

Environmental Impacts of the Marshall Fire

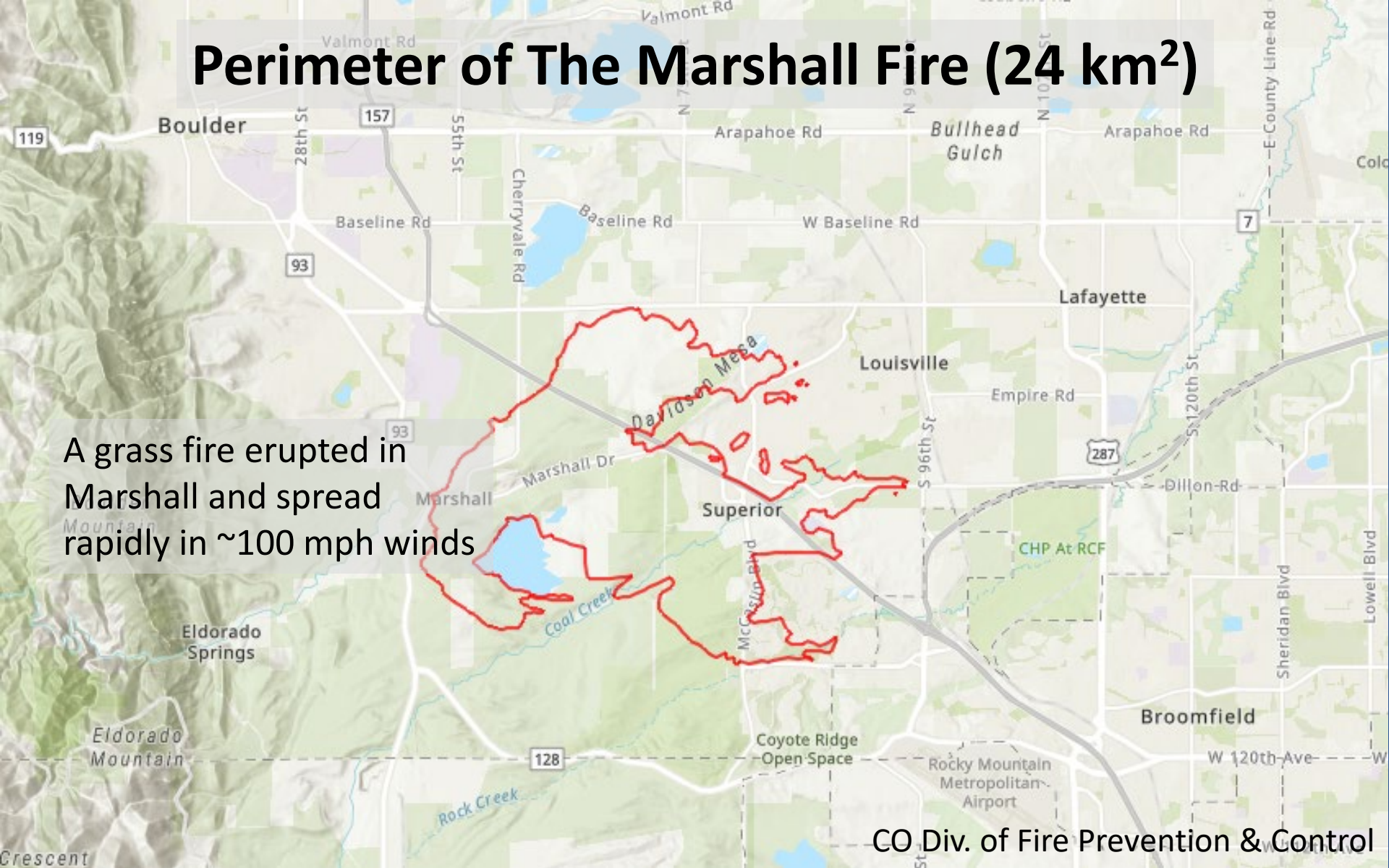
Boulder, Colorado
December 30, 2021

Photo: Leo Pelle

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Perimeter of The Marshall Fire (24 km²)

