Ambient Monitoring and the Chemistry of Urban Interface Fires

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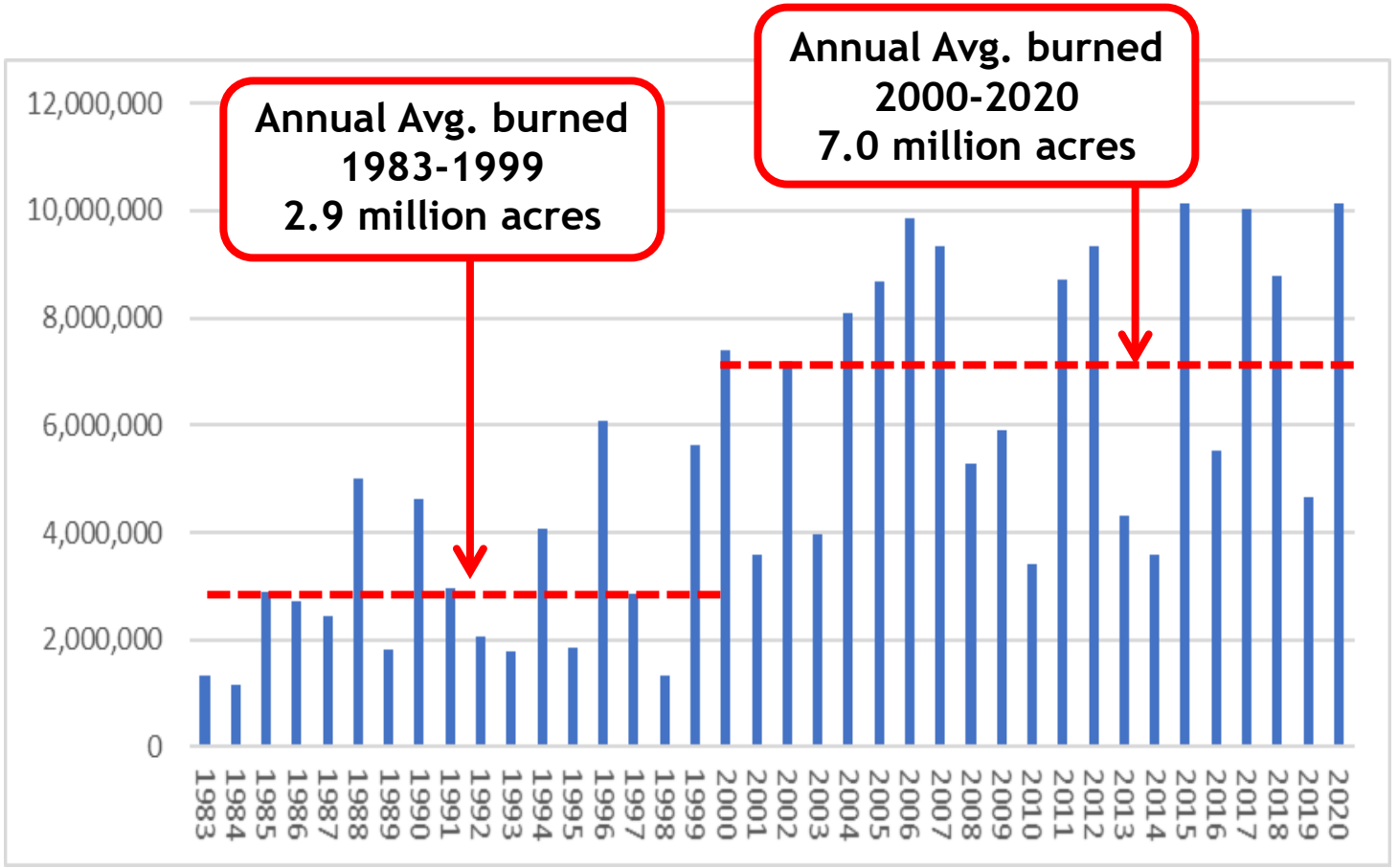
Outline

- Overview of wildfire trends
- Definition of the wildland urban interface (WUI)
- What makes a WUI fire different from other wildfires?
- Is there a chemical fingerprint in WUI fire smoke?
- Conclusions and outlook

Disclaimer: The views expressed in this presentation are those of the authors and do not necessarily represent the views or the policies of the U.S. Environmental Protection Agency.

Wildfire magnitude is increasing

- Magnitude and intensity of wildland fires are worsening
- Trends vary by region, but are increasing overall
- History of fire suppression has led to vegetative overgrowth
- Increased wildfire activity is linked to climate change



https://www.nifc.gov/fireInfo/fireInfo_stats_totalFires.html

Wildland Urban Interface (WUI)

"…exists where humans and their development meet or intermix with wildland fuel."

