



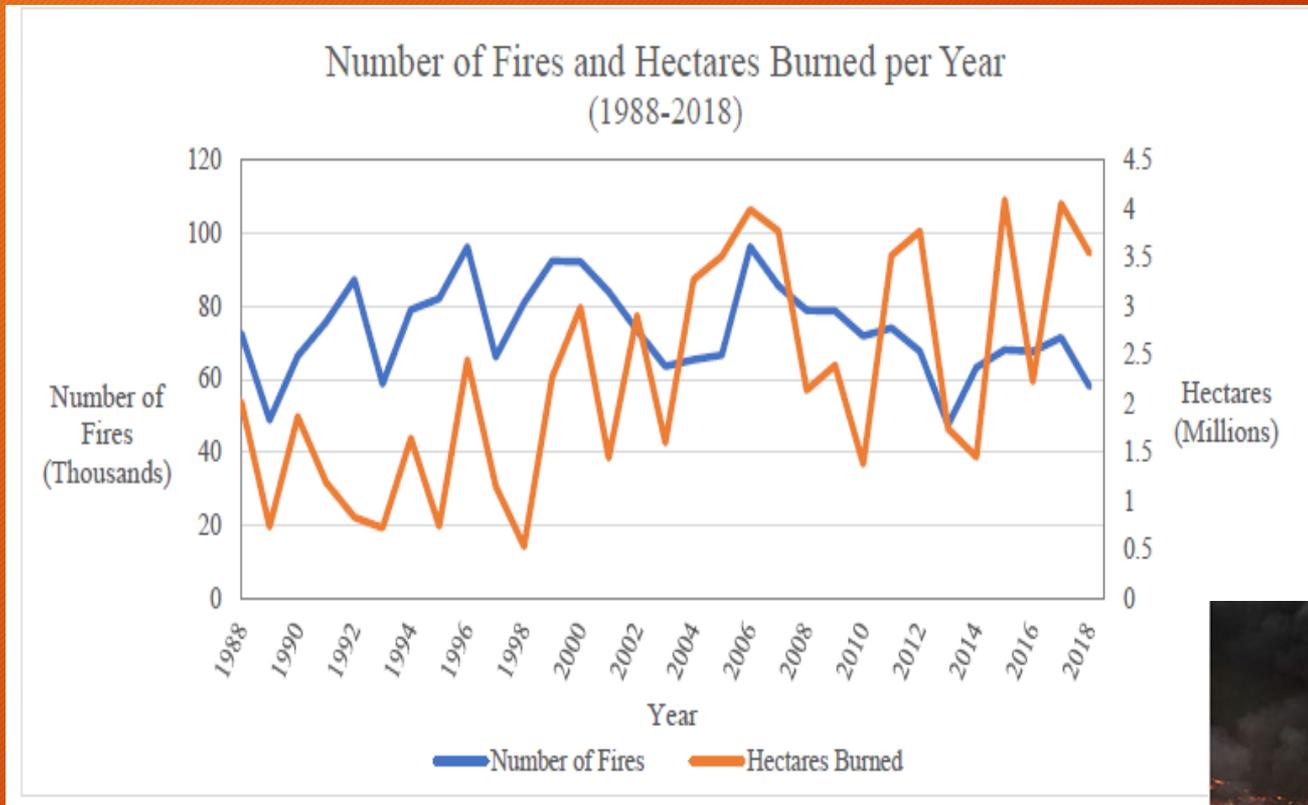
# U.S. EPA's Research Perspectives on the Health and Impacts of Wildfires and Wildfire Smoke