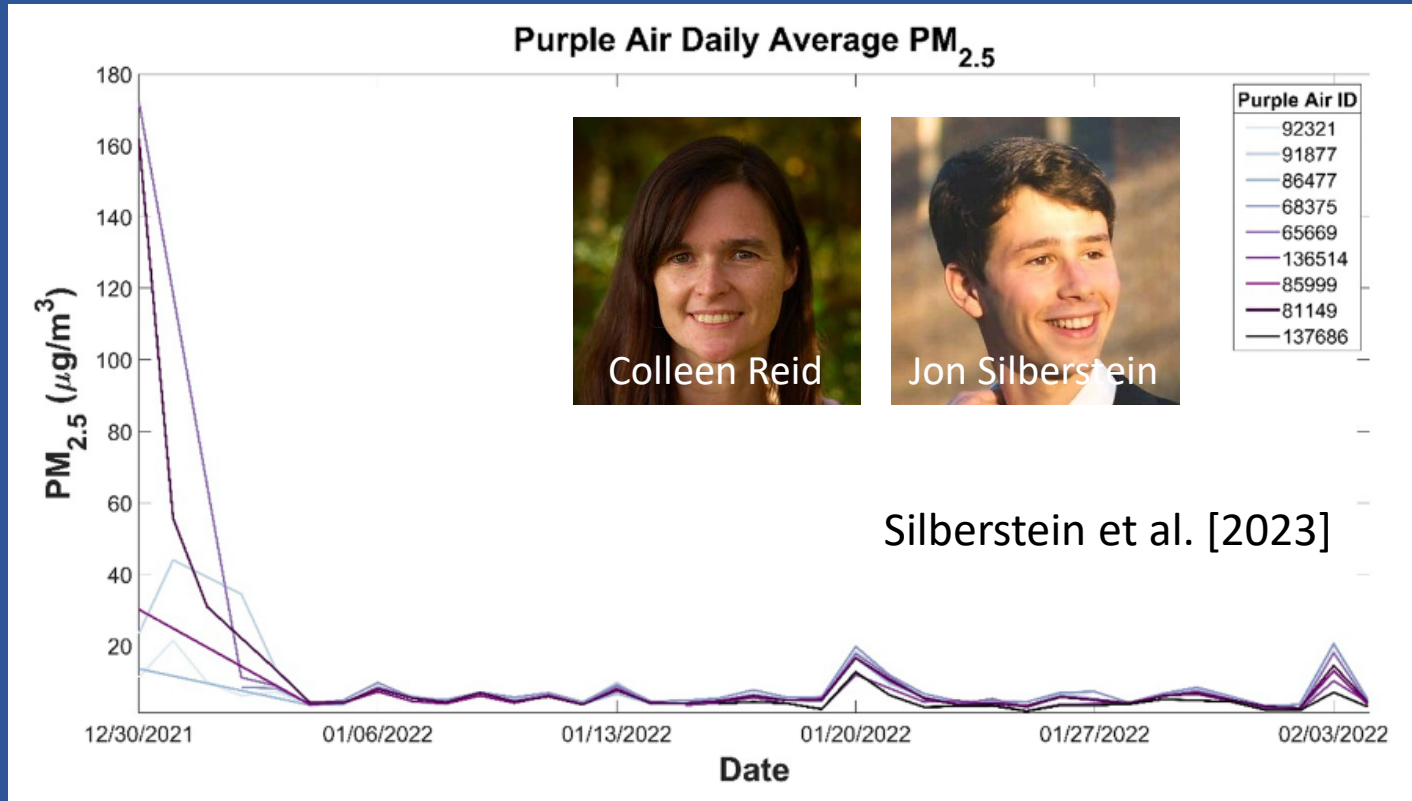
A grass fire erupted in Marshall and spread rapidly in ~100 mph winds



An aerial photograph showing the aftermath of a residential fire. The landscape is covered in ash and charred debris. Several buildings have been completely destroyed, leaving only skeletal remains of walls and roofs. Some areas are still smoldering with small fires. A road with a few cars is visible, providing a sense of scale to the devastation.