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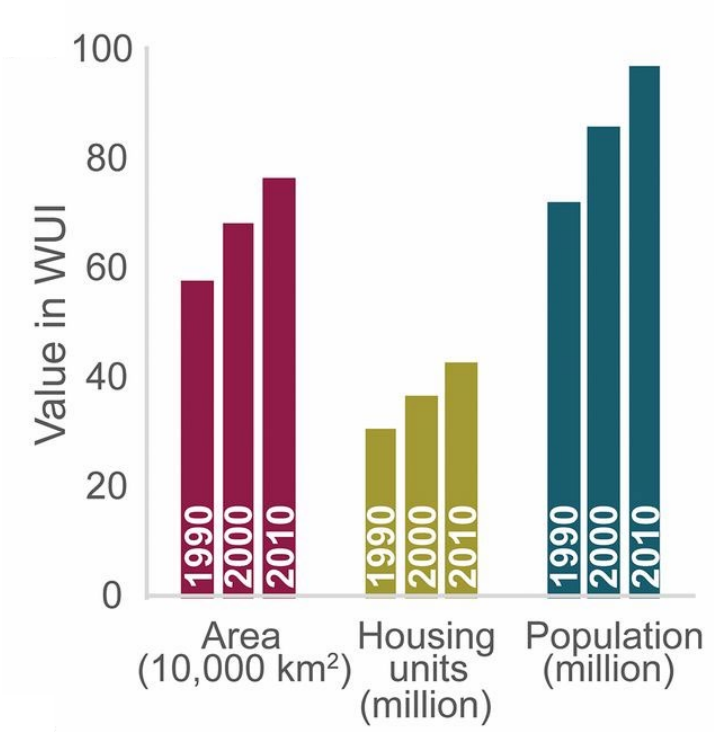
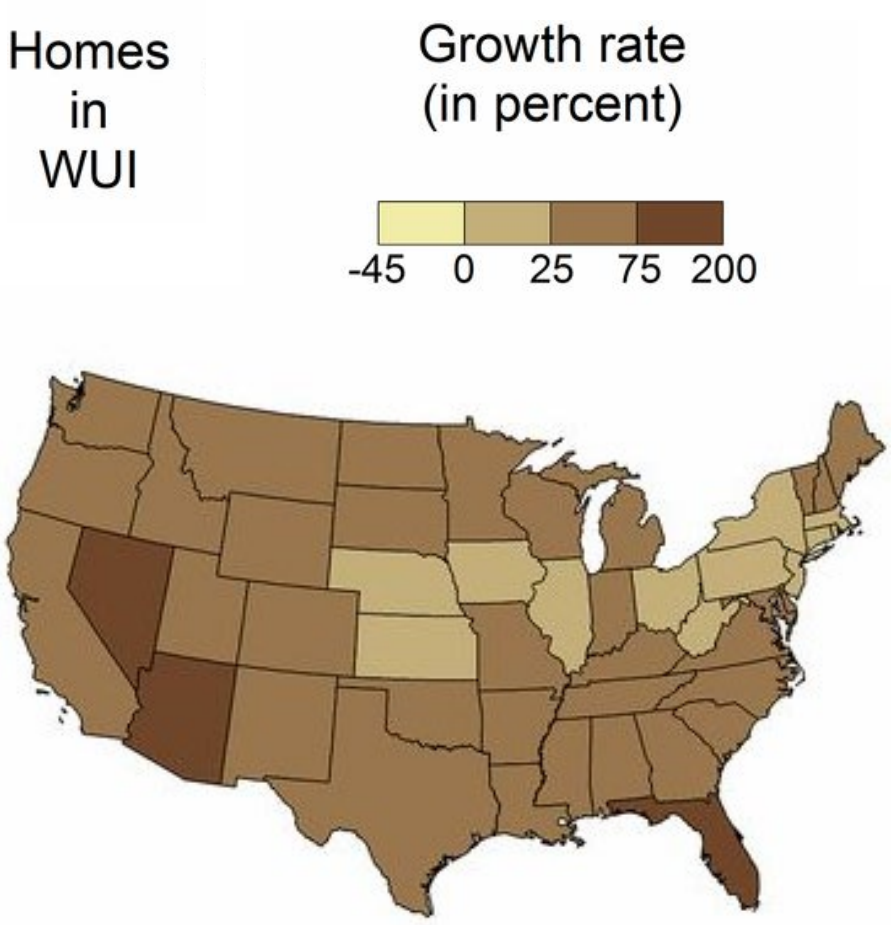
WUI areas have experienced rapid growth

