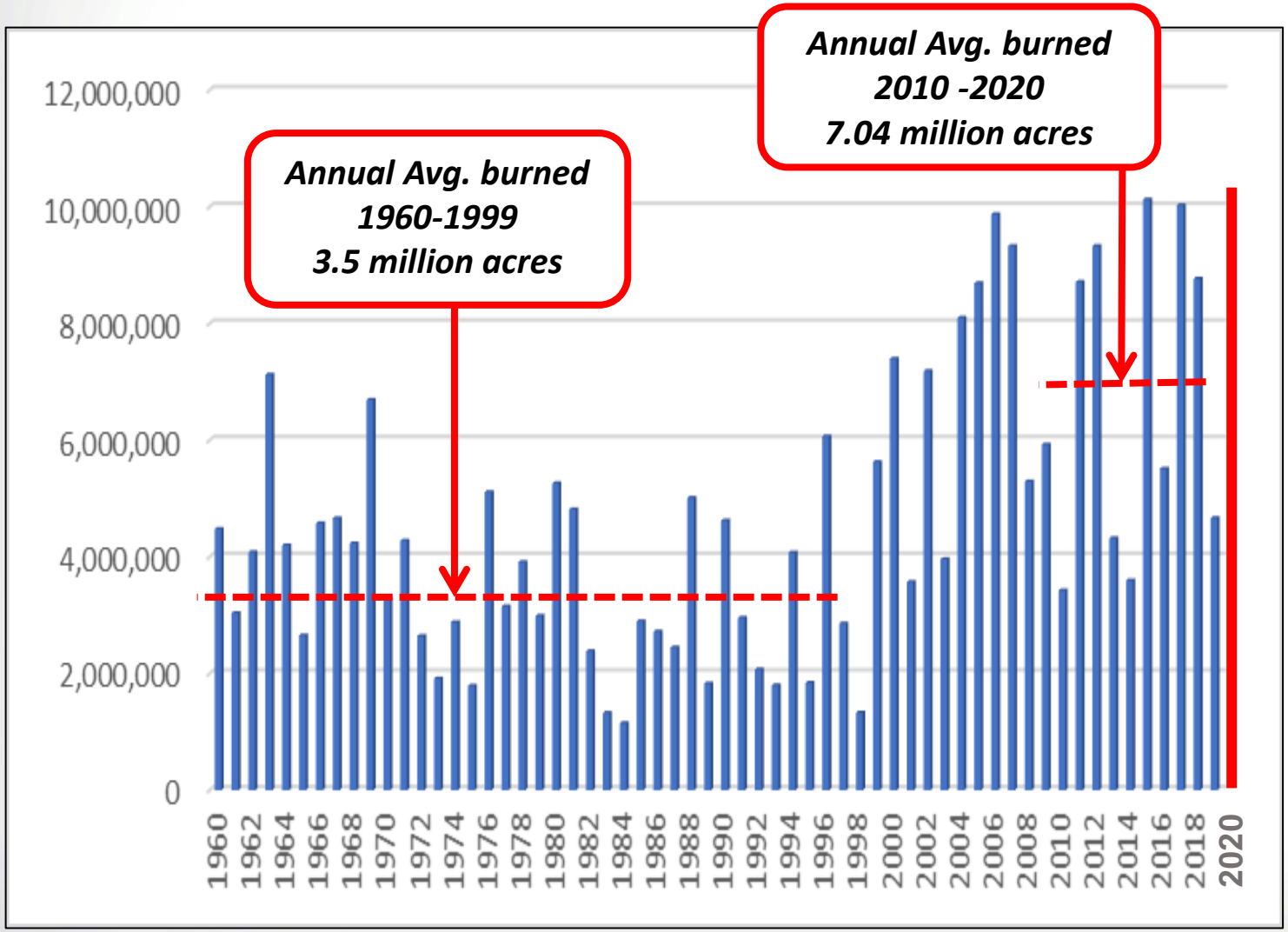
Courtesy of John Hall

Year	Wildfires		Prescribed Fires		Total Acres (nearest 10,000
	Number (nearest 100)	Acres (nearest 10,000)	Number (nearest 100)	Acres (nearest 10,000)	
2018	58,100	8,770,000	450,300	6,360,000	15,130,000
2017	71,500	10,030,000	202,400	6,430,000	16,460,000
2016	67,700	5,510,000	83,000	4,020,000	9,530,000
2015	68,200	10,130,000	37,300	2,960,000	13,090,000
2014	63,300	3,600,000	17,000	2,390,000	5,990,000
2013	47,600	4,320,000	18,800	2,000,000	6,320,000
2012	67,800	9,330,000	16,600	1,970,000	11,300,000
2011	74,100	8,710,000	8,700	2,110,000	10,820,000
2010	72,000	3,420,000	16,900	2,420,000	5,840,000
2009	78,800	5,920,000	12,400	2,530,000	8,450,000
10-Year Average	66,910	6,970,000	94,200	3,320,000	10,290,000

Table sources: National Interagency Fire Center (raw data); John Hall (rounded values). May get different values for prescribed fire from other sources (e.g., Melvin, MA. 2018. Tech. Rep. 03–18). Wildfires must exceed a threshold value to be recorded.

Wildfire in the U.S.

Acreage Burned in the U.S. Annually



Adapted from https://www.nifc.gov/fireInfo/nfn.htm

Present Concerns

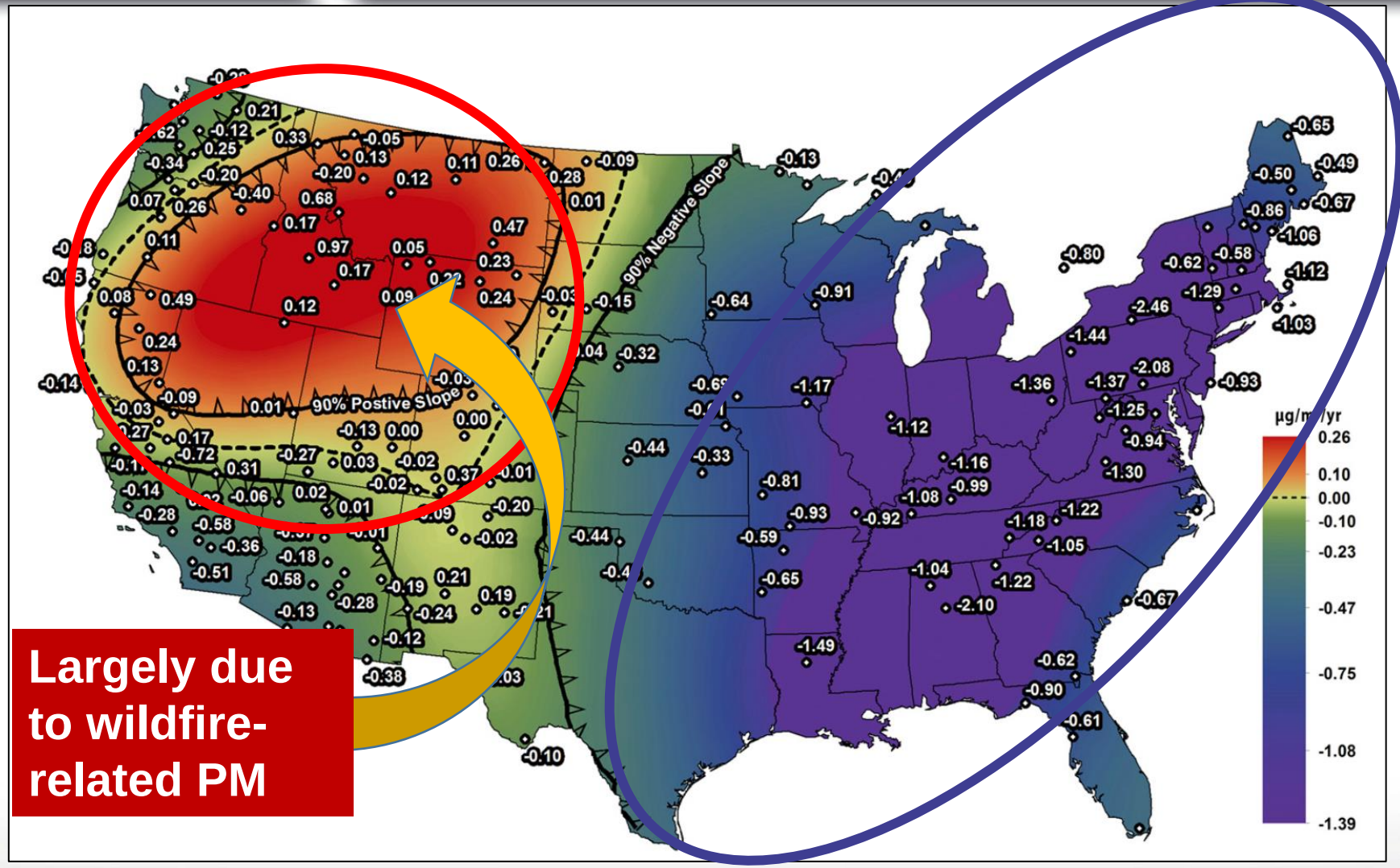
- ***Increasing acreage burned***
- ***Increasing impact on urban areas***
  - ***10% of all land with housing are situated in the wildland-urban interface***
  - ***Between 1990 and 2010 housing in the Wildland Urban Interface (WUI) grew 41% and land by 33%*** *(Radeloff et al. PNAS 2010)*
- ***Increasing vulnerable and sensitive populations***

Air Quality Improves in U.S. from 1988-2016

Except in Wildfire-Prone Areas

Worsening Air Quality

Increasing annual ambient air particle pollution



Improving Air Quality

Decreasing annual ambient air particle pollution

McClure CD and Jaffe DA. PNAS 115 (31): 7901-7906, 2018

Air-Quality Impacts Extend Long Distances Affecting Urban Areas & Large Populations

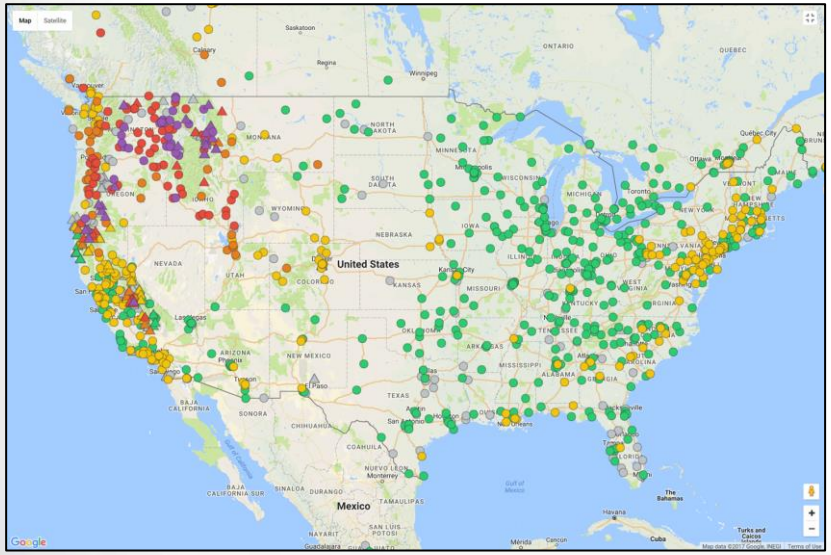
Health Impacts Can Extend Hundreds of Miles

- **Forest fires in Quebec, Canada, during July 2002 (red circles)**
- **Baltimore, Maryland, a city nearly a thousand miles downwind**
- **30-fold increase in airborne fine particle concentrations**

Source: Moderate Resolution Imaging Spectroradiometer (MODIS) instrument on the Terra satellite, Land Rapid Response Team, NASA/GSFC

Smoke Impacts from Wildfire are a Concern for Federal, State & Local Officials

- **Overall days in 2018:** 3730 USG, 1995 Unhealthy, 105 Hazardous
- **95% of all Hazardous days on Temporary Monitors** (these monitors are 200x more likely to detect these levels than the permanent monitors)



September 6, 2017 Monitoring of PM2.5, Hourly updated display at: https://monitoring.airfire.org/monitoring/v3/#/?date=LATEST&productType=plotTable&userProfile=simple

Number of days across all monitors in a state (fixed and temporary) that the Air Quality Index level for $PM_{2.5}$ exceeds the standard for Unhealthy Sensitive Groups

State	2017	2018
WA	555	631
OR	647	536
CA	684	2036
NV	9	39
ID	323	192
UT	12	33
AZ	4	8
NM	32	36
CO	18	62
WY	7	6
MT	436	105

Air Quality Index (AQI)	Actions to Protect Yourself
Good	None
Moderate	Unusually sensitive individuals should consider limiting prolonged or heavy exertion.
USG	People within Sensitive Groups* should **reduce** prolonged or heavy outdoor exertion.
Unhealthy	People within Sensitive Groups* should **avoid all** physical outdoor activity.
Very Unhealthy	Everyone should avoid prolonged or heavy exertion.
Hazardous	Everyone should avoid any outdoor activity.

