Wildfire smoke impacts on indoor air quality assessed using crowdsourced data in California

Yutong Liang, Deep Sengupta, Mark J. Campmier, David M. Lunderberg, Joshua S. Apte, and Allen H. Goldstein
PurpleAir sensors adoption driven by wildfires?

Deployed sensor count rapidly increases during wildfire events
Bay Area: the pointy end of the PA spear

57% of all global public PurpleAirs are in California: 69% outdoor, 31% indoor
Study design

How do indoor PM$_{2.5}$ levels respond to wildfire smoke?

- Identify 1400 indoor, public PurpleAir sensors in SF & LA areas
- Match each indoor sensor with closest outdoor PurpleAir sensor
- Develop / evaluate network calibration
- Acquire building-level information from Zillow
- Apply mass-balance model to estimate “infiltrated” PM$_{2.5}$: indoor particles of outdoor origin.
- Evaluate response of indoor PM$_{2.5}$ to wildfire smoke
Behavioral adaptation

Infiltration of outdoor particles is lower on fire days.

### Mean outdoor concentration (μg · m⁻³)

<table>
<thead>
<tr>
<th></th>
<th>Mean ± SD</th>
<th>GM, GSD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-fire days</td>
<td>9.1 ± 4.0</td>
<td>4.1 ± 2.5</td>
</tr>
<tr>
<td>Fire days</td>
<td>45.4 ± 17.0</td>
<td>11.1 ± 8.3</td>
</tr>
<tr>
<td>Unhealthy days</td>
<td>61.2 ± 20.5</td>
<td>13.5 ± 10.6</td>
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### Mean infiltration ratio

<table>
<thead>
<tr>
<th></th>
<th>Mean ± SD</th>
<th>GM, GSD</th>
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<tbody>
<tr>
<td>Non-fire days</td>
<td>0.90 ± 0.88</td>
<td>0.45 ± 0.15</td>
</tr>
<tr>
<td>Fire days</td>
<td>0.41 ± 0.44</td>
<td>0.27 ± 0.14</td>
</tr>
<tr>
<td>Unhealthy days</td>
<td>0.31 ± 0.42</td>
<td>0.23 ± 0.14</td>
</tr>
</tbody>
</table>

**A**

- Infiltration of outdoor particles is lower on fire days.

**B**

- Infiltration of outdoor particles is lower on fire days.
Newer homes and homes with A/C seem to have lower infiltration of wildfire smoke.
Homes with PA sensors have higher average Zillow values

Behavior of PurpleAir owners is unlikely to be representative of broader population.
Indoor sensors: a tale of two cities
Key conclusions

- Buildings can and do effectively protect people from smoke.

- PurpleAir owners appear to undertake behavioral changes to reduce smoke infiltration into their homes.

- It would be extremely useful to have a more representative sample of indoor air quality with LCS.

- **Opinion:** the LCS community has insufficiently emphasized the opportunity to better understand *indoor exposures*. This is a real opportunity.