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May 6, 2019

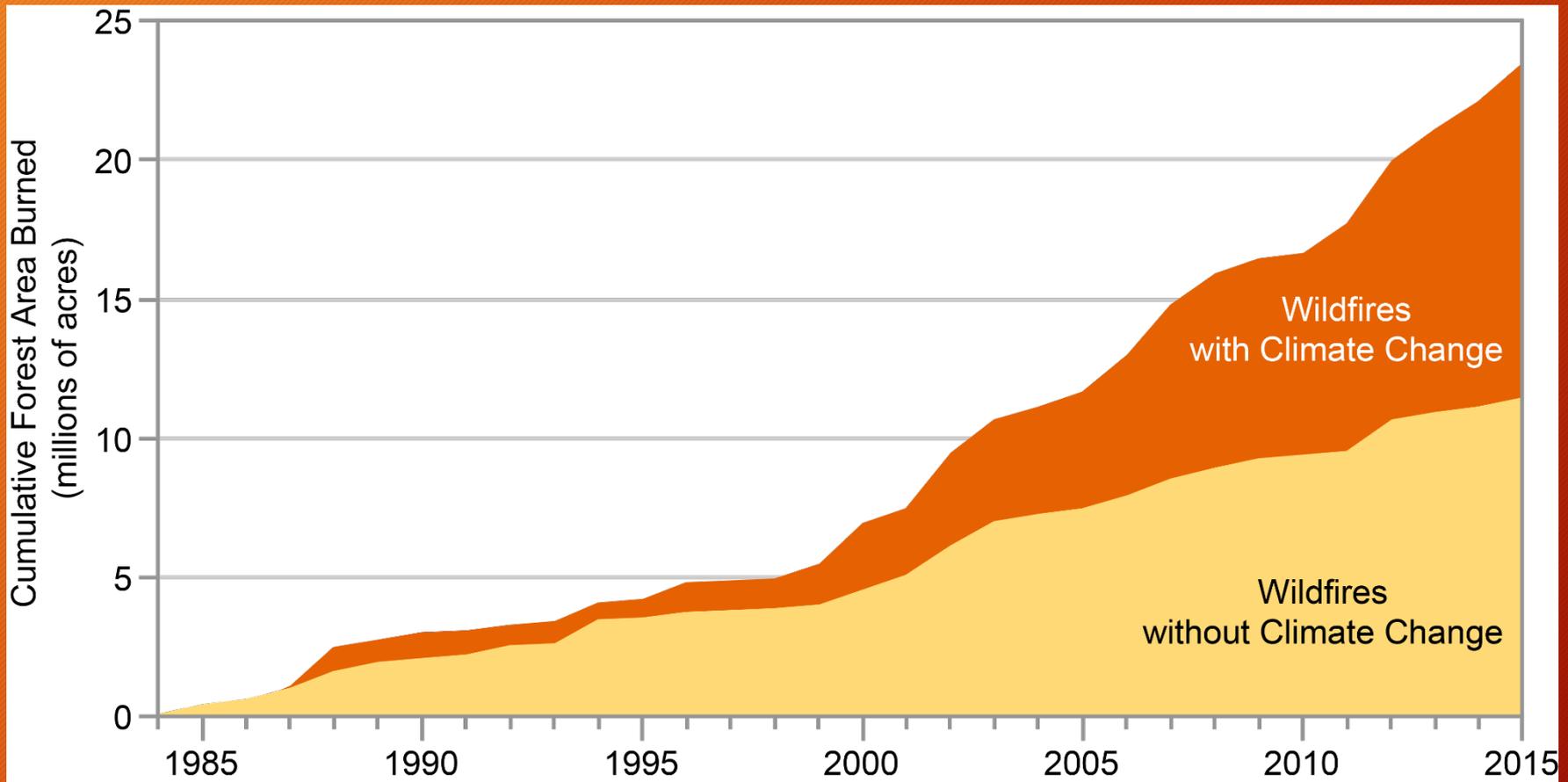
# A Growing National Issue



Source: National International Fire Center



# Wildfires in the U.S. Southwest

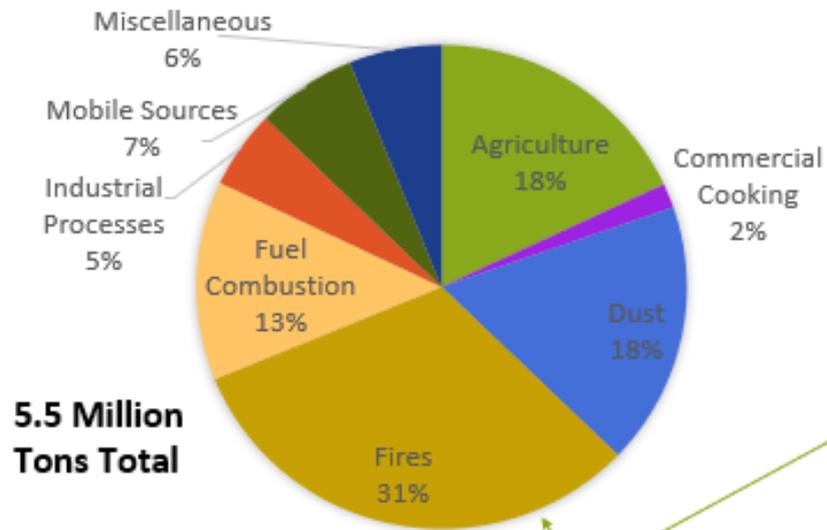


## Fourth National Climate Assessment (NCA4) - Figure 25.4: Climate Change Has Increased Wildfire

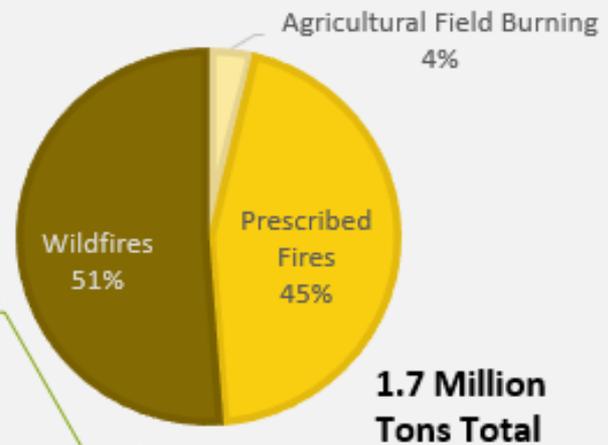
The cumulative forest area burned by wildfires has greatly increased between 1984 and 