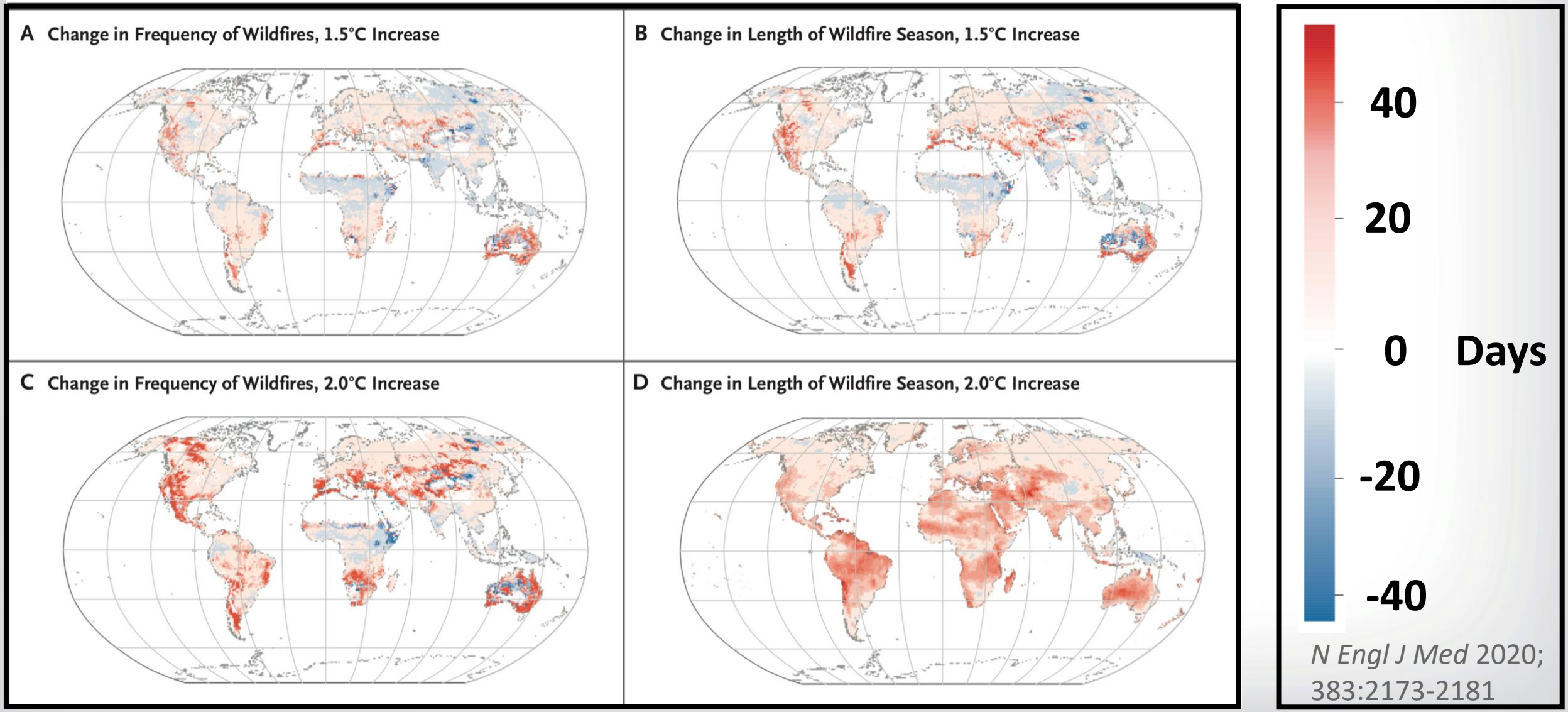
USG = Unhealthy for Sensitive Groups

Permanent monitors
Temporary monitors

Courtesy of John Hall

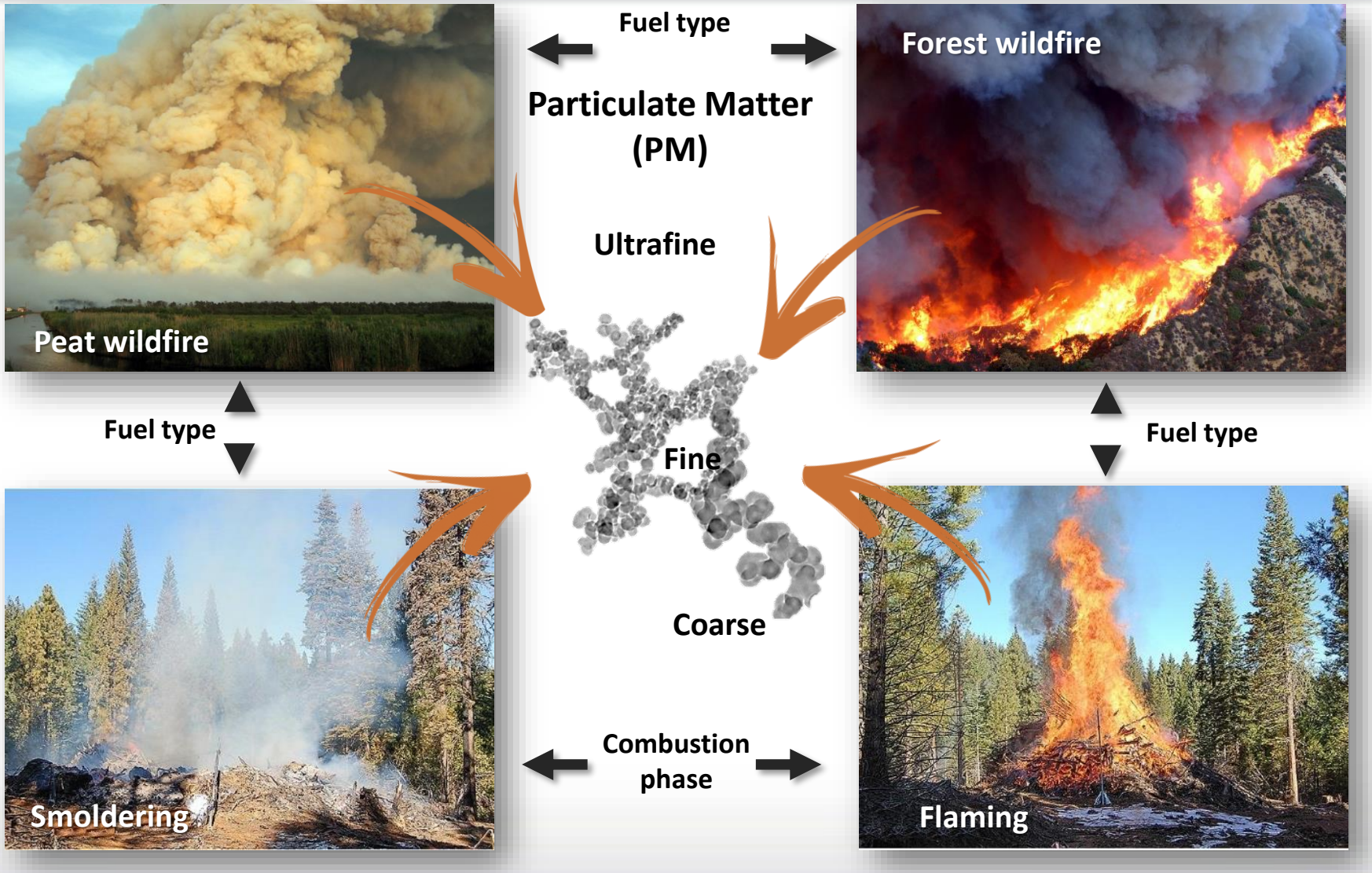
FIRESCIENCE.GOV
Research Supporting Sound Decisions

