What do we need to know? How do we get there?

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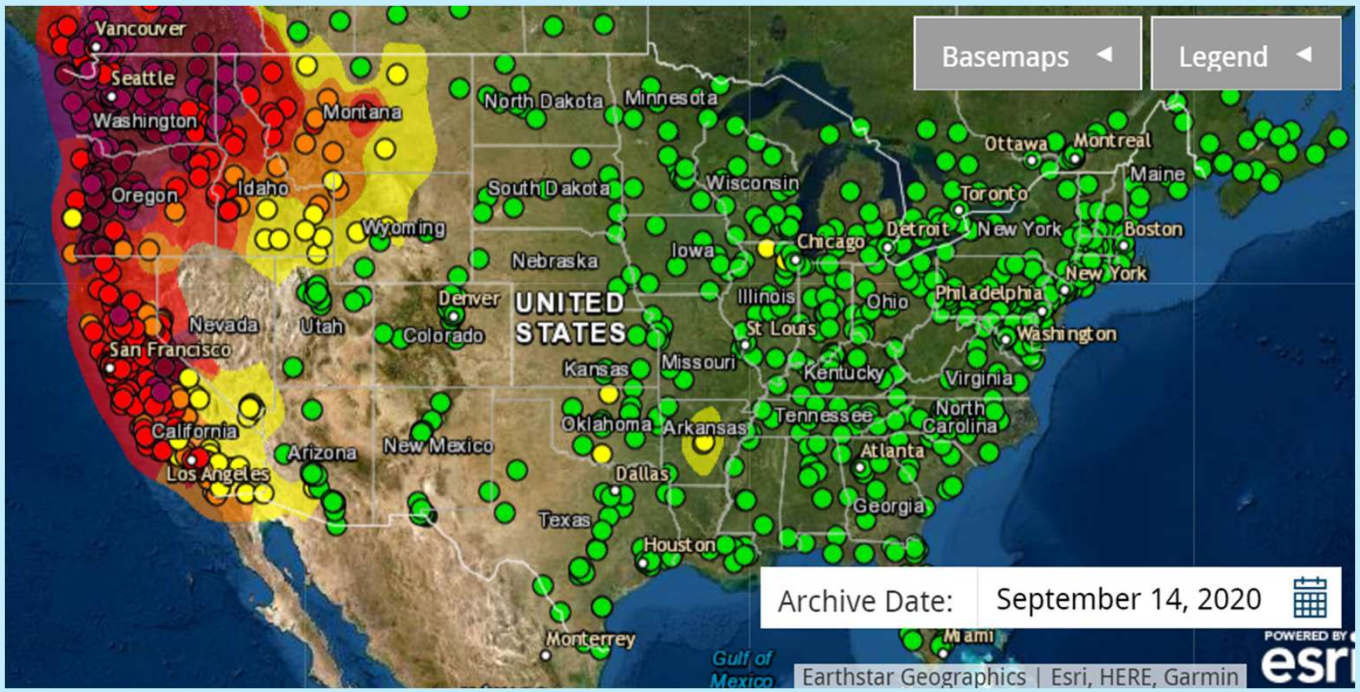

1. Photochemistry, O_3 and smoke.
2. Need for unique smoke markers as part of routine monitoring.
3. What are the emissions and impacts of prescribed burning vs wildfires? What limits our ability to do more prescribed burning?
4. Indoor air quality and protecting people from smoke.

In 2020: millions of people have been exposed to "very unhealthy" to "hazardous" air quality due to smoke. PM2.5 broke many records along the west coast in the past 2 weeks.