2015, with analyses estimating that the area burned by wildfire across the western United States over that period was twice what would have burned had climate change not occurred.

# Wildfire Emissions Contribution

**PM<sub>2.5</sub> Emissions in the 2014 National Emissions Inventory (NEI)**



**PM<sub>2.5</sub> Fire Emissions in the 2014 NEI**



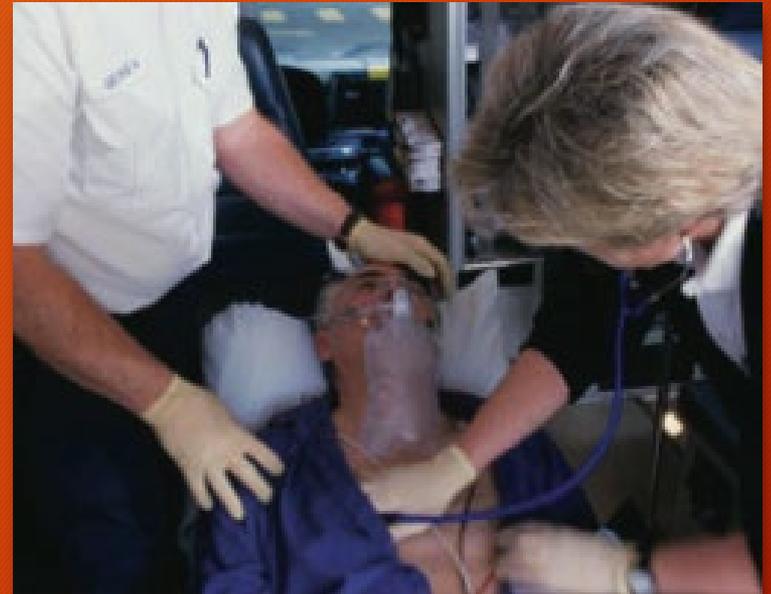
<https://www.epa.gov/air-emissions-inventories/2014-national-emissions-inventory-nei-data>