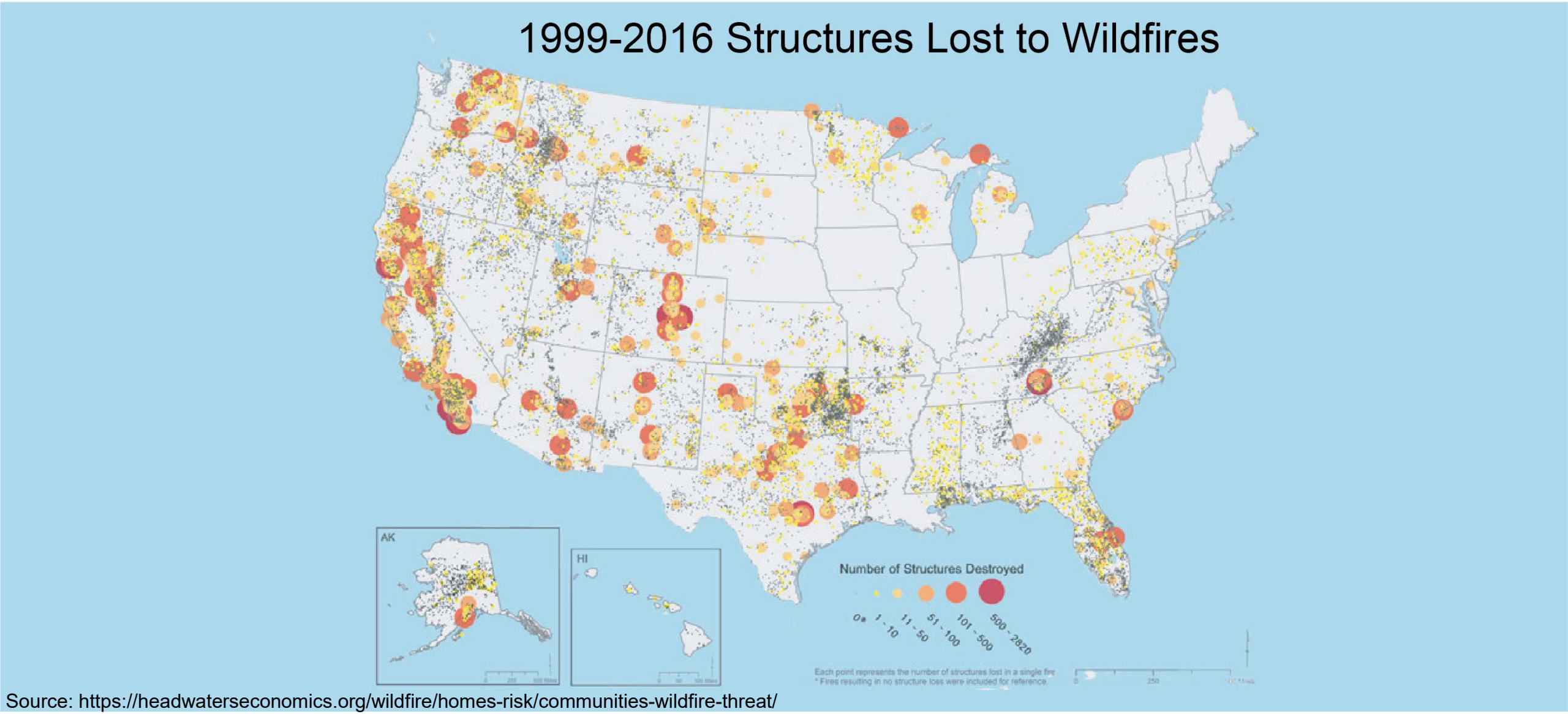
WUI growth in the US from 1990 - 2010





Radeloff et al. 2018 DOI:10.1073/pnas.1718850115

WUI fires occur across the U.S.



Source: https://headwaterseconomics.org/wildfire/homes-risk/communities-wildfire-threat/

WUI fires are different from wildland fires

Urban “fuel” is housing materials

Lumber framing

Insulation

Surface finishes

Urban “fuel” includes the contents in the home

- Furniture
- Carpet
- Clothing
- Electronics
- Cleaning materials
- Pesticides
- Herbicides
- Fixtures

Urban fuel includes vehicles as well

Image Source: Circacies https://commons.wikimedia.org/wiki/File:Garage_Workbench_Clutter.jpg

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Structural fire research can shed light on WUI fire emissions composition

We anticipate greater amounts of some species in WUI fires that have been observed in laboratory structure fire experiments

- Hazardous organic pollutants
  - Dioxins/furans
  - Flame retardants
  - PCBs
- Toxic gases
  - HCl
  - HF
  - Isocyanates
- Toxic metals
  - As, Pb, Sb, Cu, Cr, etc.