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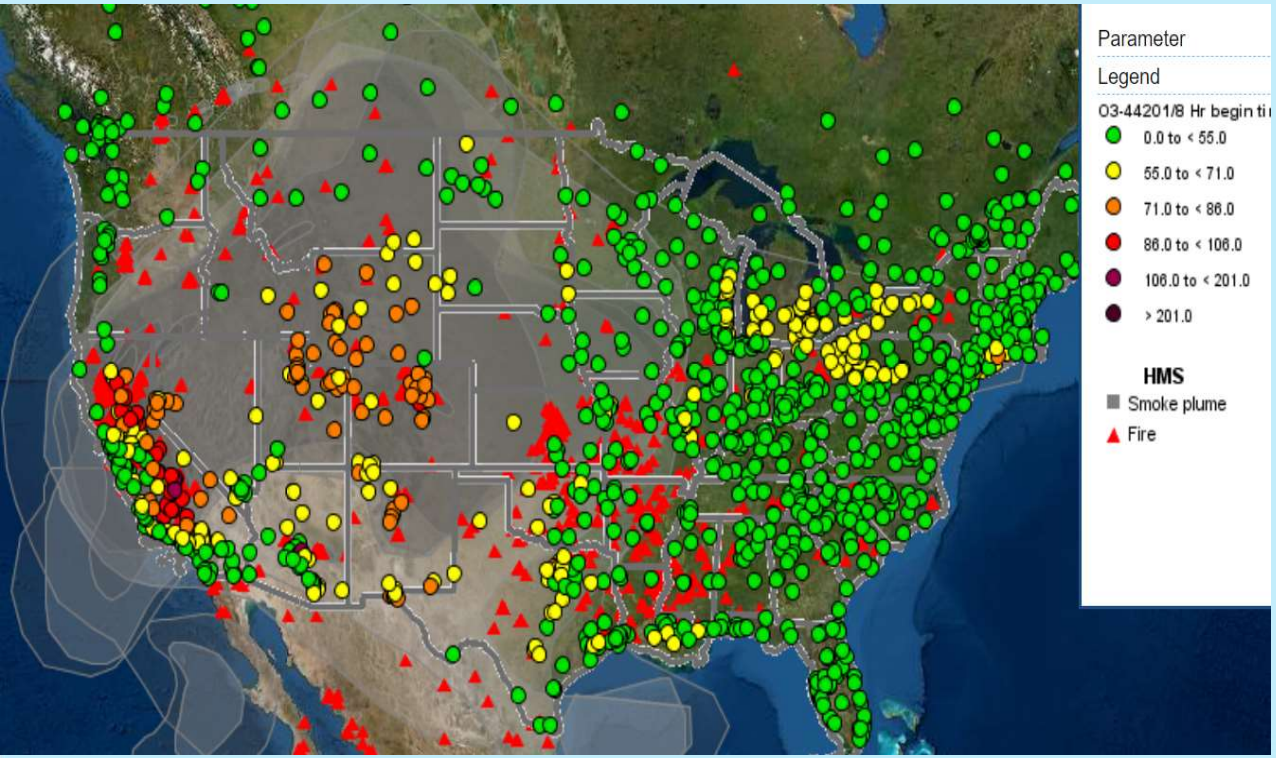
Photochemistry, O_3 and smoke.



MDA8 O_3 values for Aug 22, 2020

- Strong evidence that smoke contributes to O_3 exceedances in urban areas. (Jaffe et al 2004, 2008; Gong et al 2017; Lindaas et al 2017; McClure and Jaffe 2018; Buysee et al 2019; Jaffe et al 2020).
- Poor understanding of processes involved (Zhang et al 2014; Baker et al 2016; Lu et al 2016; Buysse et al 2019)
- Important for policy and health (Jaffe et al 2020).
- Need more focus studies on urban O_3 and smoke.