Projected Change in Wildfire from 1981-2000 to 2080-2099

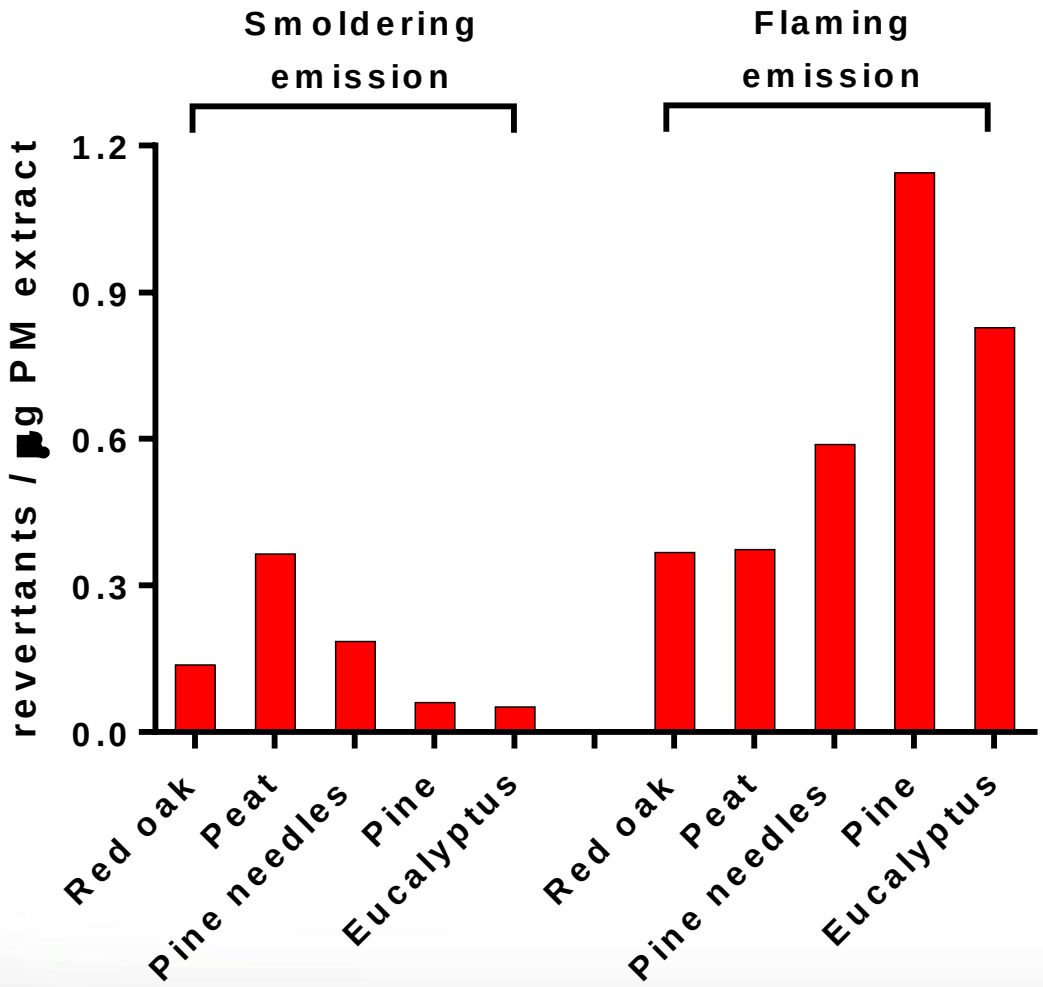


N Engl J Med 2020; 383:2173-2181

Different Types of Wildfire Smoke Have Different Toxicological Effects



Mutagenicity of the Biomass Smoke Condensates Based on Equal Mass



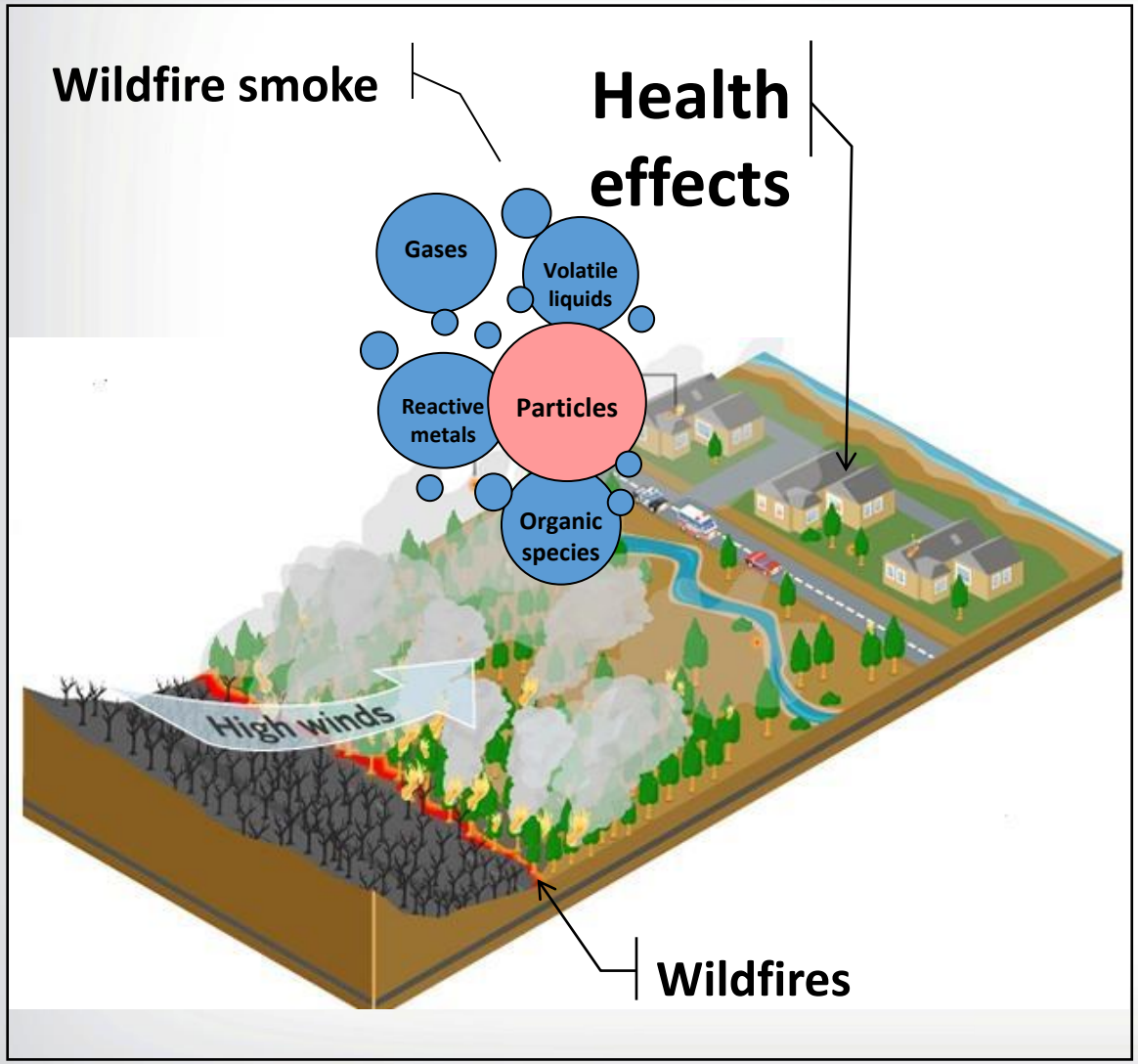
Mutagenicity

Salmonella strain TA98 +S9

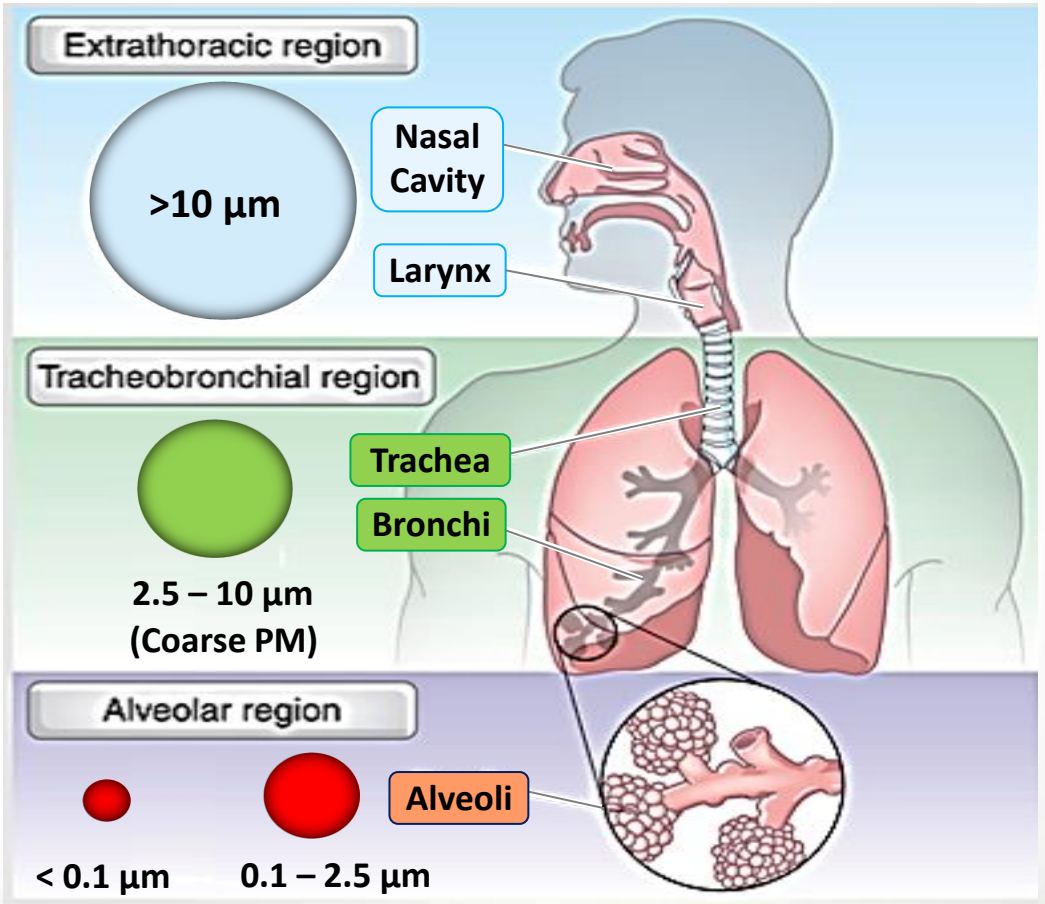
Flaming emissions > **Smoldering emissions**

Kim et al EHP (126:1), 2018

Where There is Smoke There is Illness



Inhaled particle deposition in the lung



Health Effects of Wildfire Smoke
Known, Suspected and Knowledge Gaps

Known

- **All-cause mortality**
- **Respiratory morbidity**
  - *Asthma & COPD exacerbations*
  - *Bronchitis & pneumonia*
  - *Childhood respiratory disease*

Suspected

- **Cardiovascular morbidity**
- **Adverse birth outcomes**
- **PTSD, anxiety and mood disorders**

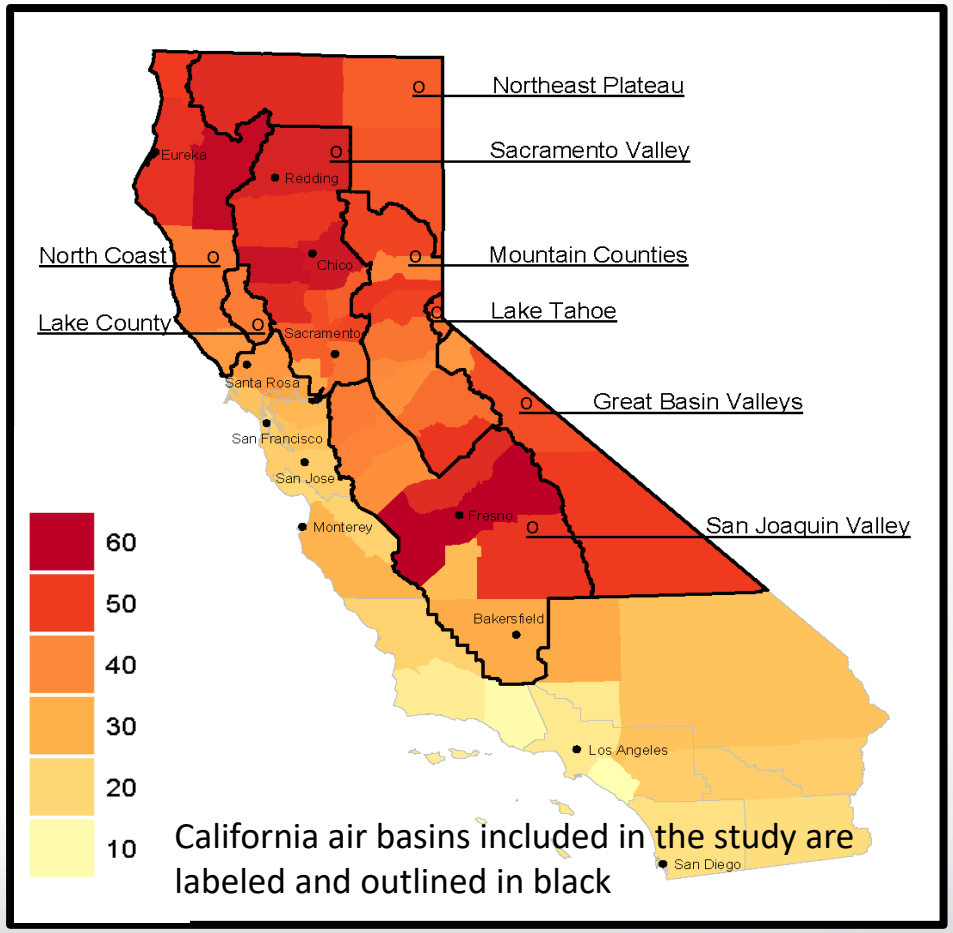
Measuring the Health Effects of Wildfire Smoke

California 2015 Wildfire Study

Epidemiology study designed to examine respiratory, cardio-vascular, & cerebrovascular health effects of wildfire smoke

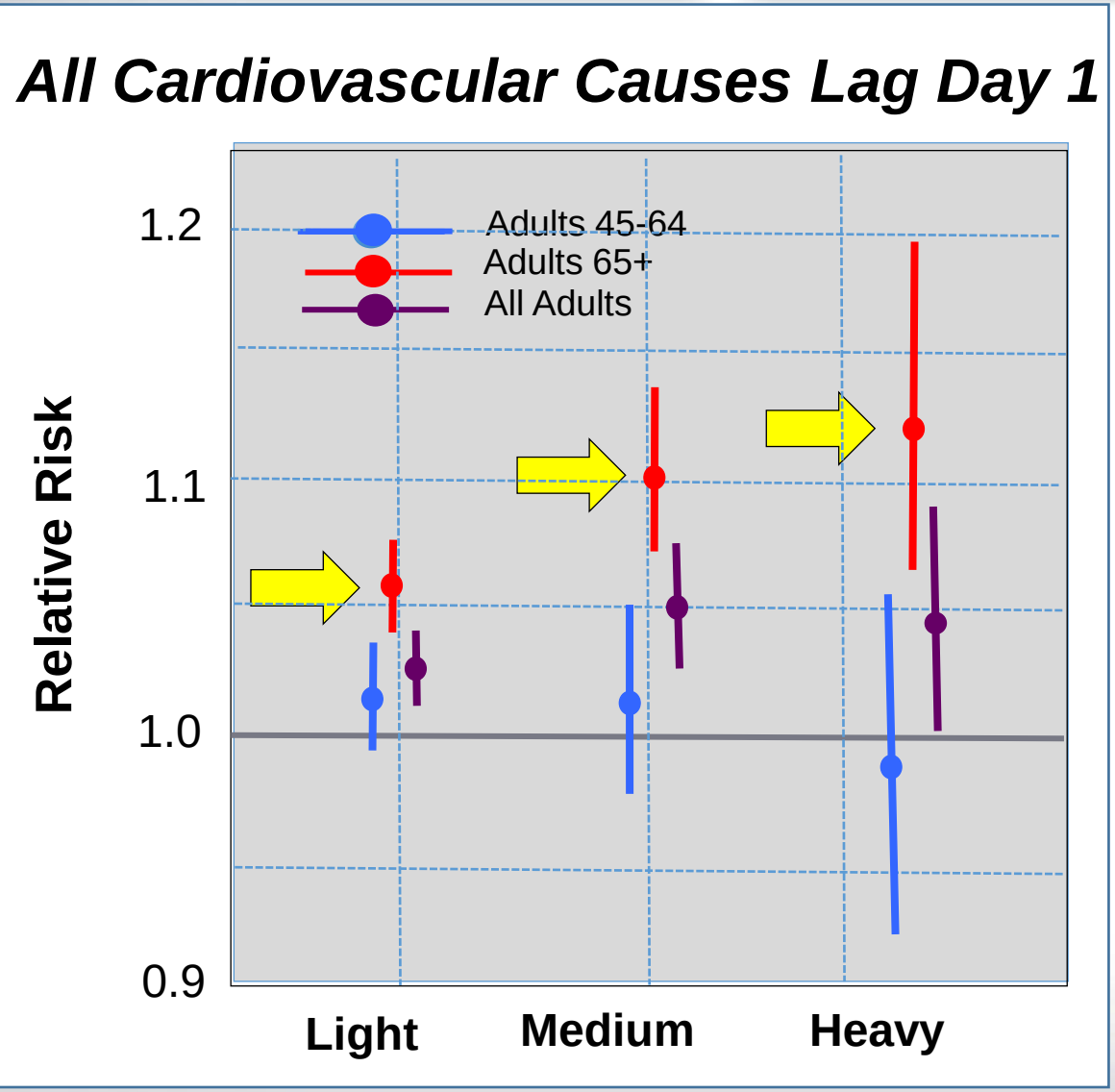
- Associate wildfire-$PM_{2.5}$ exposure with emergency department visits for cardiovascular and respiratory diagnoses

Smoky days/county during the study: May through September 2015



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

Wildfire-$PM_{2.5}$ Increases Heart Attack & Stroke



- *Wildfire-$PM_{2.5}$ associated with heart attacks and strokes for all adults, particularly for those over 65 yrs old*
- *Increase in risk the day after exposure:*
  - All respiratory causes, 18%
  - All cardiovascular, 12%
  - Heart attack, 42%
  - Heart failure, 16%
  - Stroke, 22%
  - Heart rhythm abnormalities, 24% (on the same day as exposure)

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

Health Effects of Wildfire Smoke
Children and Pregnancy

Respiratory Effects

- *Short-term Exposures*
  - Asthma
    - Modified by BMI
    - Greatest in infants and children <5 years old
- *Longer-term Exposures*
  - Eye irritation
  - Upper respiratory effects
    - (throat, and nose symptoms)
  - Respiratory infections
    - (like pneumonia)

Low Birth Weight

- California: Administrative Data
  2003 San Diego wildfires
- Decreased birth weight related to wildfire smoke exposure throughout pregnancy
- Small changes in birth weight are important as they can have lifelong cardiovascular implications

Preterm Delivery

- Colorado: Vital records data 2007 to 2015
- Exposed to wildfire smoke anytime during pregnancy
- 1.076 times the odds of delivering preterm

S. M. Holm et al. *Journal of Exposure Science & Environmental Epidemiology Sept. 2020*

Who's at Risk from Wildland Fire Smoke?