# A Costly Individual and Public Health Issue

Estimated Economic Value of Wildfire  
Attributed  $PM_{2.5}$ - Premature Deaths  
and Respiratory Admissions

- *Short-term: \$11-20 billion/yr*
- *Long-term: \$76-130 billion/yr*

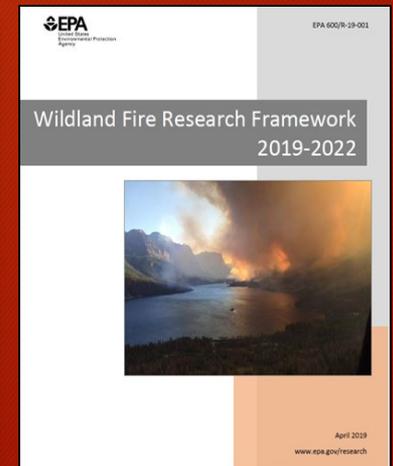
Fann N et al., *Science of the Total Environment* 610–  
611 (2018) 802–809



# An Integrated Science Focus

EPA's Air and Energy (A-E) Research Program emphasizes wildland fire research:

- Specific focus in [draft A-E Strategic Research Action Plan \(StRAP\)](#) and strategic plans for other EPA national research programs
- [Wildland Fire Research Framework](#) issued in April 2019



# A Big Picture View

- EPA anticipates using the wildland fire issue to:
  - Engage with a wide range of stakeholders
  - Address critical research needs and knowledge gaps
  - Explore new ways to integrate social and natural science perspectives
  - Investigate opportunities to better understand, manage, and communicate public health and environmental risks



# Facets of EPA Wildland Fire Research

EPA is working collaboratively with key stakeholders to:

- Improve models and measurements to assess wildland fire emissions and evaluate potential impacts on air quality, water quality, and ecosystems
- Expand knowledge of at-risk human populations and ecosystems
- Consider mobilization or accidental release of chemicals if wildland fires impact industrial, agricultural, and/or contaminated sites (e.g., Superfund sites) and burning of other structures in wildland-urban interface (WUI)
- Enhance understanding of approaches (e.g., best practices for prescribed fires) to mitigate risks to public health and the environment
- Evaluate effectiveness of how and to whom we communicate these approaches/guidance to reduce risks

Emissions  
Characterization

Measurements

Air Quality  
Modeling

Toxicology

Epidemiology and  
Public Health

Drinking Water  
Impacts and  
Ecosystem  
Vulnerability

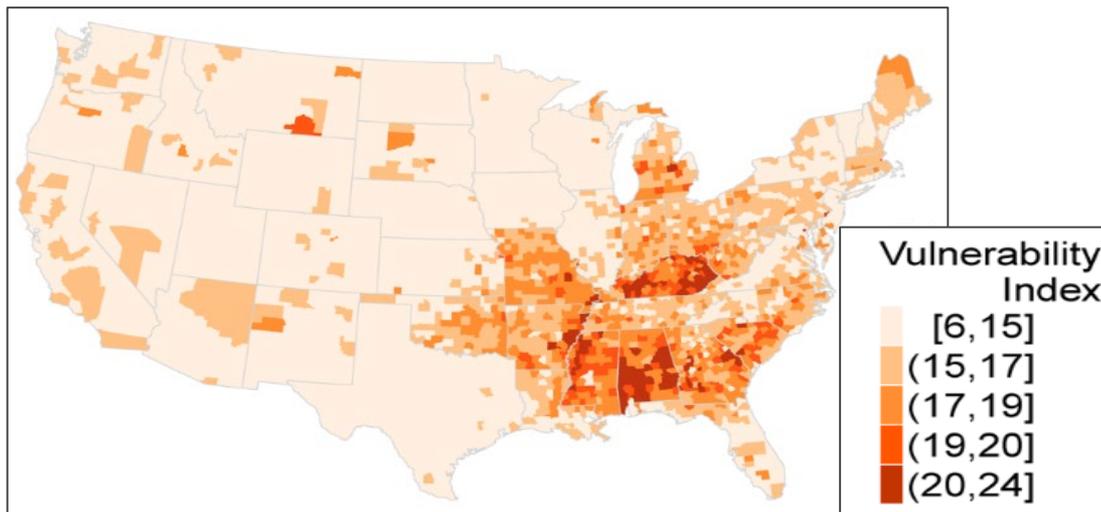
A few highlights . . .