Top 20 Most Destructive California Wildfires

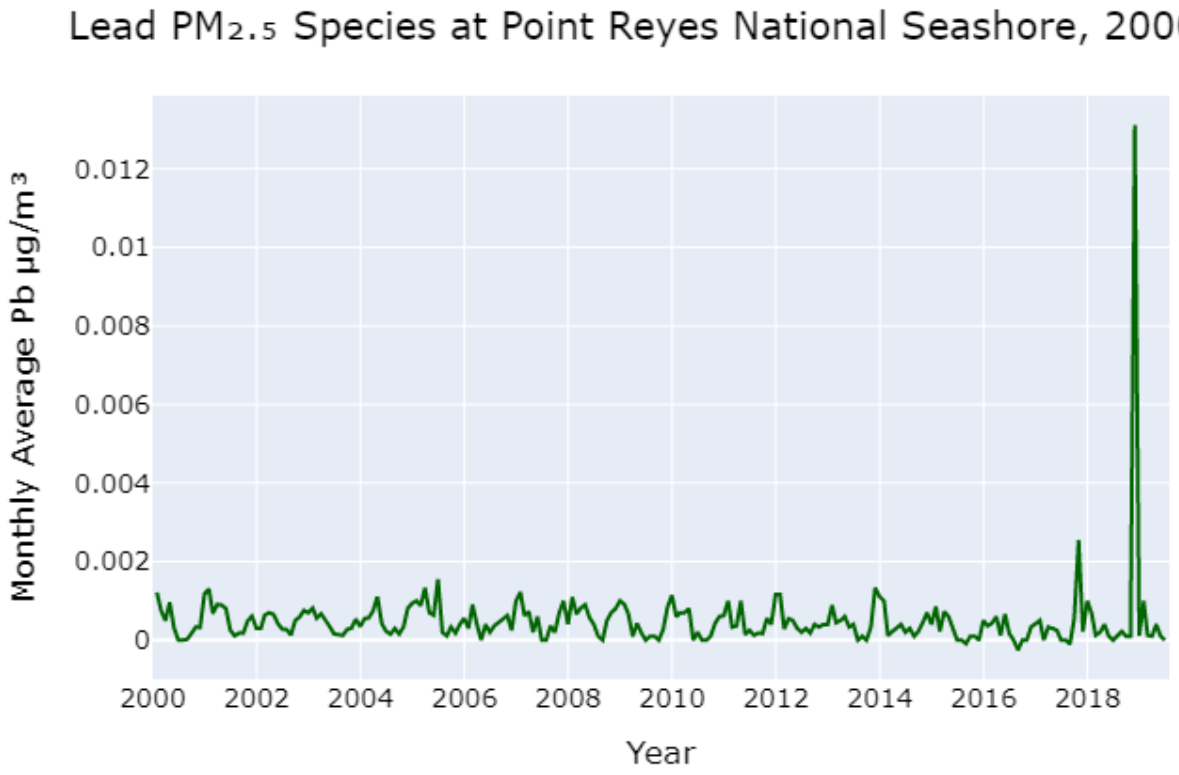
	FIRE NAME *(CAUSE)*	DATE	COUNTY	ACRES	*STRUCTURES*	DEATHS
1	CAMP *(Powerlines)*	November 2018	Butte	153,336	18,804	85
2	TUBBS *(Electrical)*	October 2017	Napa & Sonoma	36,807	5,636	22
3	TUNNEL - Oakland Hills *(Rekindle)*	October 1991	Alameda	1,600	2,900	25
4	CEDAR *(Human Related)*	October 2003	San Diego	273,246	2,820	15
5	NORTH COMPLEX *(Under Investigation)*	August, 2020	Butte, Plumas, & Yuba	318,935	2,352	15
6	VALLEY *(Electrical)*	September 2015	Lake, Napa & Sonoma	76,067	1,955	4
7	WITCH *(Powerlines)*	October 2007	San Diego	197,990	1,650	2
8	WOOLSEY *(Under Investigation)*	November 2018	Ventura	96,949	1,643	3
9	CARR *(Human Related)*	July 2018	Shasta County, Trinity	229,651	1,614	8
10	GLASS FIRE *(Under Investigation)*	September 2020	Napa & Sonoma	67,484	1,520	0
11	LNU LIGHTNING COMPLEX *(Under Investigation)*	August 2020	Napa, Solano, Sonoma, Yolo, Lake, & Colusa	363,220	1,491	6
12	CZU LIGHTNING COMPLEX *(Lightning)*	August 2020	Santa Cruz, San Mateo	86,509	1,490	1
13	NUNS *(Powerline)*	October 2017	Sonoma	54,382	1,355	3
14	DIXIE *(Under Investigation)**	July 2021	Butte, Plumas, Lassen, & Tehama	747,091	1,273	0
15	THOMAS *(Powerline)*	December 2017	Ventura & Santa Barbara	281,893	1,063	2
16	OLD *(Human Related)*	October 2003	San Bernardino	91,281	1,003	6
17	JONES *(Undetermined)*	October 1999	Shasta	26,200	954	1
18	AUGUST COMPLEX *(Under Investigation)*	August 2020	Mendocino, Humboldt, Trinity, Tehama, Glenn, Lake, & Colusa	1,032,648	935	1
18	BUTTE *(Powerlines)*	September 2015	Amador & Calaveras	70,868	921	2
20	CREEK *(Under Investigation)*	September 2020	Fresno & Madera	379,895	856	0

"Structures" include homes, outbuildings (barns, garages, sheds, etc) and commercial properties destroyed.
This list does not include fire jurisdiction. These are the Top 20 regardless of whether they were state, federal, or local responsibility.
*Numbers not final

8/26/2021

15 of top 20 most destructive CA wildfires since 2015

Is there a unique air quality signature associated with fires burning in the WUI?