At-risk populations include –

- Aged adults
- Children
- People with respiratory disease
- People with cardiovascular disease
- Pregnant women and fetuses

~30% of the U.S. population is at-risk

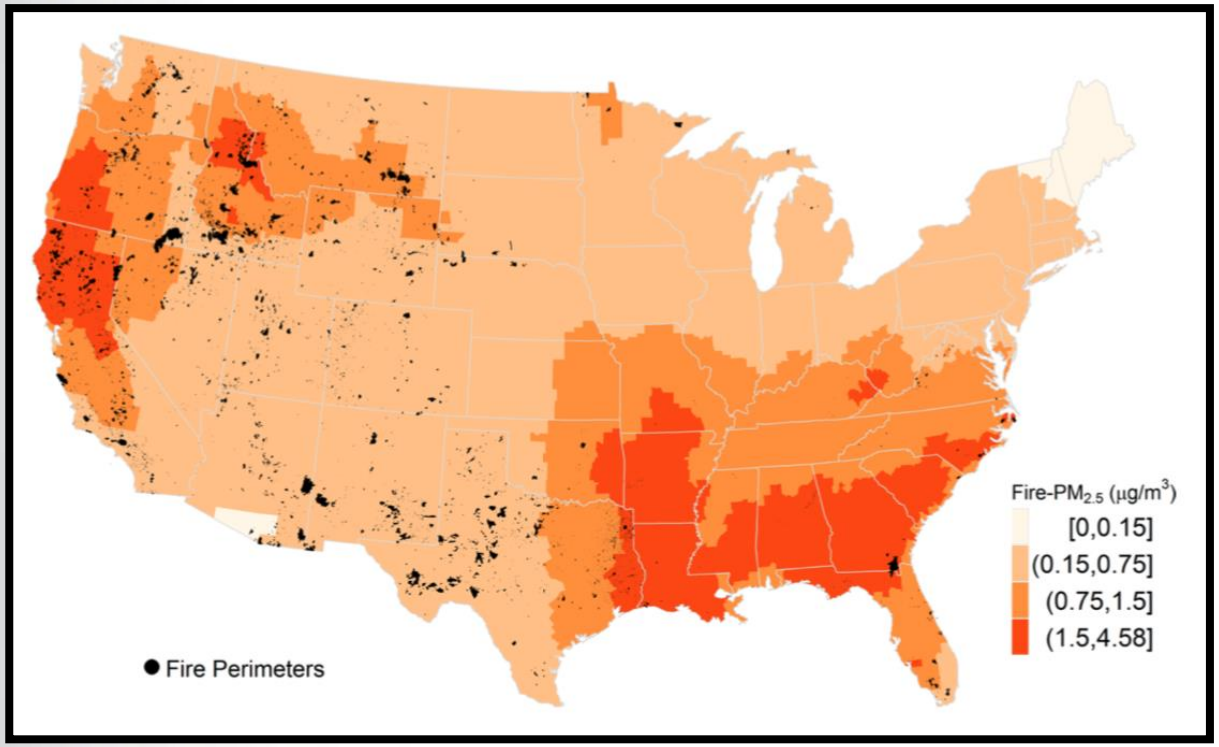
Populations suspected to be at greater risk –

- Women, Non-White and populations with lower socio-economic status*
- Populations with chronic inflammatory diseases (e.g., diabetes, obesity)

* Liu C *et al. Am J Epidemiology* 2017

Potential Exposures to Populations to Wildland Fire Smoke

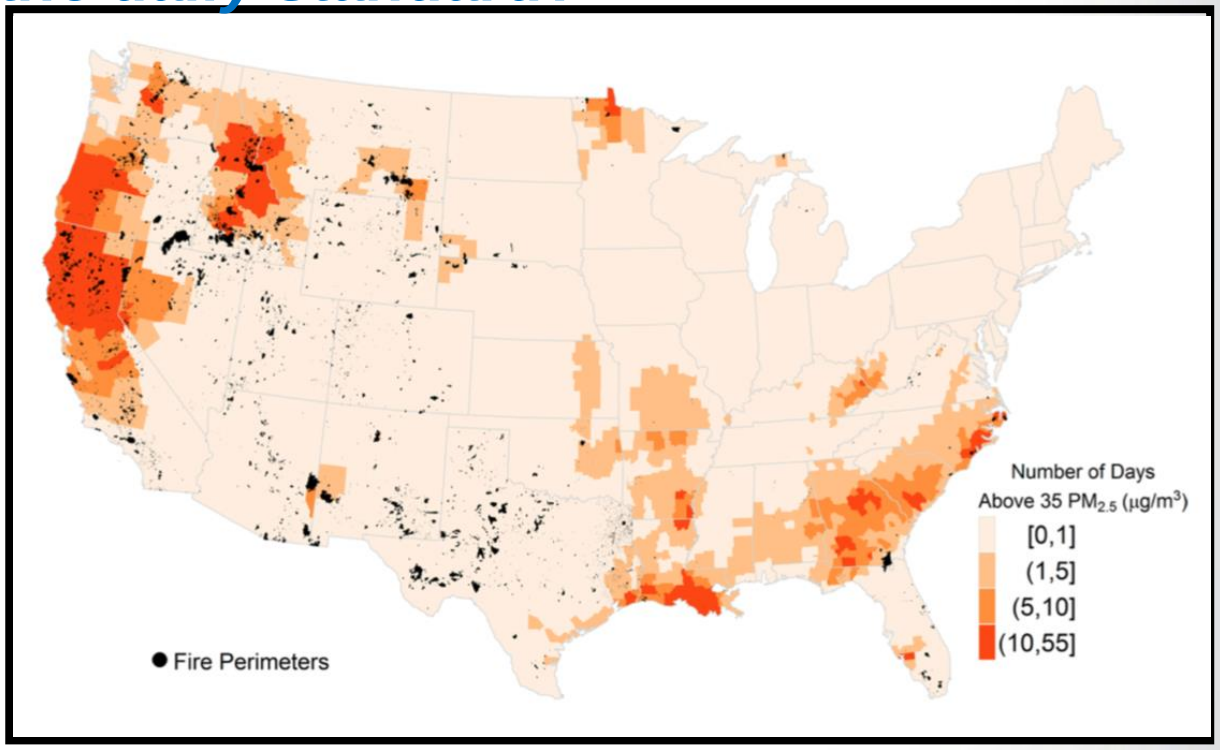
Annual average daily fire- $PM_{2.5}$ footprint for US counties



Annual avg. daily fire-$PM_{2.5}$ footprint by counties

Areas burned by large fires in black between 2008 - 2012.

How much does smoke contribute to air quality and how often does it exceed the daily standard?



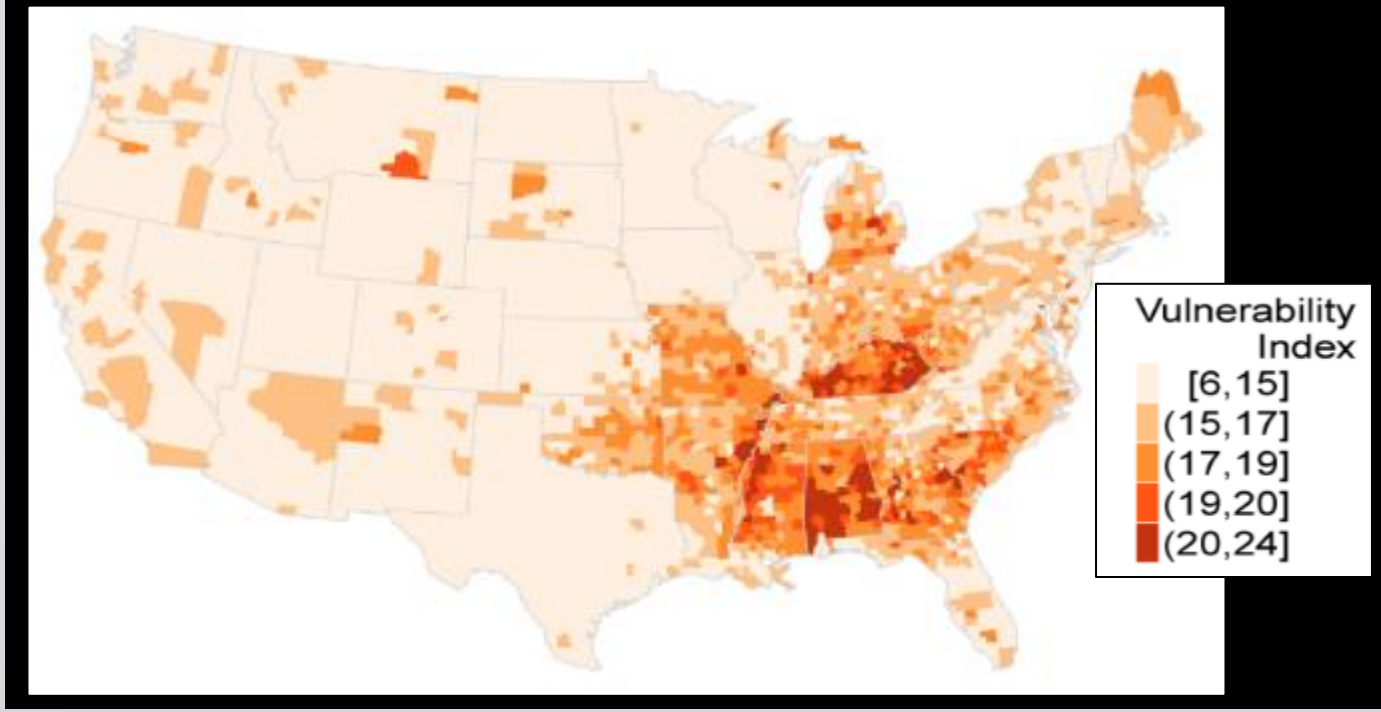
Number of days with fire-$PM_{2.5}$ above 35 µg/m^3 by counties

Rappold A, et al. Environ Sci & Technol 2017

Community Health-Vulnerability Index

EPA tool for public health officials to identify populations at risk from wildland fire smoke exposure

- **More smoke in the West, but population is less vulnerable than those in the south**
- **This tool considers factors that define susceptibility to air pollutant-related health effects**



Factors of Vulnerability

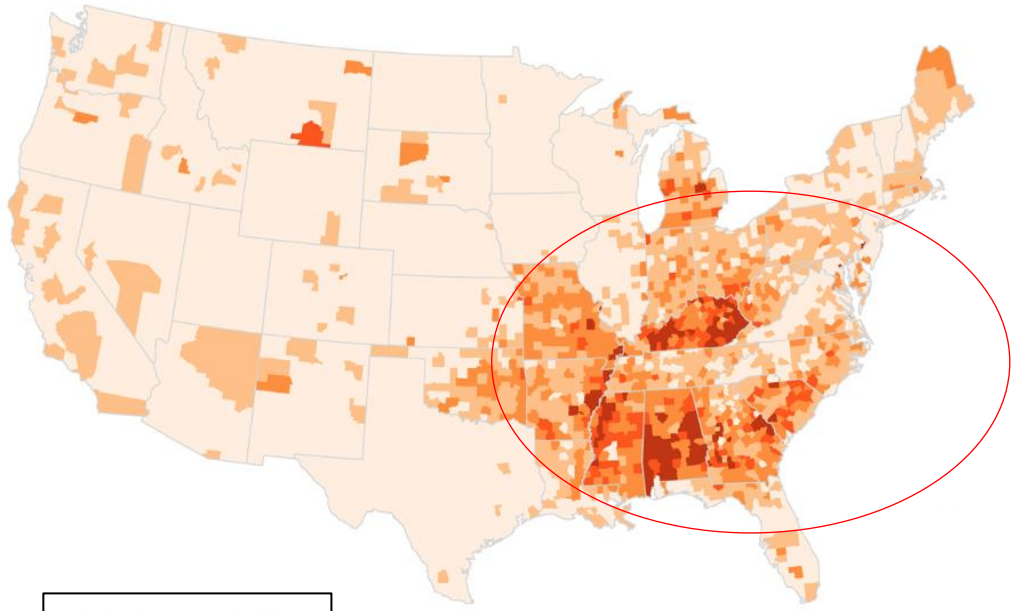
- Peds & Adult Asthma
- COPD
- Obesity
- Diabetes
- Hypertension
- % population age 65+
- Income, education, poverty, unemployment

Rappold AG, et al Environ Sci Technol 2017

Community Health-Vulnerability

Community-Health Vulnerability Index

National map of Community-Health Vulnerability Index to Adverse Health Effects from Wildfire Smoke