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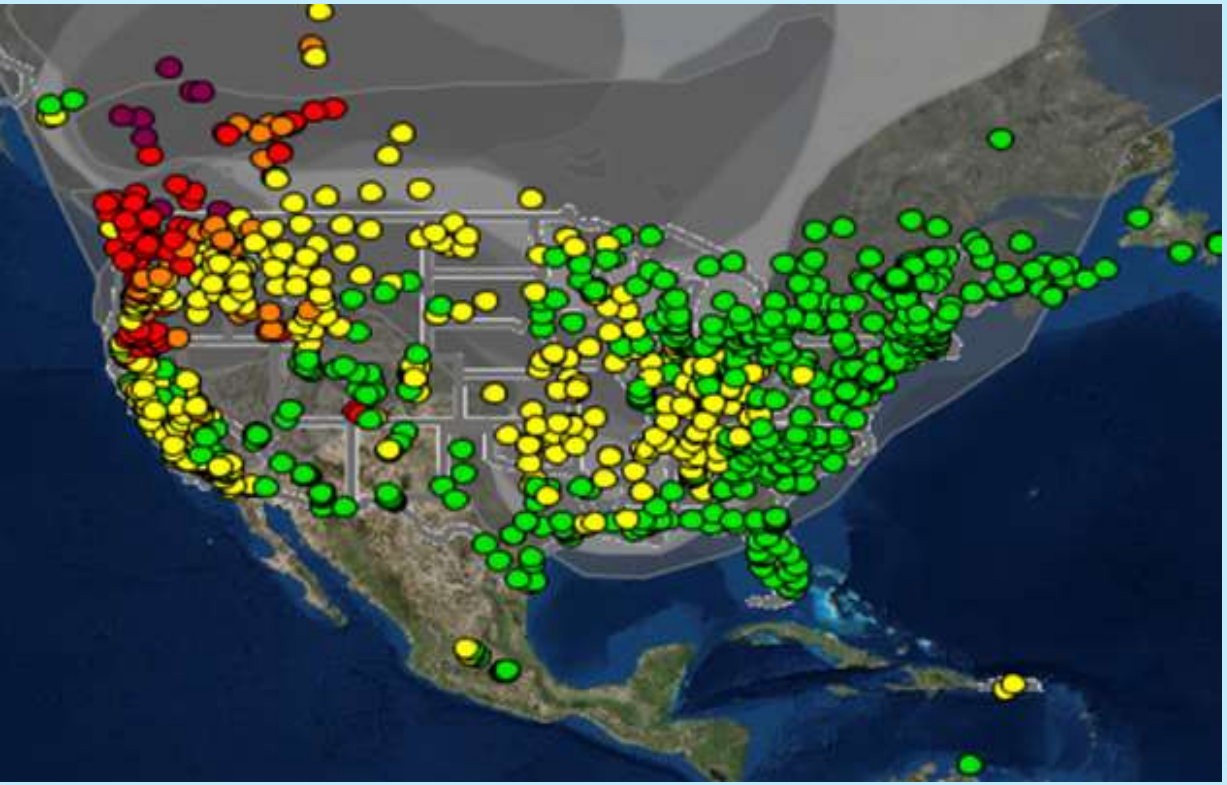
Need for unique smoke markers as part of routine monitoring



Surface $PM_{2.5}$ smoke plumes on Aug 22, 2018.

1. Smoke can impact surface sites 1000s of km away from the fire location.
2. This leads to $PM_{2.5}$ concentrations that are moderately enhanced, but this is difficult to prove.
3. At these moderate PM levels, impacts on O_3 appear to be greatest (Buysse et al 2019).
4. Need better tools for routing monitoring to identify smoke at low to moderate concentrations (e.g. CH_3CN, aerosol chem, etc)

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What are the emissions and impacts of prescribed burning vs wildfires?