2 Lives lost
1084 Buildings burned
149 Damaged

Ambient Air Quality was only Briefly Impacted



Caveat: many sensors were destroyed or went off-line

But: Post-Fire Impacts Were Significant



- Ash and soot were deposited indoors
- Strong burn smell indoors
- Many people did not return for weeks if not months

Our Responses to the Community Concerns

What Did We Do?

Updated after LA fires

🕒 Friday, January 17, 2025

How to mitigate post-fire smoke impacts in your home

CU Boulder scientists provide facts on wildfire-related indoor air quality and tips on how to mitigate





We Made Measurements of
PM and VOCs Inside Homes



We Measured Outside



And Surveyed ~15 More Homes



Thanks: Abby Koss +
Tofwerk

We Collected Soil and Water Samples



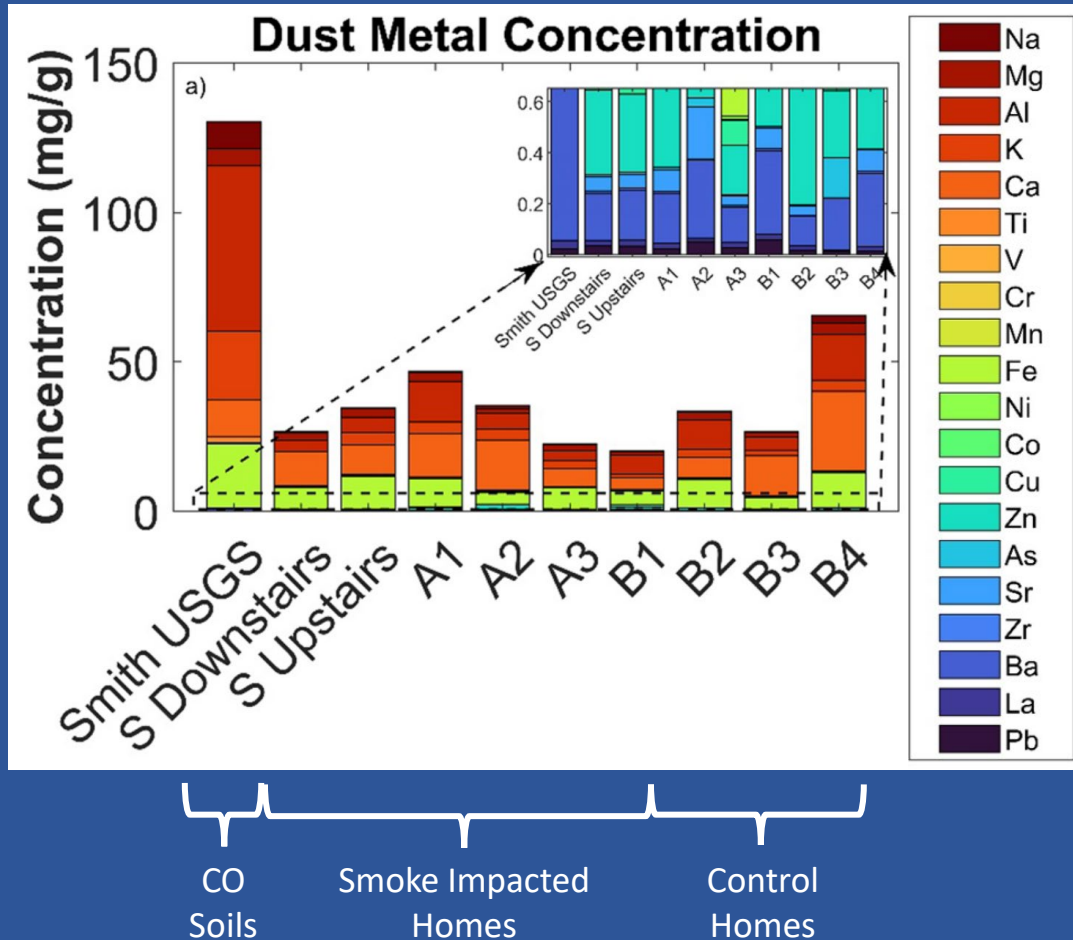
Thomas Borch, Eve
Hinckley and Noah Fierer