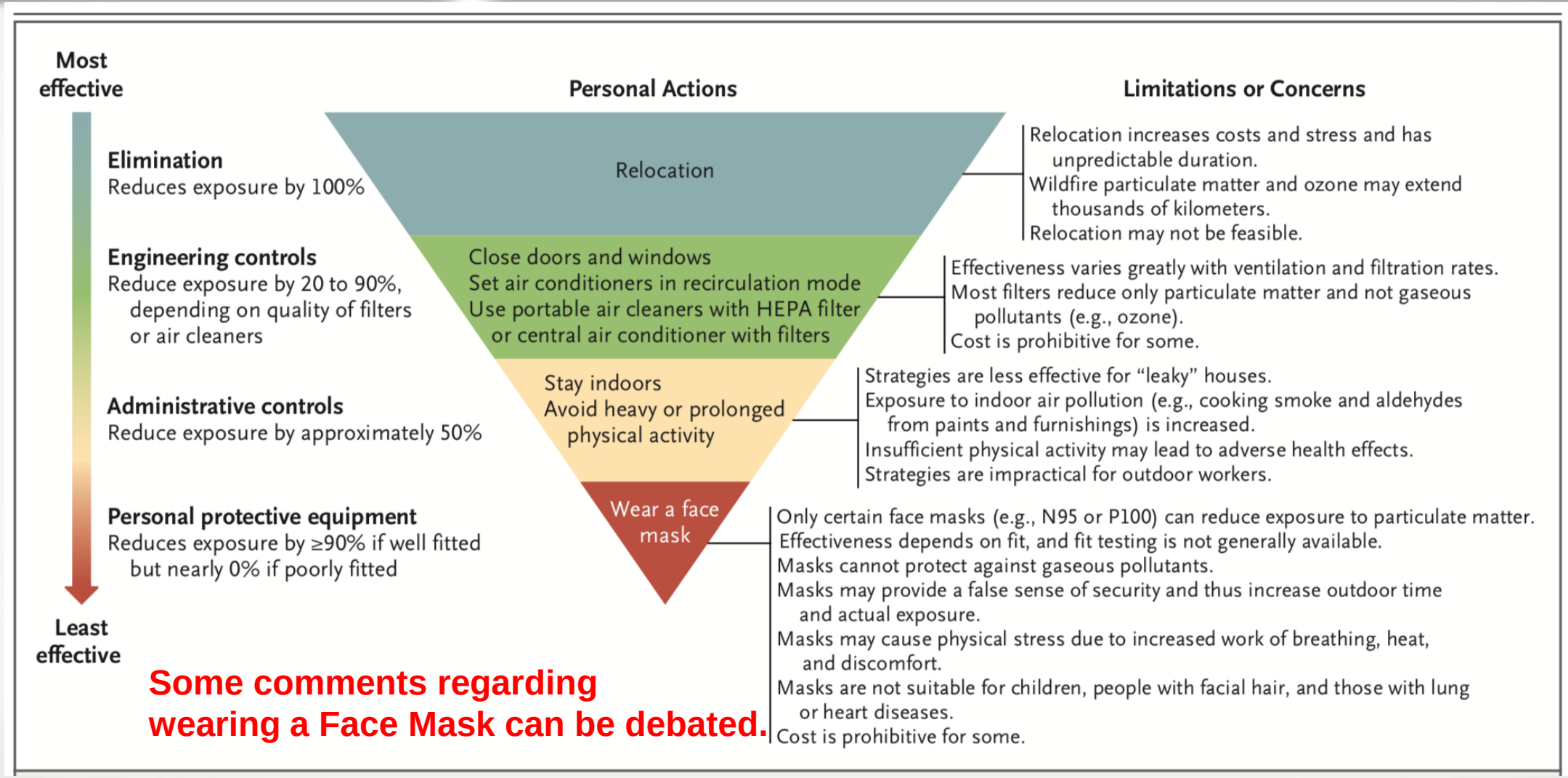


- The Community Health-Vulnerability Index identifies the most vulnerable counties
- 30.5 million lived in the areas where annual average fire-$PM_{2.5}$ was high (>1.5 µg/m^3)
- 10.3 million people experienced >10 unhealthy air quality days due to smoke

- Shows that these communities experience more smoke exposures in comparison to less vulnerable communities

Rappold AG, et al Environ Sci Technol 2017

Main Actions that Individual People can Take to Reduce Wildfire Smoke Exposure

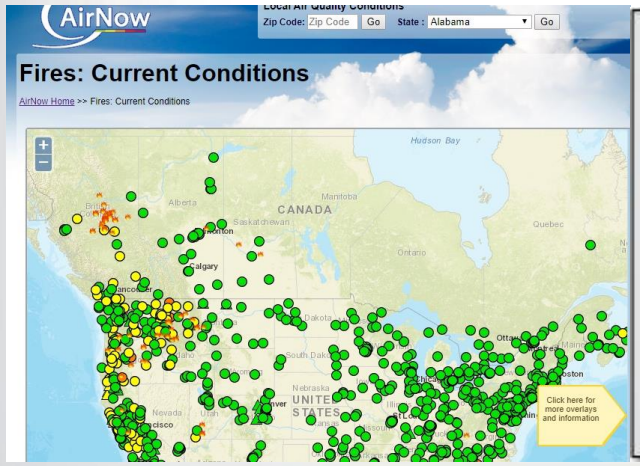


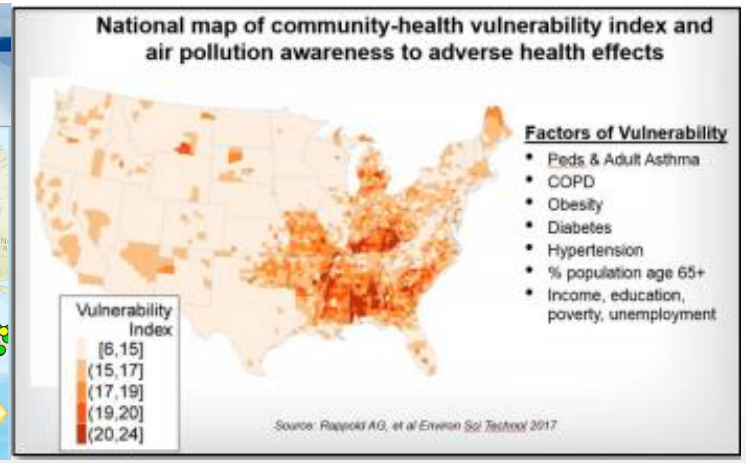
Some comments regarding wearing a Face Mask can be debated.

N Engl J Med 2020; 383:2173-2181

EPA Plays a Supportive Role

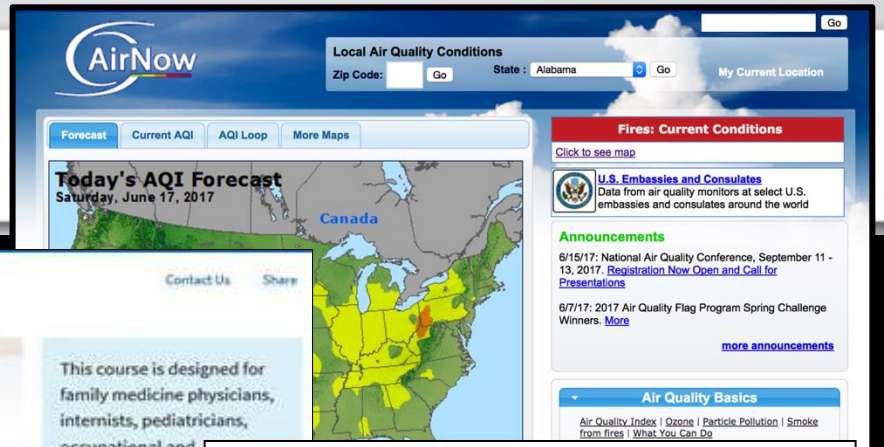
- **Public health outreach**: helping the public understand how fires impact their health, including providing real-time information during fire events.
  - AirNow
  - Health Messaging, e.g., Wildfire Smoke: A Guide for Public Health Officials
  - Smoke Sense App
- **Preparedness resources**
  - Clean Air Spaces
  - Respirator Use
- **Information Clearinghouse**: Smoke Ready Toolbox
- **Research**
  - How to improve community capacity and resiliency around smoke events
  - Community Health Vulnerability Index
  - How fires impact air quality
  - Monitoring Needs

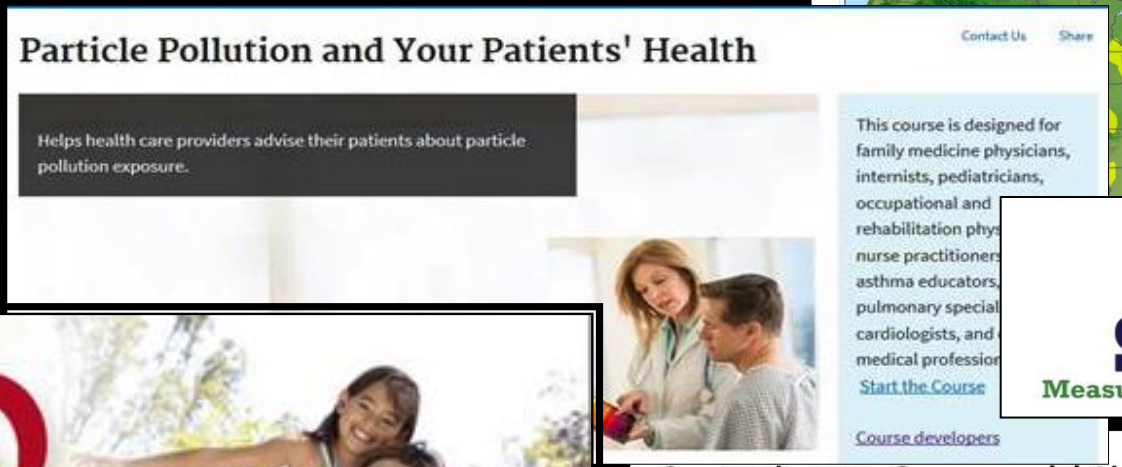


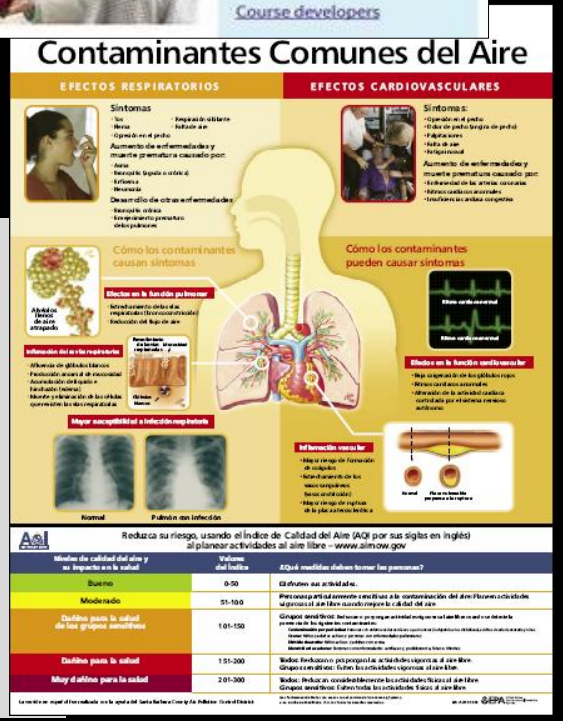


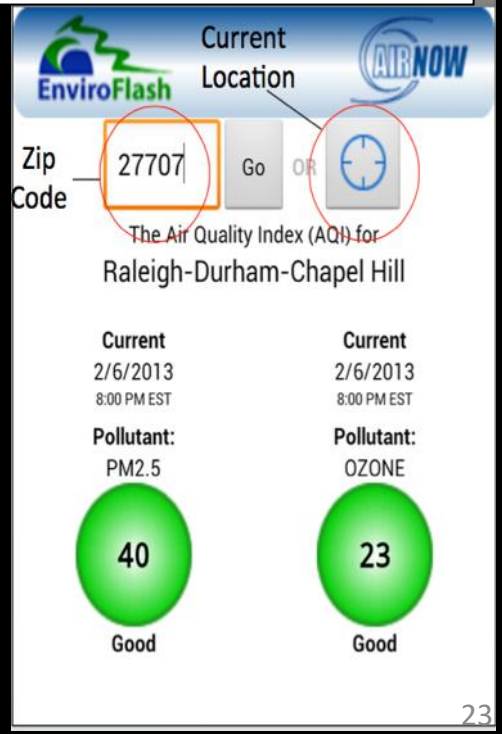
Courtesy of Erika Sasser, OAR

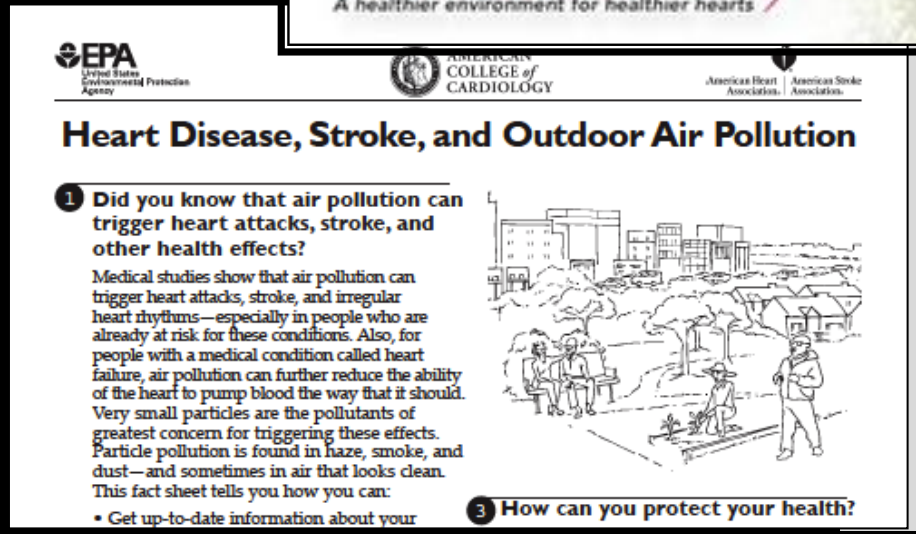
Engaging the Public
Examples of Products











Smoke Ready Toolbox for Wildfires

Airnow.gov: Current Fire Conditions
Get current air quality conditions and learn what to do to protect your health from air pollution, including smoke from wildland fires. Airnow.gov provides local air quality forecasts using EPA's science-based air quality index. https://airnow.gov/index.cfm?action=topics.smoke_wildfires

How Smoke From Fires Can Affect Your Health
Learn who is more at risk from smoke, how to tell if it is affecting you, and steps you can take to protect your health. Learn what to do before, during and after a wildfire. https://airnow.gov/index.cfm?action=smoke.index

Wildfire Smoke: A Guide for Public Health Officials
The guide is an easy-to-use resource that outlines whose health is most affected by wildfire smoke, how to reduce exposure to smoke, what public health actions are recommended, and how to communicate air quality to the public. The recommendations are based on science conducted by EPA and others. https://www3.epa.gov/airnow/wildfire_may2016.pdf

Wildfire Smoke Exposure Infographics
Two infographics provide information on actions to take to reduce health risks from smoke exposure in areas with wildfire smoke and what respirator (mask) to wear if you have to go outside and how to wear it properly. https://www3.epa.gov/airnow/smoke_fires/reduce-health-risks-with-wildfire-smoke.pdf and https://airnow.gov/static/topics/images/epa-infographic-respirator.jpg