# Community Health-Vulnerability Index (CHVI)

A new tool for public health officials to identify vulnerable populations at risk from wildland fire smoke exposure

- Considers factors known to define susceptibility to air pollutant-related health effects
- Can be combined with air quality forecast data generated by models to develop maps of counties, regions, or other designated areas where at-risk populations live

## CHVI for Continental U.S.



## Factors of Vulnerability

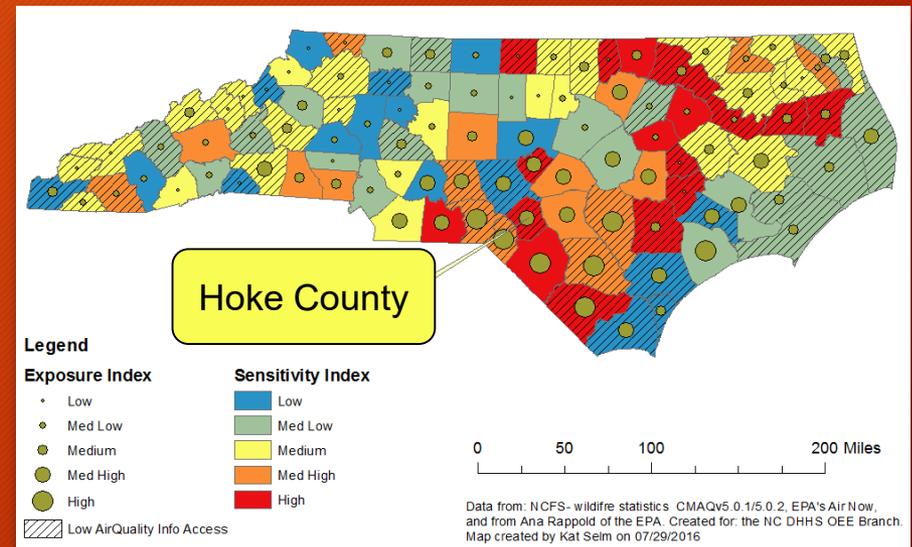
- Peds & Adult Asthma
- Chronic Obstructive Pulmonary Disease (COPD)
- Obesity
- Diabetes
- Hypertension
- % population age 65+
- Income, education, poverty, unemployment