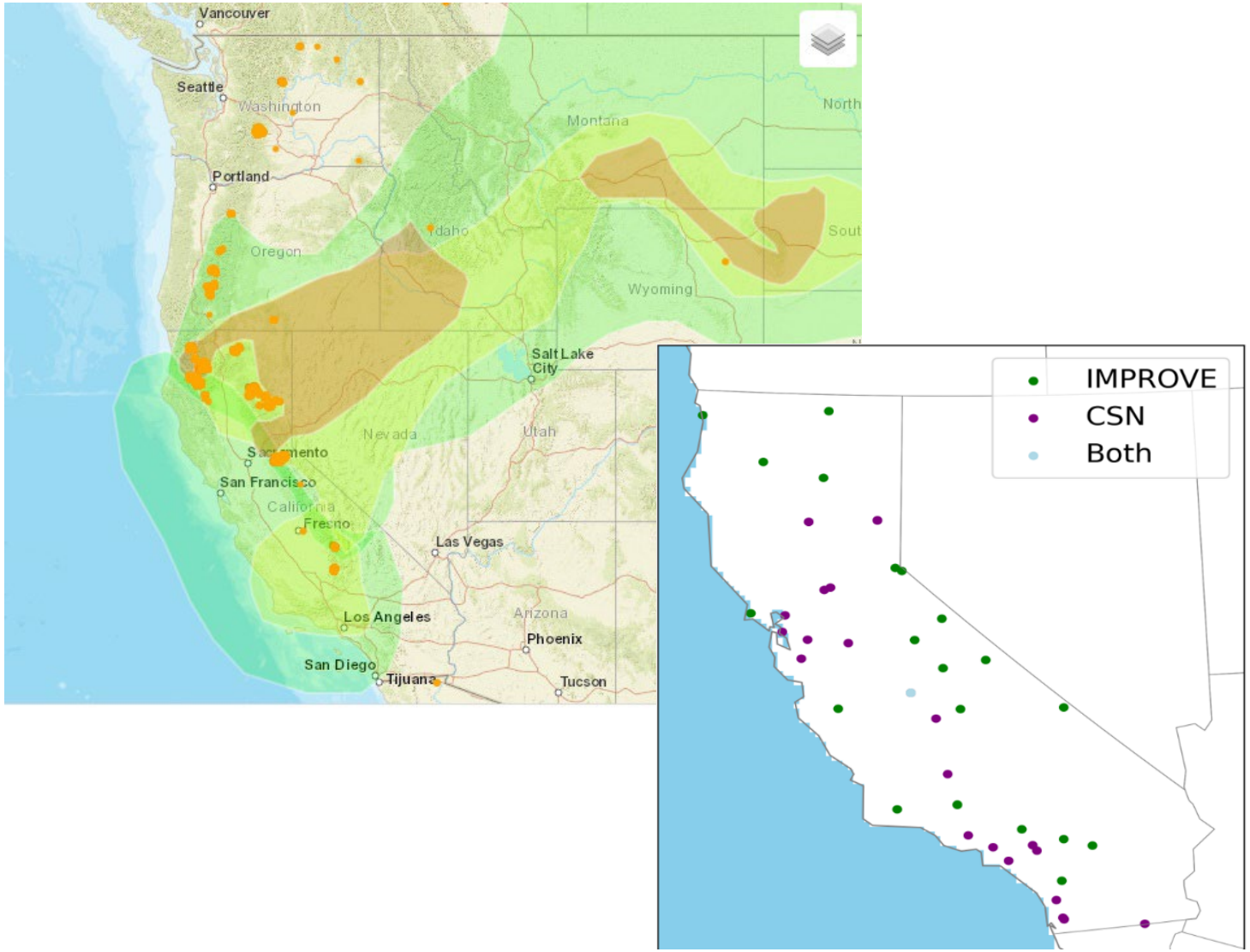


Lead spike from Camp Fire, which burned ~18,000 structures and ~23,000 vehicles

Use ambient monitoring data to find WUI Fire fingerprint

Methods and Data

- **Location and time:** California, 2006-2018
- Identified fire days using NOAA Hazard Mapping System
- Overlaid AQS $PM_{2.5}$ Speciation monitors for concentrations
- Identified major WUI fires in scope