Julie Korak and Cresten Mansfeldt

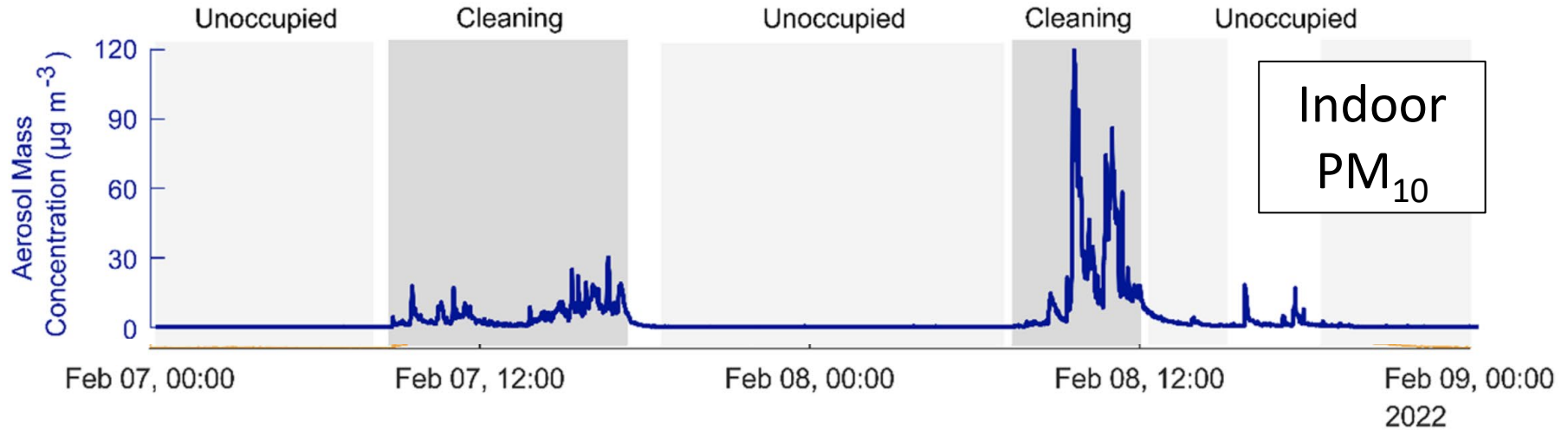
What Did We Find?

Chemical Composition of Indoor Ash and Soot



- Samples did contain fire tracers
- But only small enhancements of heavy metals like lead