*Rappold AG, et al Environ Sci Technol 2017*

# CHVI Used in CDC-funded North Carolina Health Program

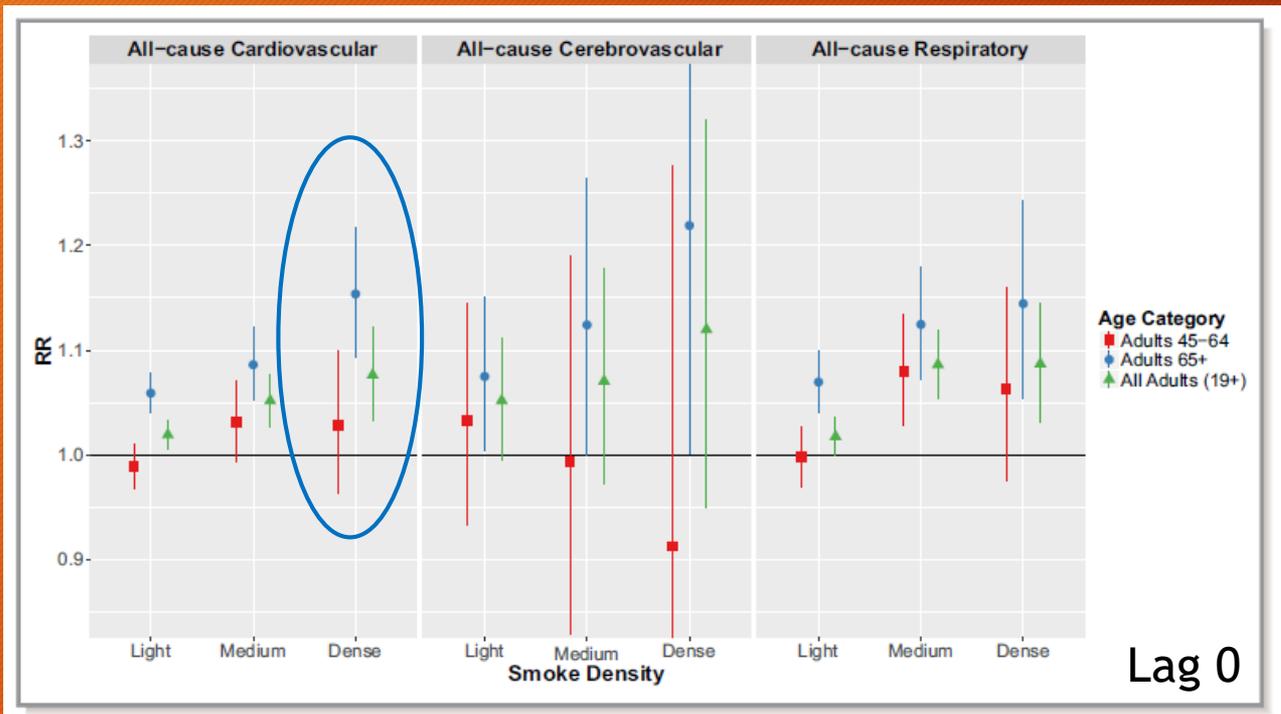
## *Community Health Vulnerability Index (CHVI) was translated for use in North Carolina (NC)*

- Utilized CHVI to identify NC community most at risk to smoke health impacts
- Used CHVI to identify and add NC-specific layers (e.g., NC Forestry data)
- Engaged Hoke County stakeholders (e.g., local fire departments) with CHVI to discuss vulnerability to smoke health impacts
- CHVI discussion has given way to implementing prevention efforts, such as *Smoke Sense* (see next slide)



Courtesy of Lauren Thie NC Department of Public Health

# Epidemiological Evidence



Assessed daily cardiovascular and cerebrovascular emergency department visits associated with wildfire smoke exposures in CA in 2015

*Wettstein et al, J Am Heart Assoc., 2018*

- Rates of all-cause cardiovascular emergency department (ED) visits elevated across all lags
  - Greatest increase observed on dense smoke days, in individuals 65 years or older at lag 0
- All-cause cerebrovascular visits and respiratory conditions also associated with smoke
  - Especially on dense smoke days, in individuals 65 years or older at lag 1

# Toxicological Evidence



- Studying potential health effects of breathing wildfire smoke using a novel combustion and smoke collection system to investigate the toxicity of wildfire smoke based on:
  - Type of fuel burned (e.g., red oak, peat, pine needles, pine, and eucalyptus)
  - Combustion phase (e.g., flaming vs. smoldering)
- Observed PM from different wood burned and combustion phases had appreciable differences in lung toxicity and mutagenic potency
  - On an equal mass basis, flaming had higher lung toxicity and mutagenic potency than smoldering
  - When emissions factors (EFs) were taken into account, smoldering had a greater effect

# Smoke Sense App

- EPA researchers developed a mobile application called Smoke Sense App (Android and iOS) for people impacted by wildfire smoke
- Smoke Sense Project is a citizen science initiative that makes smoke and health resources easily available
  - Information when and where they are needed and
  - Opportunities to explore why and how gaps exist between recommended actions and the actions that individuals take to protect their health during a wildfire