Carr Fire

- 7/23-8/30/2018
- 229,651 acres
- 1,604 structures burned

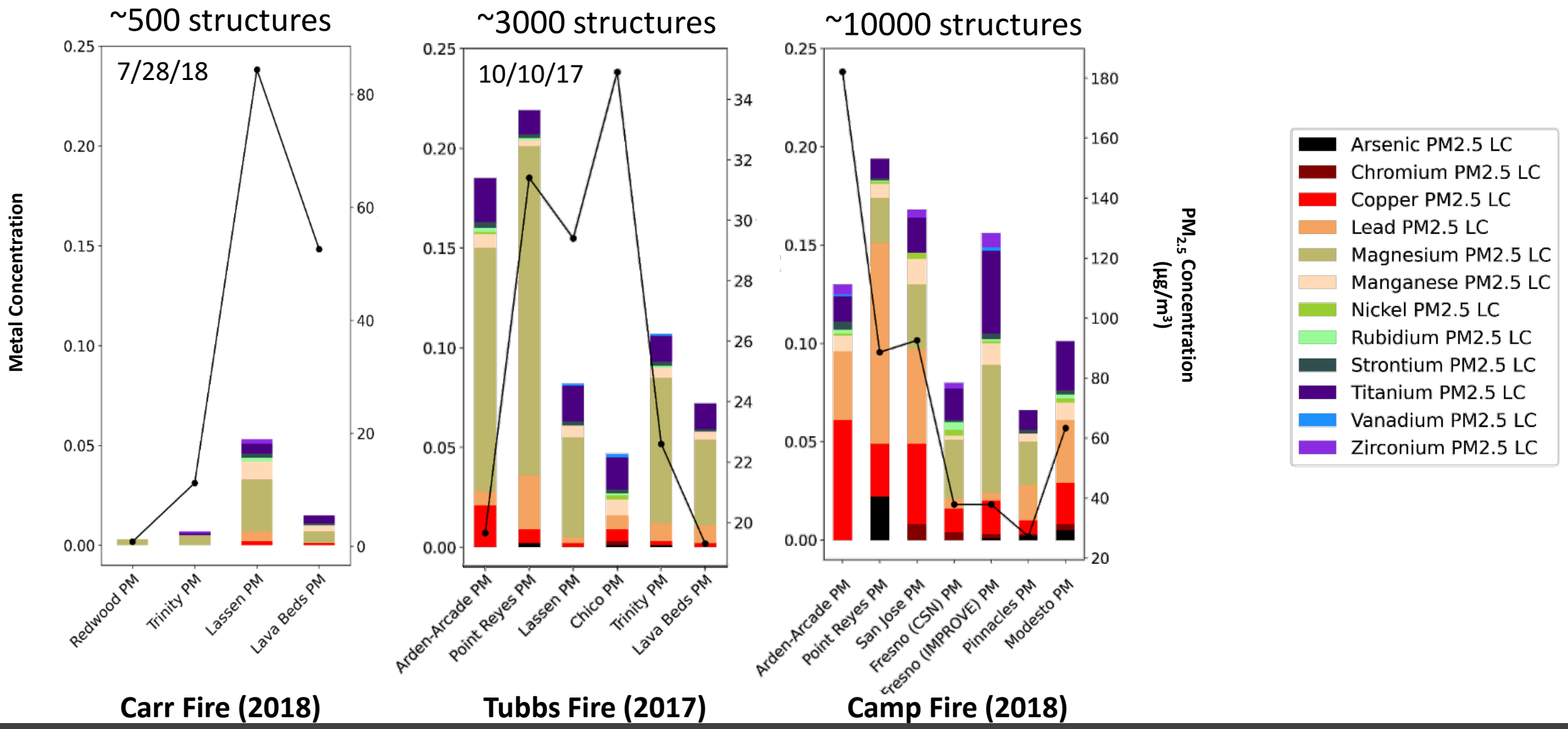
Tubbs Fire

- 10/8-10/31/2017
- 36,807 acres
- 5,643 structures burned

Camp Fire

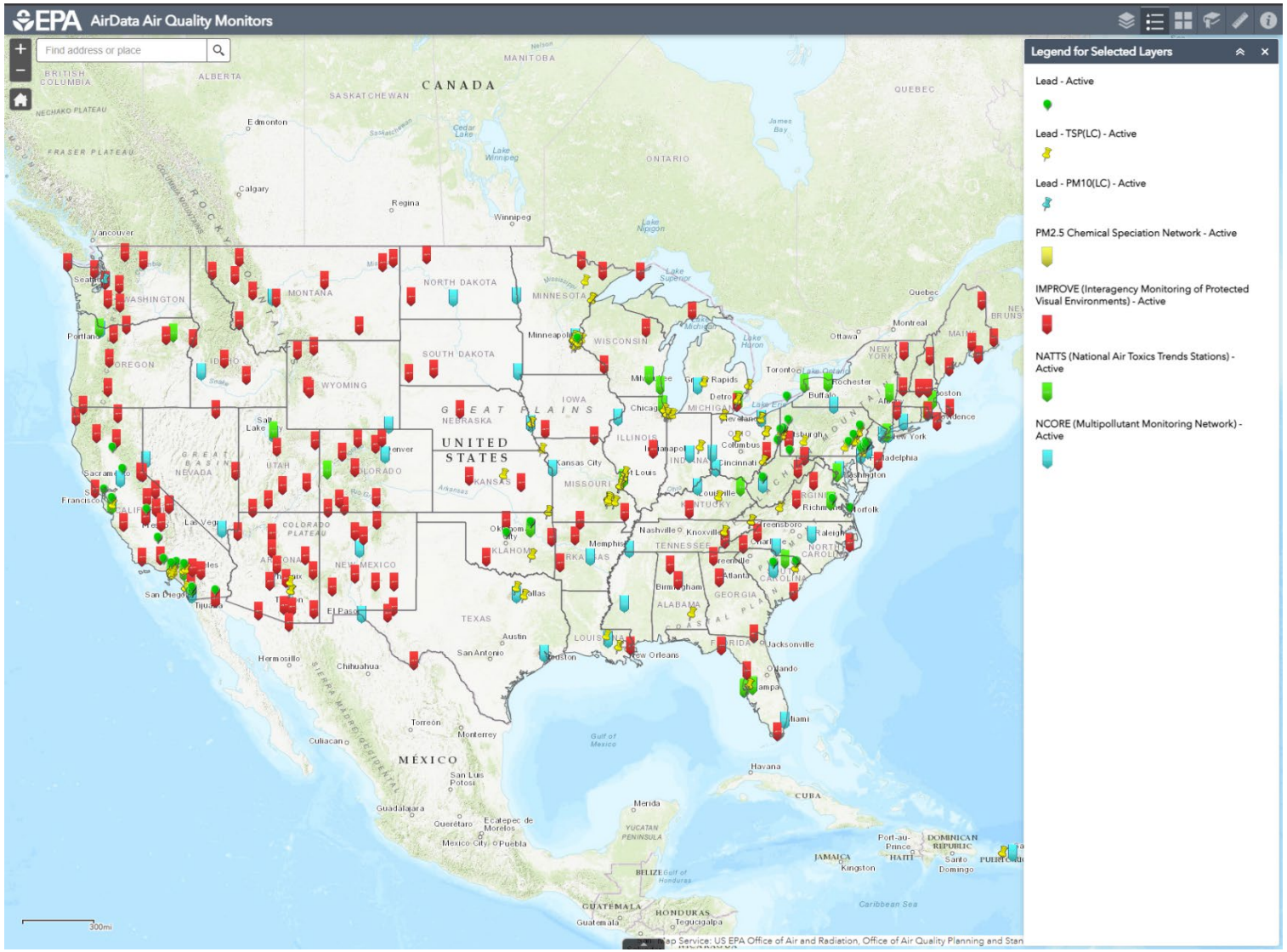
- 11/8-11/25/2018
- 153,336 acres
- 18,804 structures burned