Smoke Sense App
The Smoke Sense mobile app, developed by EPA researchers, enables you to get information on air quality and learn how to protect your health from wildland fire smoke. The app is being used in a citizen science study to determine how smoke from fires impacts public health. The app is available for anyone to use and can be downloaded on Android or iOS. www.epa.gov/air-research/smoke-sense

Particle Pollution and Your Patients' Health Course
Particle pollution, also known as particulate matter or PM, is the main component of haze, smoke, and dust. This course provides health professionals with knowledge they can share with patients to help reduce overall risk of PM-related health effects, particularly in individuals with heart and lung disease. www.epa.gov/pmcourse

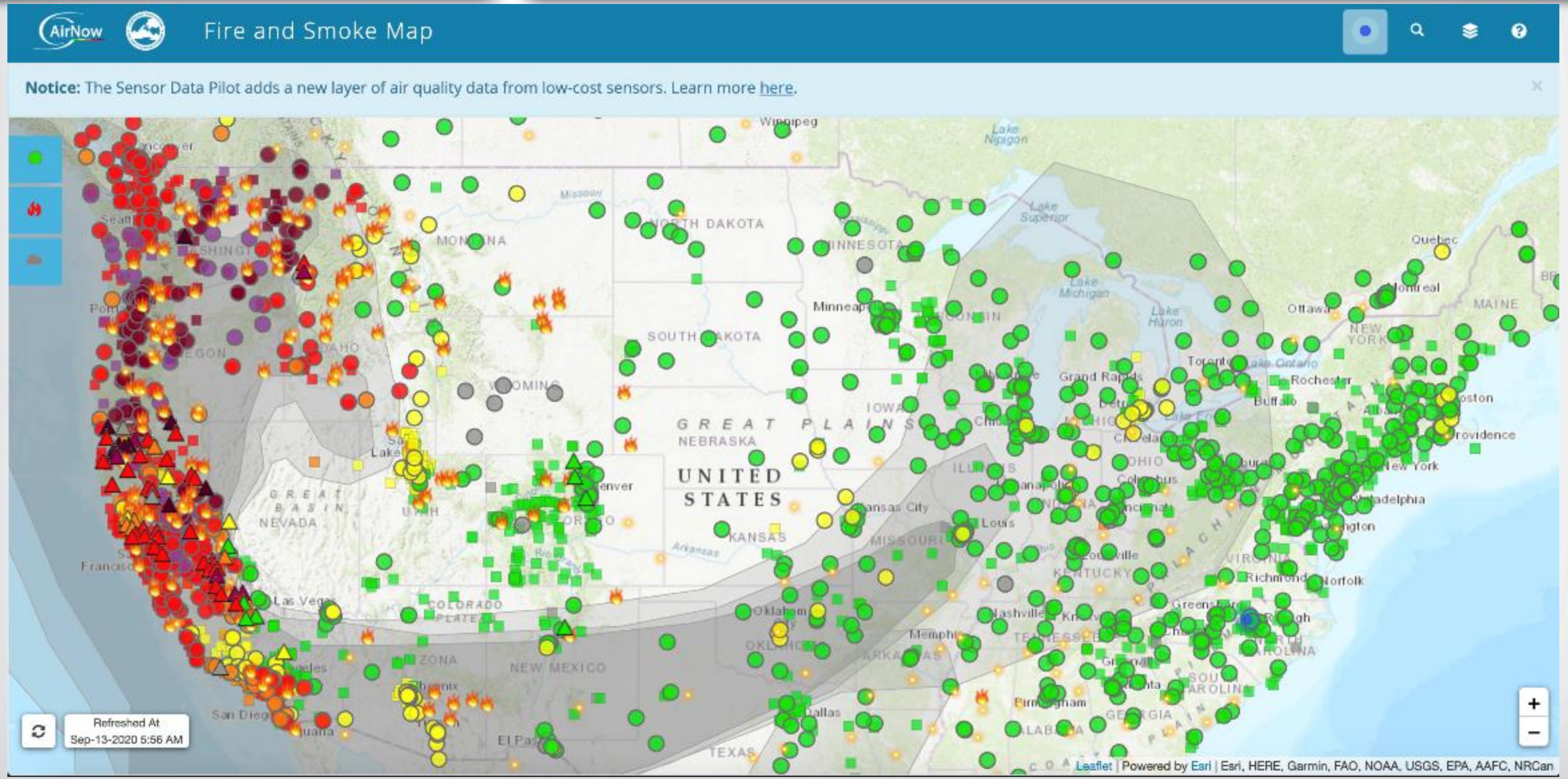
Online Healthy Heart Toolkit
Breathing in fine particulate matter ($PM_{2.5}$) can trigger heart attacks, ischemic stroke, abnormal heart rhythms and worsen heart failure in people with cardiovascular disease or older adults with medical conditions that put them at risk. Particle pollution is a main component of smoke. Use the toolkit to protect your heart. https://www.epa.gov/air-research/healthy-heart-toolkit-and-research

Smoke Ready Toolbox for Wildfires

- **Resources health officials can use to educate the public about the risks of smoke exposure and actions people can take to protect their health**

https://www.epa.gov/smoke-ready-toolbox-wildfires

AirNow Fires: Fire and Smoke Map
September 13, 2020

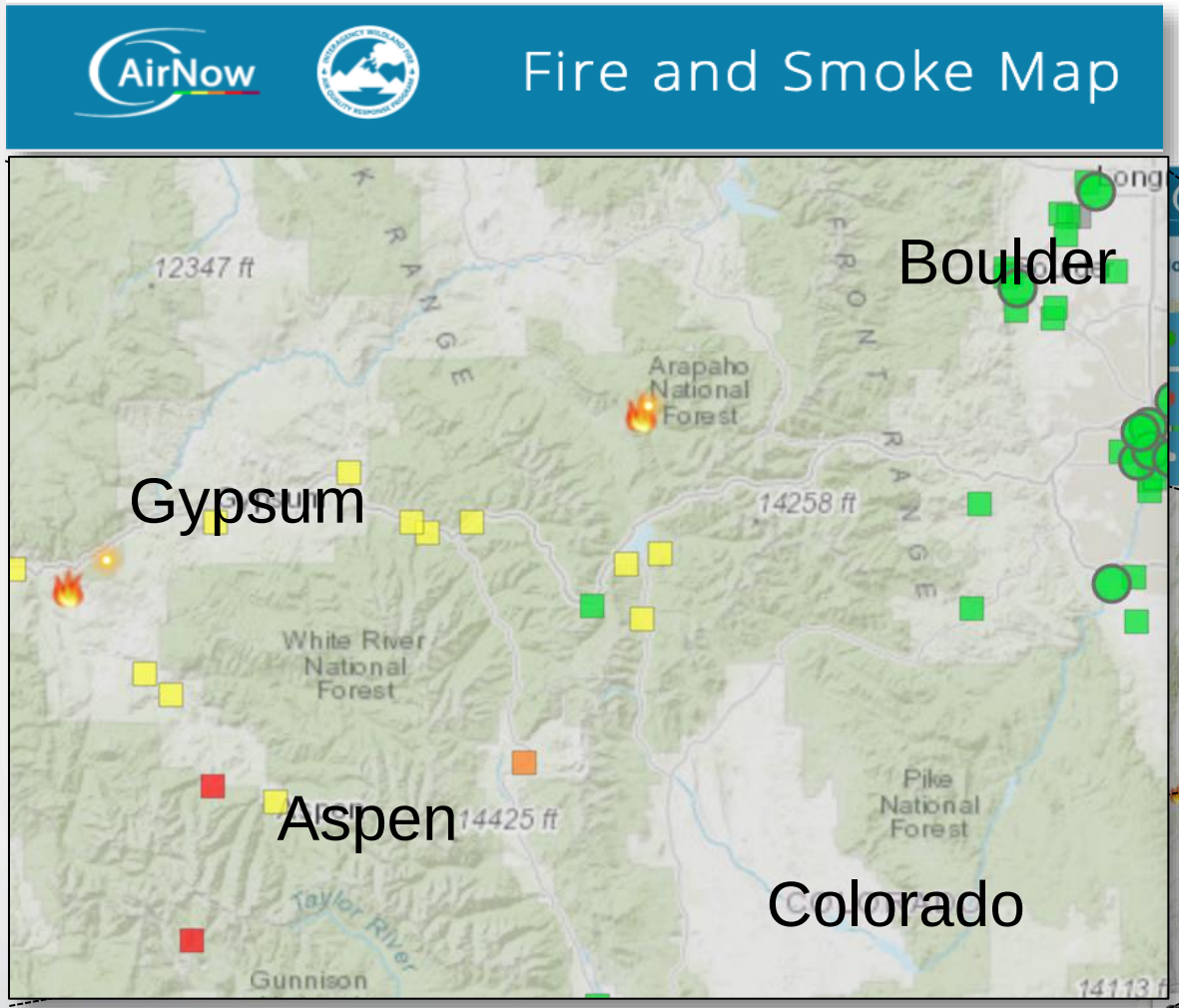


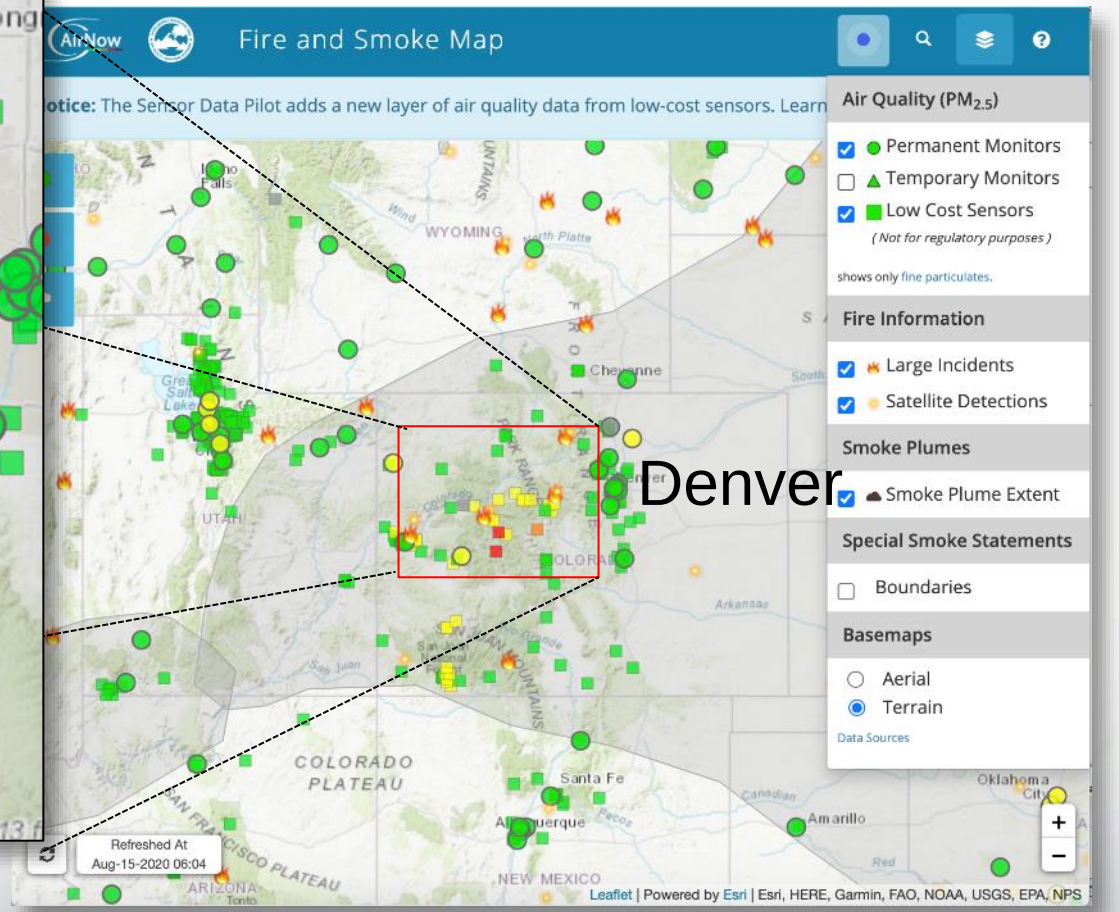
Enhanced Ambient Air Quality ($PM_{2.5}$) Data