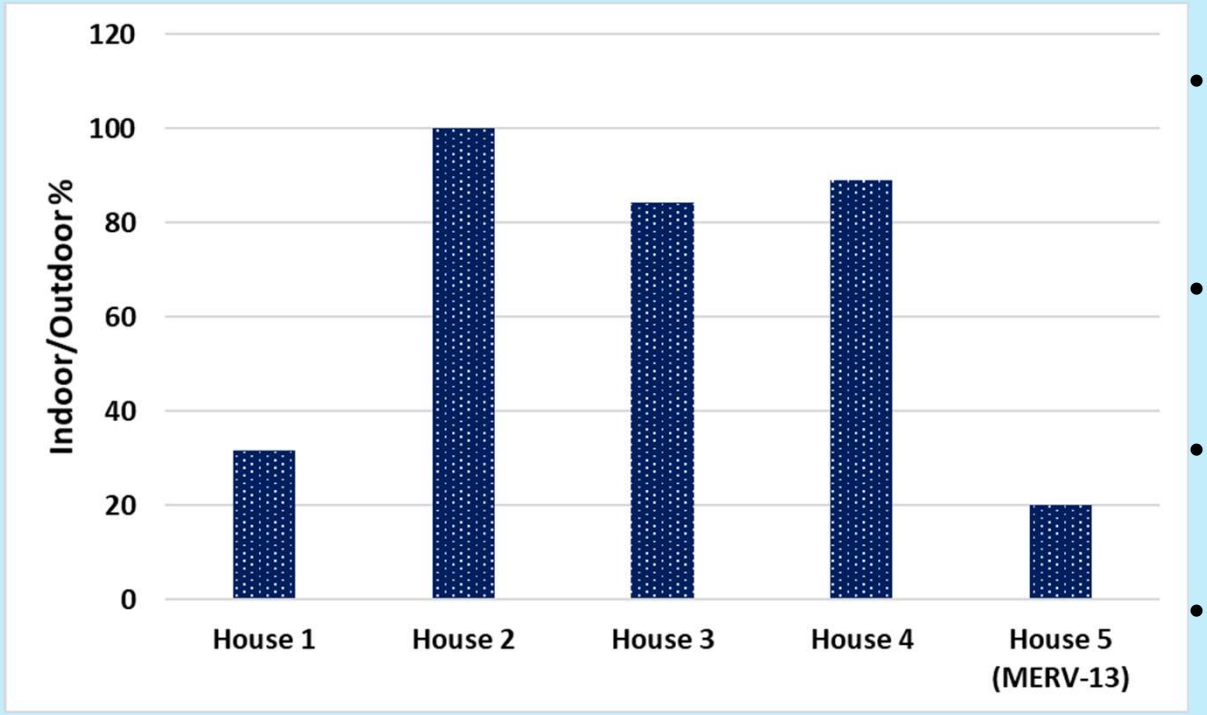
State	2017 Area Burned (ha)	Peak Month	Peak month-Area Burned (ha)	Peak month-$PM_{2.5}$ Emitted (tons)*	Highest Daily $PM_{2.5}$ in that month ($\mu g/m^3$)
Wildfires:					
CA	641,440	Oct.	151,492	106,657	215
Prescribed fires:					
TX	632,470	Feb.	143,468	12,807	29

1. Most prescribed burning occurs in the south and southeast U.S. Most wildfires occur in the western U.S.
2. Much higher emissions per acre from wildfires.
3. Prescribed burning and land management could be important tools for reducing smoke, but very limited observational data.
4. What limits our ability to do more prescribed burning?
5. Need better understanding of the strategies to reduce emissions and population exposure from prescribed fires.

Jaffe D.A., O'Neill S.M., Larkin N.K., Holder A.L, Peterson D.L., Halofsky J.E. and Rappold A.G. Wildfire and prescribed burning impacts on air quality in the United States, J. Air and Waste Mgt. Assn., doi: 10.1080/10962247.2020.1749731, 2020.

*Data from EPA National Emission Inventory for 2017.

Indoor air quality and protecting people from smoke.



Indoor/outdoor ratio (%) for 0.5 µm particles at 5 homes in Seattle on 9/14/2020 during heavy smoke (outdoor PM2.5 ≈ 150 µg m-3). House 5 used a low cost box fan with a MERV-13 filter.

- **When smoke is bad, community advice is to stay indoors. But we have very little information on the indoor environment during smoke events.**
- **Limited evidence indicates that indoor concentrations of fine particles can be nearly as bad as outdoors.**
- **Relatively simple and low cost tools can reduce PM exposure and help protect people from smoke exposure.**
- **Need comprehensive studies to look at PM size distributions, O_3, CO_2, etc, in indoor environments.**

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Summary

- Smoke contributes to enhanced O_3 in urban areas. Need to understand the processes.
- Need for unique smoke markers as part of routine monitoring.
- Need better understanding of prescribed burning and how it can help.
- Need to understand indoor air quality and protecting people from smoke.

Seattle, Aug. 21, 2018.
$PM_{2.5}$ = 110 ug/m^3

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