WUI Fire fingerprint in metal speciation data



Carr Fire (2018) **Tubbs Fire (2017)** **Camp Fire (2018)**

Speciation data are invaluable for identifying WUI impact



- WUI Fires are:
  - Unpredictable and often short duration
  - May generate smoke plumes with limited spatial extent
- Speciated $PM_{2.5}$ data have been critical to identify the WUI Fire emissions
- Speciated monitoring networks have limited spatial and temporal coverage

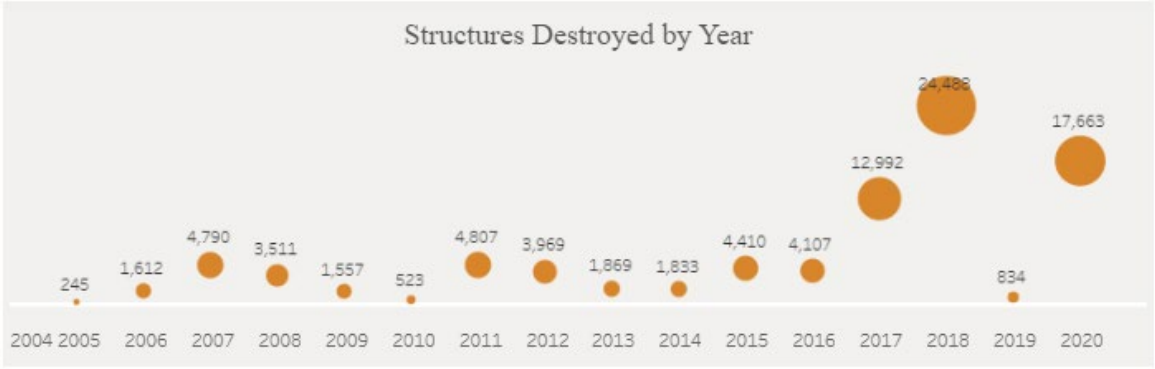
We need more measurement locations and more frequent sampling to obtain more speciated measurements in WUI fire prone areas