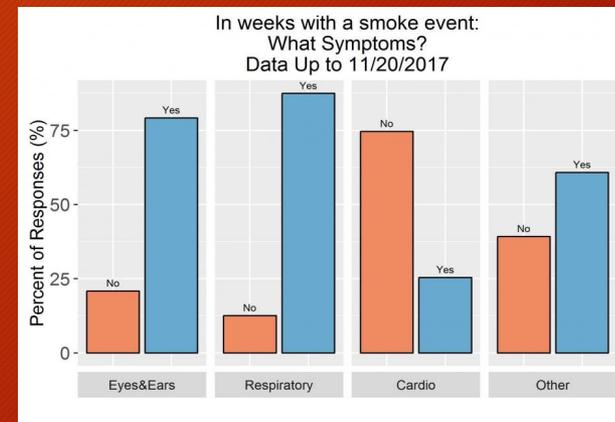
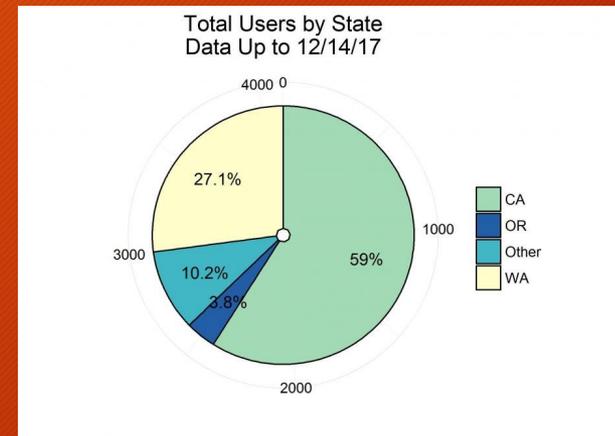
<https://www.epa.gov/air-research/smoke-sense-study-citizen-science-project-using-mobile-app>



# Smoke Sense App Usage - 2017

- Participants logged health symptoms and smoke observations weekly
- Nearly 5,000 Smoke Sense users on Android and iOS
  - 46.5% users Android devices
  - 53.5% used iOS devices
- Over 50,000 unique sessions between August 1 and December 14, 2017
- Majority of users returned to Smoke Sense on multiple occasions
- Majority of users from Western US

<https://www.epa.gov/air-research/smoke-sense-study-app-usage-statistics-health-symptoms-and-smoke-observations>



# Respirator/Face Mask Study

- EPA is evaluating effectiveness of a range of devices, including:
  - NIOSH-approved N95 or P100 respirators
  - Surgical masks
- Results will expand our understanding of the health benefits provided by these devices during a wildland fire event and inform risk communication approaches



# Evaluating Clean Air Spaces

*Focus: Interested in better understanding the effectiveness of air cleaning filtration systems in wildfire smoke conditions*

- Exploring research priorities with key stakeholders, 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?
- Considering specific laboratory and field studies to expand the science to inform recommendations on developing clean air spaces
- Partnering with:
  - Missoula City-County Health Department
  - Climate Smart Missoula
  - University of Montana

# Model Development and Integration

**Plume Transport  
(WRF/CMAQ) &  
Chemical Evolution  
(CMAQ)**

**Plume rise  
(CMAQ or  
SMOKE)**

**Emissions  
(BlueSky & SPECIATE)**

**Fuel & Consumption  
(BlueSky)  
Location/Area Burned  
(SmartFire)**

## More information:

- Community Multiscale Air Quality (CMAQ) Modeling System  
<https://www.epa.gov/cmaq>
- Weather Research and Forecasting (WRF)-CMAQ Coupled Model  
<https://www.epa.gov/cmaq/cmaq-models-0>
- BlueSky (developed by U.S. Forest Service, USFS)  
<http://www.getbluesky.org/>
- Sparse Matrix Operator Kernel Emissions (SMOKE) processing system  
<https://www.cmascenter.org/smoke/>
- SPECIATE – particulate matter (PM) and volatile organics speciation profiles for air pollution sources  
<https://cfpub.epa.gov/speciate/>