Purple Air Now Displayed on AirNow

Air Quality ($PM_{2.5}$) Layers: Monitors and sensors reporting $PM_{2.5}$ data

- Permanent Monitors: Federal, State, Tribal
- Temporary Monitors: Typically gov. agencies
- Low Cost Sensors: Currently from Purple Air





https://fire.airnow.gov/

26

Wildfire Smoke and PM Web CE Courses

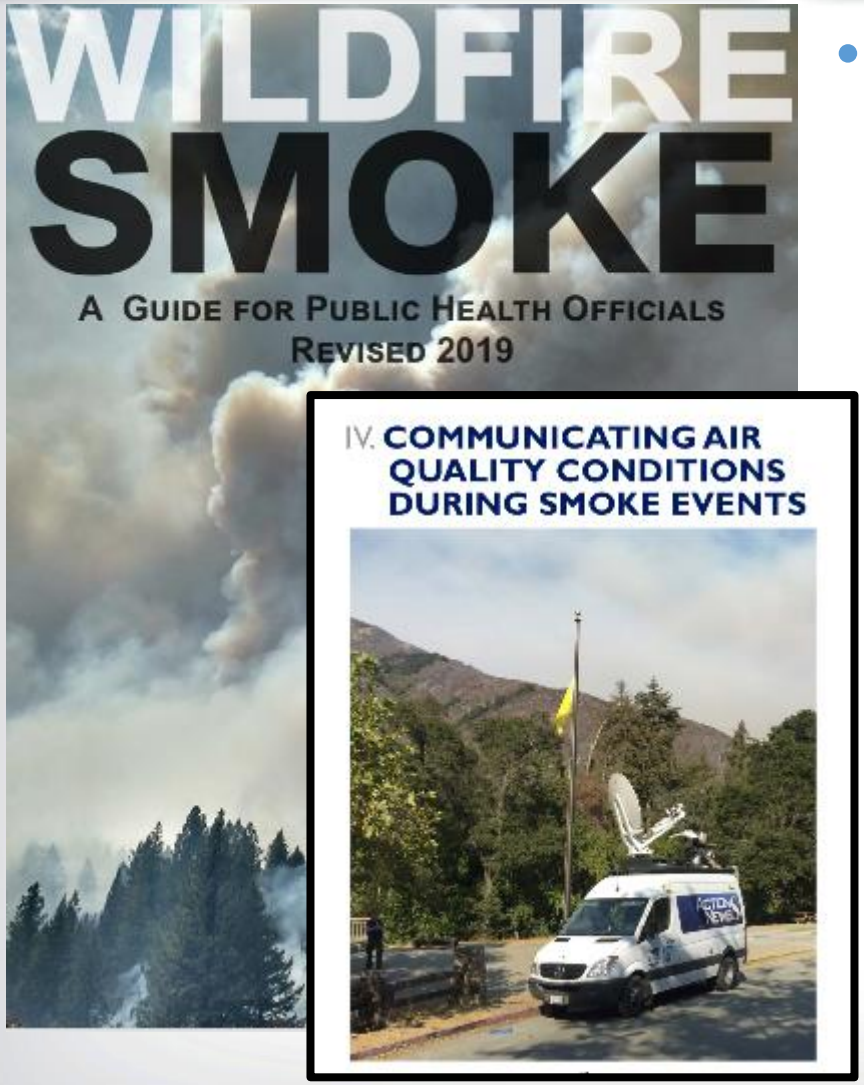
For Healthcare Professionals and Educators

In September 2020 Over 40,000 visits were made to the CE courses for:

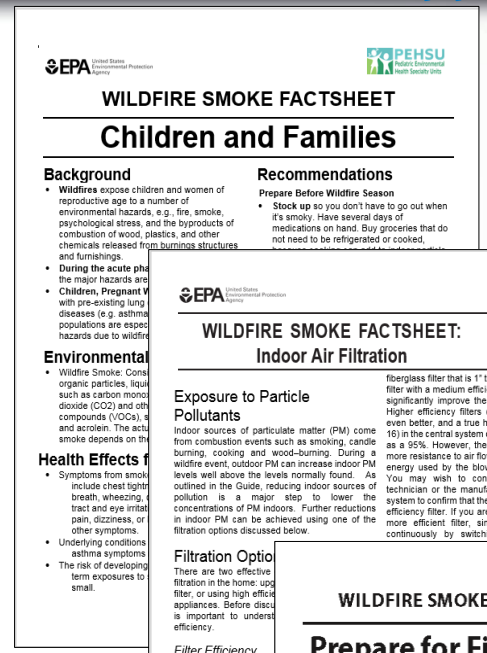
- **PM**
- **Wildfire Smoke**

CME credit from CDC to physicians, nurses and health educators

Wildfire Smoke: A Guide for Public Health Officials



- **Stand-alone fact sheets**
  - *Prepare for Fire Season*
  - *Protect Yourself from Ash*
  - *Indoor Air Filtration*
  - *Reduce Your Smoke Exposure*
  - *Protect Your Lungs from Wildfire Smoke or Ash*
  - *Protecting Children from Wildfire Smoke and Ash*
  - *Protect you Pets and Wildfire Smoke*
  - *Protect Your Large Animals and Livestock from Wildfire Smoke*


WILDFIRE SMOKE FACTSHEET

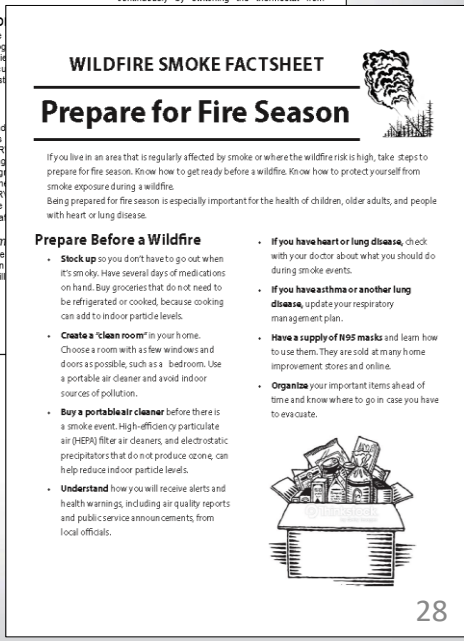
Children and Families

Background

Recommendations


WILDFIRE SMOKE FACTSHEET: Indoor Air Filtration

Exposure to Particle Pollutants


WILDFIRE SMOKE FACTSHEET

Prepare for Fire Season

Prepare Before a Wildfire

https://airnow.gov/index.cfm?action=topics.smoke_wildfires_guide_factsheets

Animals Can be Affected
Protecting Pets, Farm Animals and Livestock

WILDFIRE SMOKE FACTSHEET

Protect Your Pets from Wildfire Smoke

Your pets can be affected by wildfire smoke. If you feel the effects of smoke, they probably do, too! Smoke can irritate your pet's eyes and respiratory tract. Animals with heart or lung disease and older pets are especially at risk from smoke and should be closely watched during all periods of poor air quality.

Know the Signs

If your animals have any of these signs, call your veterinarian:

- Coughing or gagging
- Red or watery eyes, nasal discharge, inflammation of throat or mouth or reluctance to eat hard foods
- Trouble breathing, including open-mouth breathing, more noise when breathing, or fast breathing
- Fatigue or weakness, disorientation, uneven gait, stumbling
- Reduced appetite or thirst

Recommended Actions

Even if the fire danger is not imminent, high levels of smoke may force you to stay indoors for a long time or even to evacuate. Reduce your pet's exposure to smoke as you would reduce your own.

Before the fire season:

- Whether you have a central air conditioning system or a room unit, buy high efficiency filters you can use to capture fine particles from smoke.
- Think about creating a clean room in your house with a portable air cleaner.

When smoke is present:

- **Keep pets indoors** as much as you can, with doors and windows closed. Bring outdoor pets into a room with good ventilation, like a utility room, garage, or bathroom. Move potentially dangerous products, such as pesticides, out of the reach of pets.
- **Smoke is especially tough on your pet birds.** Keep them inside when smoke is present.
- **Keep indoor air clean**: do not fry or broil foods, vacuum, burn candles, use a fireplace or woodstove, or smoke tobacco products. These activities add particles to your home.
- **Spend less time outdoors and limit physical activities when it is smoky**. For example, when it's smoky, it's not a good time for you and your pet to go for a run. Let dogs and cats outside only for brief bathroom breaks if air quality alerts are in effect.

https://www3.epa.gov/airnow/smoke_fires/protect-your-pets-from-wildfire-smoke.pdf

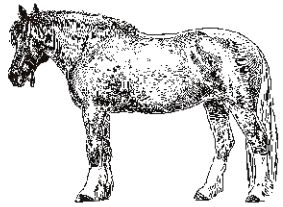
WILDFIRE SMOKE FACTSHEET

Protect Your Large Animals and Livestock from Wildfire Smoke

Your animals can be affected by wildfire smoke. If you feel the effects of smoke, they probably do too! High levels of smoke are harmful. Long exposure to lower levels of smoke can also irritate animals' eyes and respiratory tract and make it hard for them to breathe. Reduce your animals' exposure to smoke the same way you reduce your own: spend less time in smoky areas and limit physical activity. Animals with heart or lung disease and older animals are especially at risk from smoke and should be closely watched during all periods of poor air quality. Take the following actions to protect your large animals and livestock against wildfire smoke.

Protect Your Animals During Smoke Episodes

- ☐ Limit strenuous activities that increase the amount of smoke breathed into the lungs.
- ☐ Provide plenty of fresh water near feeding areas.
- ☐ Limit dust exposure by feeding low-dust or dust-free feeds and sprinkling or misting the livestock holding areas.
- ☐ Consider moving outdoor birds to a less smoky environment, such as a garage or basement.
- ☐ Give your livestock 4 to 6 weeks to recover fully from smoky conditions before resuming strenuous activity.
- ☐ Protect yourself, too! Think about wearing an N95 or P100 respirator while taking care of your animals.



Prepare Before a Wildfire

Know where to take your livestock if smoke persists or becomes severe, or if you need to evacuate. Good barn and field maintenance can reduce fire danger for horses and other livestock.

Record Keeping

- ☐ Make sure your animals have permanent identification (ear tags, tattoos, electronic microchips, brands, etc.).
- ☐ Keep pictures of animals, especially high-value animals, such as horses, up-to-date.
- ☐ Keep a list of the species, number and locations of your animals with your evacuation supplies.
- ☐ Note animals' favorite hiding spots. This will save precious rescue time!
- ☐ Keep vaccination records, medical records and registration papers with your Evacuation Kit.

Preparing for Evacuations

- ☐ Assemble an Evacuation Kit.
- ☐ Know where you can temporarily shelter your livestock. Contact your local fairgrounds,

https://www3.epa.gov/airnow/smoke_fires/protect-your-large-animals-and-livestock-from-wildfire-smoke.pdf

Federal and Professional Partners

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

DEPARTMENT OF HEALTH & HUMAN SERVICES · USA

CDC Centers for Disease Control and Prevention

FOREST SERVICE US DEPARTMENT OF AGRICULTURE

AVMA American Veterinary Medical Association

Wildfire Smoke Guide Post-Publication Updates

CDC has provided important new considerations for protecting health during wildfire attendant to the COVID-19 pandemic.

Wildfire Preparedness and Response during COVID-19

- CDC - Wildfire Smoke and COVID-19
- CDC - Public Health Strategies to Reduce Exposure to Wildfire Smoke during the COVID-19 Pandemic
- CDC-USFS - Wildfire Smoke and COVID-19: Frequently Asked Questions and Resources for Air Resource Advisors and Other Environmental Health Professionals
- CDC - COVID-19 Considerations for Cleaner Air Shelters and Cleaner Air Spaces to Protect the Public from Wildfire Smoke
- CDC - Natural Disasters and Severe Weather
- CDC - Interim Guidance for General Population Disaster Shelters During the COVID-19 Pandemic
- CDC - FAQs for Wildland Firefighters
- CDC - Environmental Health Assessment Form for Disaster Shelters

https://www.airnow.gov/wildfire-guide-post-publication-updates/

Indoor Air Quality and COVID-19

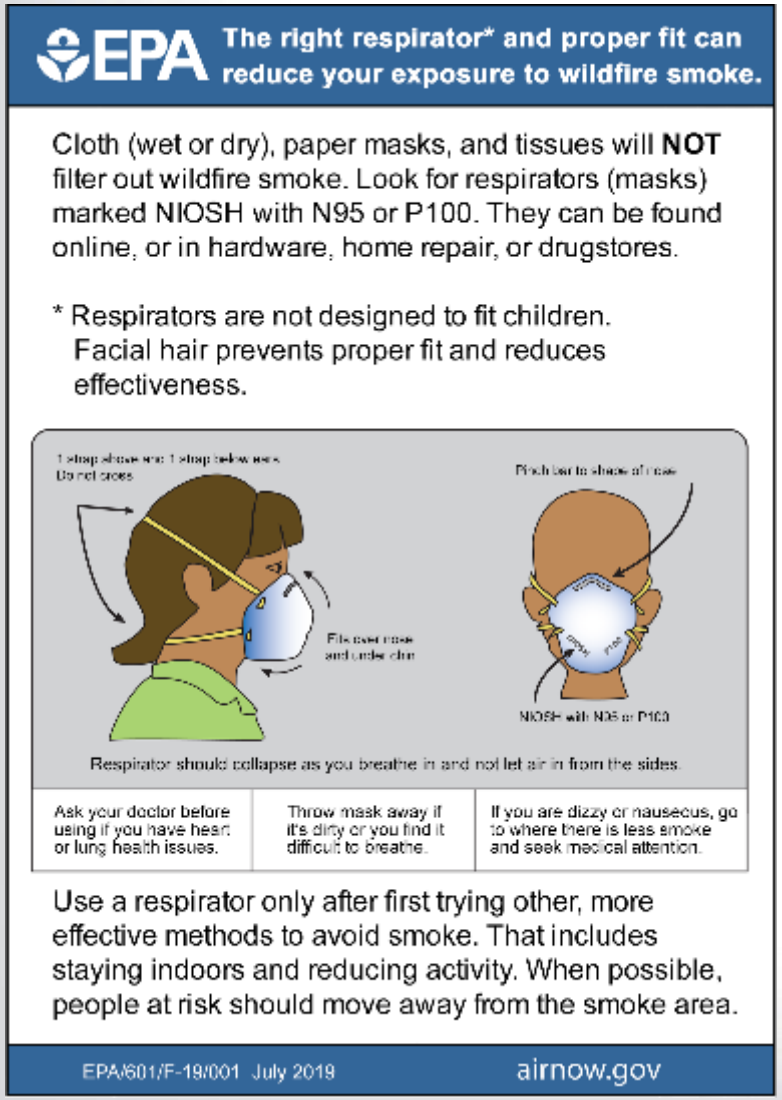
- EPA - Frequent Questions about Indoor Air and Coronavirus (COVID-19)