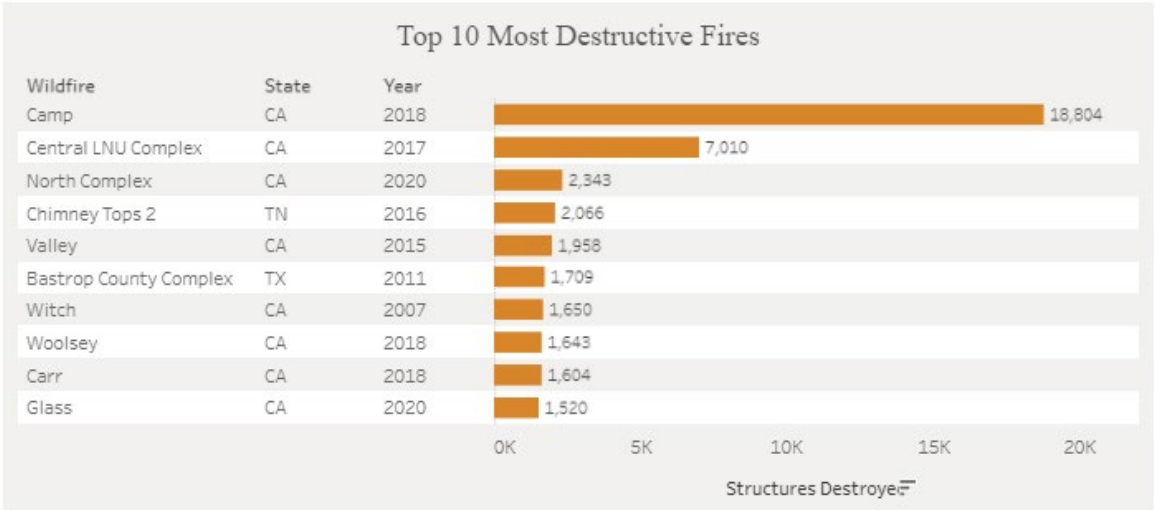
Conclusions and outlook

- $PM_{2.5}$ from WUI fires has a distinctive metals signature, with marked increases of lead, arsenic, copper, and chromium
- Burning vehicles and buildings are a likely source of these toxic metal emissions
- **We can expect more smoke and more toxic metals in the future**

➢ A warming climate results in conditions favorable for destructive wildfires (warmer temperatures + drier conditions, reduced snowpack)

➢ WUI continues to grow and ***rebuild***





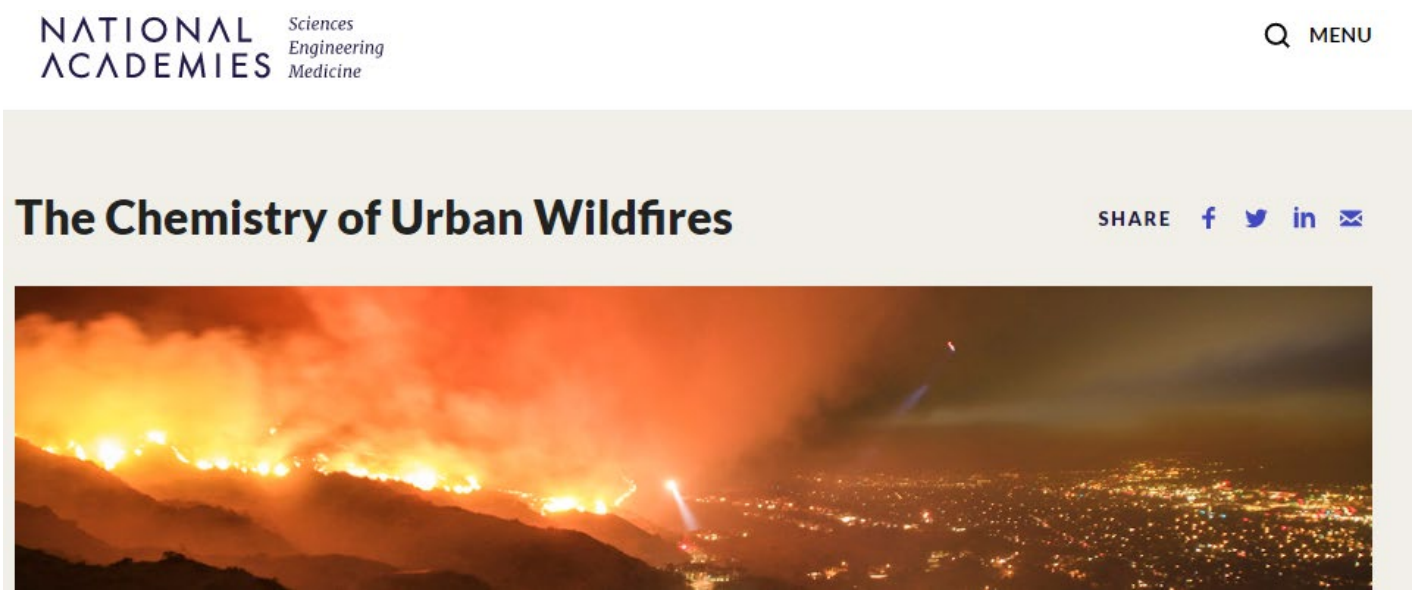
Data Source: Wildfire data for 2005-2019 are from National Fire and Aviation Management FAMWEB. Wildfire data for 2020 are from the National Interagency Fire Center's Incident Year-to-Date Report as of November 9, 2020.

HEADWATERS ECONOMICS

National Academies Consensus Study on the Chemistry of Urban Wildfires

Timeline:

- Spring 2021: Convened Committee
- Summer 2021: Held virtual information gathering session
  - Composition of building materials and combustion products
  - Emissions, sources, and exposures
  - Chemical processes
  - Data gaps and research needs
- Fall 2022: Report to be released



Focus areas:

1) The chemical processes undergone by materials unique to urban structures and otherwise not present in wildland areas that undergo combustion during wildfires
2) The identity of chemical species present in urban wildfire combustion products and debris
3) What is known about human exposure and relative importance of various human exposure pathways (in the air, water, and soil) for key chemical species, as well as challenges in collecting data to fill important data gaps.

Thank you!

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Learn more about wildfires and the built environment:
https://chemicalinsights.org/wildfires/#/

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