# Wildland Fire Sensors Challenge



Shared vision by partnering organizations:

- Advance air measurement technology to be easier to deploy, suitable to use for high concentration events, durable to withstand difficult field conditions, and able to report data continuously and wirelessly
- Measure  $PM_{2.5}$ ,  $O_3$ ,  $CO$ ,  $CO_2$
- Develop for use by first responders and public health agencies during wildland fire events

Project Timeline

- Launched Challenge in April 2017
- Received 27 written submissions; tested 10 prototype systems
- Announced winners at recent Air Sensors International Conference – September 2018

<https://www.epa.gov/air-research/winners-wildland-fire-sensors-challenge-develop-air-monitoring-system-prototypes>



# Collaborative Field Study: Flint Hills Prescribed Fires

- Annual grass/rangeland prescribed burning in Flint Hills region of central Kansas
- This practice can lead to elevated  $O_3$  and PM regionally
- Field work at Konza Prairie Biological Station to evaluate and improve emission estimates
  - Connecting source emissions to ambient impacts using the EPA “Flyer” – an unmanned, telemetry-controlled sampling system measuring PM, black and brown carbon, VOCs, and background  $O_3$
  - Also working to better understand plume rise and dispersion to improve air quality model representation of these fires

$O_3$  = ozone  
VOCs = volatile organic compounds  
CO = carbon monoxide  
CO<sub>2</sub> = carbon dioxide  
PM = particulate matter



# U.S. Wildland Fire Field Studies

WE-CAN (National Science Foundation, NSF, lead) – 2018 [https://www.eol.ucar.edu/field\\_projects/we-can](https://www.eol.ucar.edu/field_projects/we-can)

–Local to regional scale ground and aircraft measurements made downwind of large wildfires in the western U.S. in 2018

FIREX-AQ (NOAA/NASA leads) – 2019 <https://espo.nasa.gov/firex-aq>

–Local to regional scale ground and aircraft measurements made downwind of western U.S. wild fires and aircraft measurements made downwind of southeast U.S. prescribed fires in 2019

FASMEE – Fire & Smoke Model Evaluation Experiment (Joint Fire Science program, JFS, lead) – 2019/20  
[www.fasmee.net](http://www.fasmee.net)

–Focused on large prescribed burns in the western U.S. in 2019

–Focused on typical prescribed burns in the southeast U.S. in 2020/2021

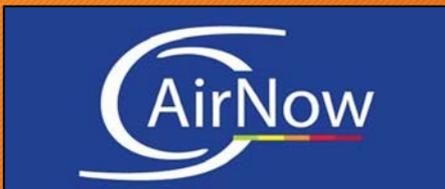
US EPA led efforts

–Region 10 project measuring emissions and plume extent from cropland fires in the northwest (2013)

–Regions 9/10 project deploying PM<sub>2.5</sub> sensors at large fires in the western U.S. (2018)

–Region 4 project measuring emissions and plume extent from prescribed fire in the southeast (2019/20)

–Region 7 project measuring emissions from grassland prescribed fires in central Kansas (2017)



### 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](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

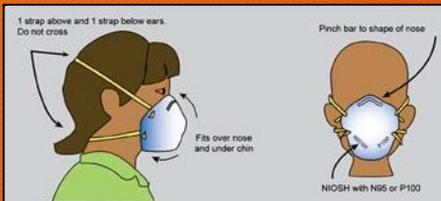
The guide is an easy-to-use resource that outlines whose health is most affected by wildfire smoke, how to reduce exposure to smoke, what public health actions are recommended, and how to communicate air quality to the public. The recommendations are based on science conducted by EPA and others.

[https://www3.epa.gov/airnow/wildfire\\_may2016.pdf](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](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>



### 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.

<https://www.epa.gov/pmcourse>



### Online Healthy Heart Toolkit

Breathing in fine particulate matter (PM<sub>2.5</sub>) 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

Available at:  
<https://www.epa.gov/air-research/smoke-ready-toolbox-wildfires>

# For More Information

## **Alan Vette**

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