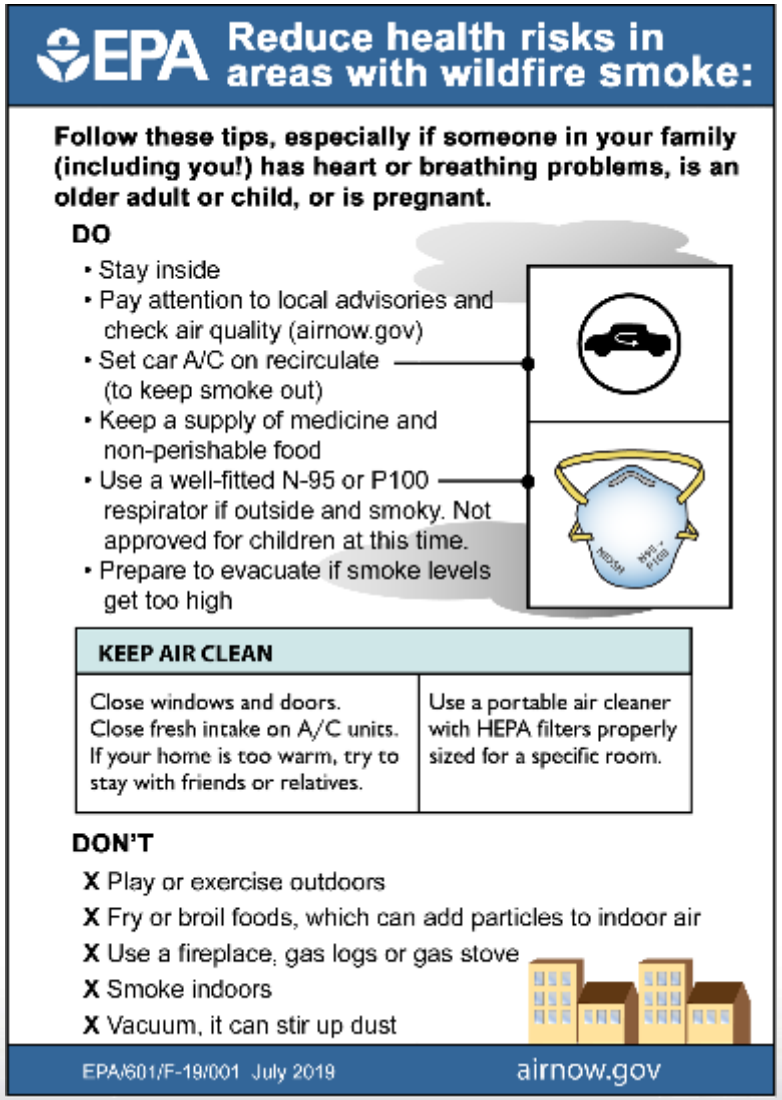
Other Smoke and COVID-19 Related Materials

- CDC - Open Burning during the COVID-19 Pandemic

N-95 Respirator Use During Wildfire Events

Infographic Available for Download on AirNow





Challenges:

- **Inconsistent public health messaging across cities and states**
- **Of value only if used correctly**
- **Not designed or recommended for children**
- **Increases work of breathing that might increase risk among those with cardiopulmonary impairment**

Research Opportunity:

- **ORD plans to investigate these issues**

Public Health Recommendations

Exposure Reduction Measures

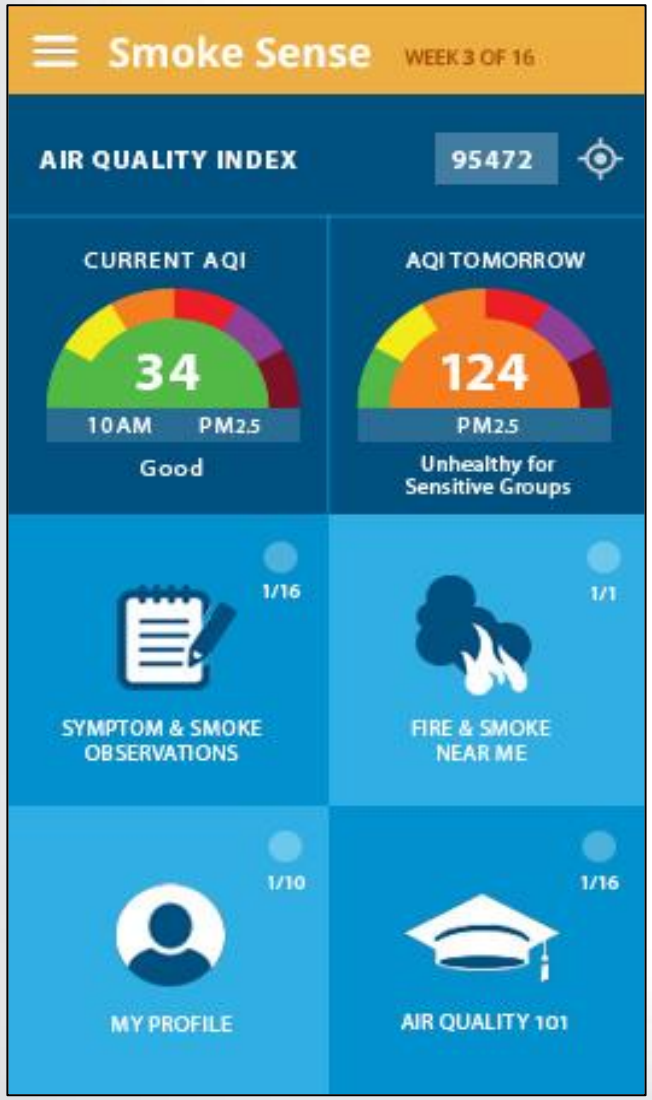
An individual can be advised to:

- Stay indoors
- Reduce outdoor physical activity
- Respirators (e.g., N-95) can help in the short-term
- Activate asthma/COPD action plans
- Use a home clean air shelter

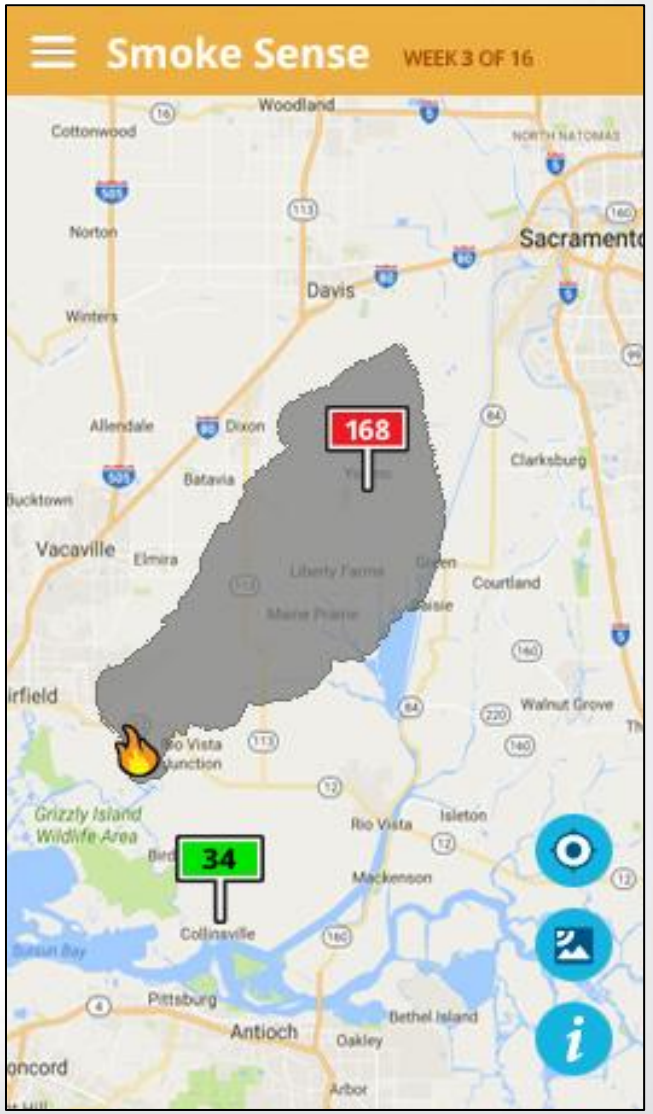
A community can be advised to:

- Provide community clean air shelters
- Increase air filtration in institutions
- Cancel outdoor events
- Evacuate

Smoke Sense Citizen Science Research



- ***Smoke Sense provides information about current and future air quality***
- ***Forecasted smoke plumes can be visualized***
- ***Less time outside during smoke episodes to decrease exposure, & protect health***
- ***Smoke Sense helps collect information about who, when, and how frequently people are impacted by smoke***
- ***Information about smoke in the air and symptoms experienced in the past week will be logged***



What is a Smoke Ready Community

- ***Prepared and empowered to:***
  - Provide residents with evidence-based, locally information during fire-related smoke events
  - Recommend actions to reduce public health impacts from smoke.
- ***Preparedness activities may depend on:***
  - Forecasted risk for wildfires
  - Frequency and severity of smoke impacts
  - Nature of the fire event (wildland fire, prescribed fire, residential wood burning
  - Underlying vulnerabilities of local populations, and other attributes of the community.
- ***EPA and partners want to provide community will tools and resources to:***
  - Assess these vulnerabilities in advance
  - Plan for appropriate responses
  - Take action during a fire

Courtesy of Erika Sasser, OAR

Thank you

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- No conflicts of interest
- The presentation represents the opinions of the speaker and does not necessarily represent the policies of the US EPA

Emerging Areas of Health Effects Research
Neurological and Neurodegenerative

Air Pollution & Neurotoxicity in Adults

- **Effects on Neurodegenerative Disorders**
  - ***Parkinson's***
    *(*Liu R et al. Environ Health Perspect 2016; Palacios et al. Rev Environ Health 2017*)*
  - ***Multiple sclerosis***
- **Non-Specific Neurological Symptoms**
  - ***Cognitive Function***
    *(*Tallon et al. *Environ Internat* 2017)
  - ***Fatigue***
  - ***Anxiety and Depression***
    (Szyszkowicz M et al. Environ Health insights 2016; Pun EHP 2016; Vert Intern J Hygiene Envir Health 2017)

Air Pollution & Neurotoxicity in Children

- **Effects on Child Neurodevelopment**
  - ***Prenatal exposure to air pollution***
  - ***Childhood exposure to air pollution***
- **Neurodevelopmental Disorders**
  - ***Autism Spectrum Disorder***
  - ***Attention-Deficit Hyperactivity Disorder***

Accelerated Biological Aging

- **Effects on telomeres**
  - ***Shortened telomeres measured at birth and in adults an indicator of biological aging***
    (*Martens DS et al. JAMA Pediatrics 2017; Ward-Caviness et al. Octotarget 2016)*

Solutions-Driven Research Pilot: Creating Cleaner Air Spaces

Focus: Measuring the effectiveness of air cleaning filtration systems in wildfire smoke conditions

- **Stakeholders identified research priorities, including:**
  - How effective are portable air cleaners (PACs) or central air filtration systems during smoke events?
  - Under what operating and maintenance conditions and in what building types?
- **Laboratory and field studies**
- **Partnering with:**
  - Missoula City-County Health Department, Climate Smart Missoula, University of Montana
  - Hoopa Valley Tribe, California

Collocation of Purple Air sensors with reference monitors at the USFS Fire Science Lab

Reducing Adverse Health Outcomes of Ambient and Indoor Exposures to Wildfire Smoke

EPA Science to Achieve Results (STAR) program Request for Application

The Interventions and Communication Strategies to Reduce Health Risks of Wildland Fire Smoke Exposures
Open Date: October 9, 2020 Closed Date: December 15, 2020

URL: https://www.epa.gov/research-grants/interventions-and-communication-strategies-reduce-health-risks-wildland-fire-smoke

Background: EPA is seeking applications proposing research that will address behavioral, technical and practical aspects of interventions and communication strategies to reduce exposures and/or health risks of wildland fire smoke.

Smoke and the Respiratory System

- Studies from the global burden of disease have found significant associations between household biomass smoke exposure in developing countries and respiratory infections (Gordon et al, 2014)
- A comprehensive meta-analysis assessed associations between air pollution exposure and emergency department visits and hospitalizations for influenza, bacterial pneumonia or culture negative pneumonia
  - Interquartile range increases in $PM_{2.5}$ over the previous 7 days were generally associated with increased excess rates of each of these specific respiratory diagnoses (Croft et al 2019).

Smoke and the Respiratory System

- Air pollution exposure increases the risk and severity of respiratory infections
  - All particles share a common mechanism of biological effect and this supports a common presentation (clinical, physiological, and pathological) following exposure.
  - Air pollution affects host defenses and include damage to the muco-ciliary escalator, reduced macrophage number or activity and a general decrease in local and systemic immune function.
- Prior observations have not differentiated between type of infection
- Most experimental research (in rodents) focused on bacterial pneumonias
  - Numerous examples that illustrate the same effects with respiratory viruses
- Tobacco smoke is a complex mixture of combustion particles and gases
  - Risk of influenza infection, likelihood of severe disease and complication was increased in smokers
  - Efficacy of influenza vaccines is reduced in smokers

Smoke and the Respiratory System
Animal Studies

Exposure to air pollutants can increase the severity and course of bacterial and viral infections

- Mice infected with influenza virus and compared the course of infection in animals exposed to diesel exhaust or fresh air
  - Viral titers and lung injury were higher in the diesel exposed animals at the peak of infection although all animals recovered to baseline by 14 days Gowdy et al (2010).

- Infectivity studies using more potent viral strains have shown that exposure to ozone increased mortality to influenza virus infection under certain exposure conditions (Selgrade et al 1998).

Features of a Smoke Ready Community

- Identifies populations at risk
- Develops plans for gathering and disseminating information
- Develops communications plans and materials in advance
- Establishes decision points for community actions
- Develops specific strategies to reduce smoke exposures
- Educates the community about the importance of being prepared
- Develops back-up plans to deal with extreme smoke events and high fire-risk situations
- Develops plans for local animals

Courtesy of Erika Sasser, OAR