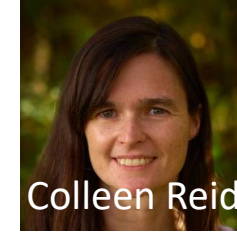
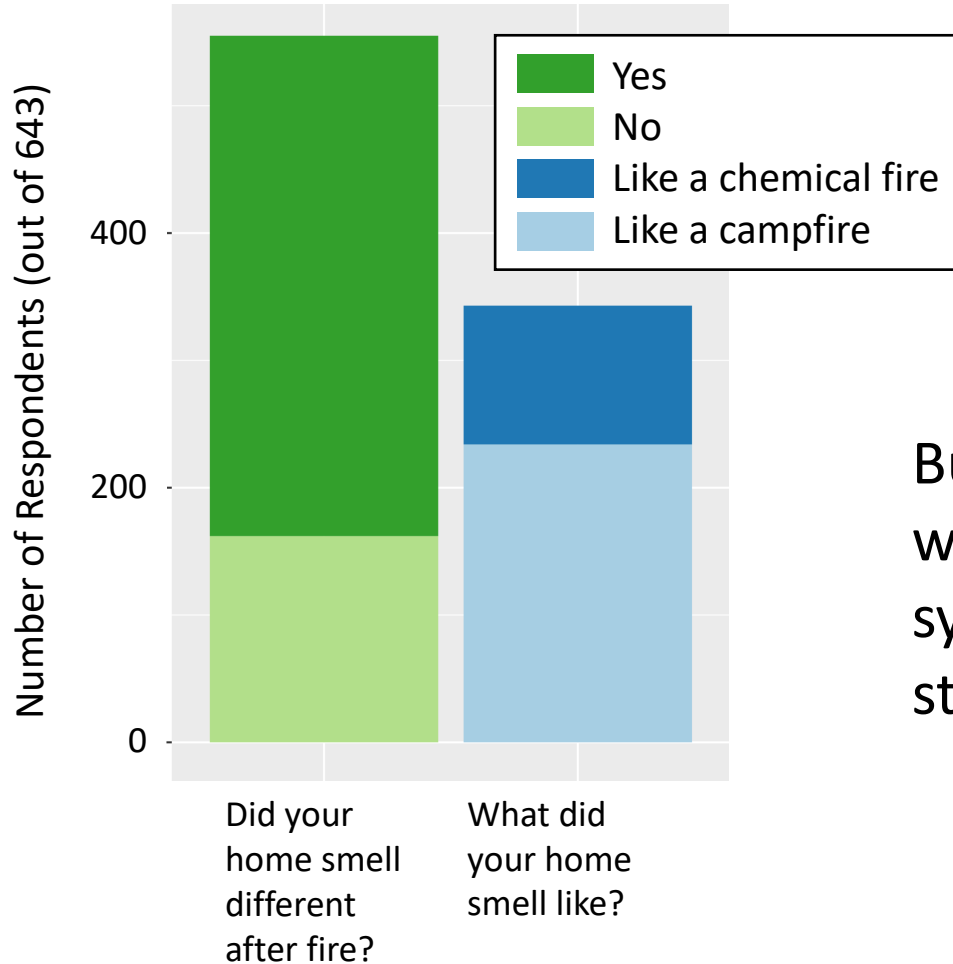
Ash and Soot were Resuspended during Home Cleaning



1. Indoor $PM_{2.5}$ was generally low after the fire
2. Cleaning caused indoor PM_{10} to spike: important to protect yourself!



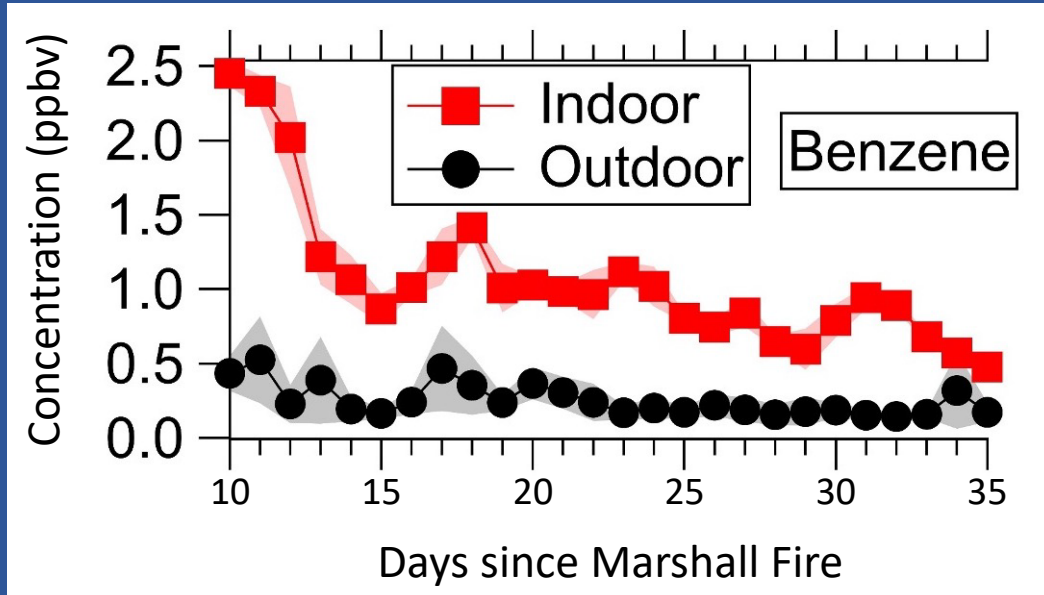
Most People Reported Indoor Burn Smells



Burn smells were associated with higher reporting of symptoms (headaches, strange taste in mouth)

Many VOCs were Enhanced Indoors

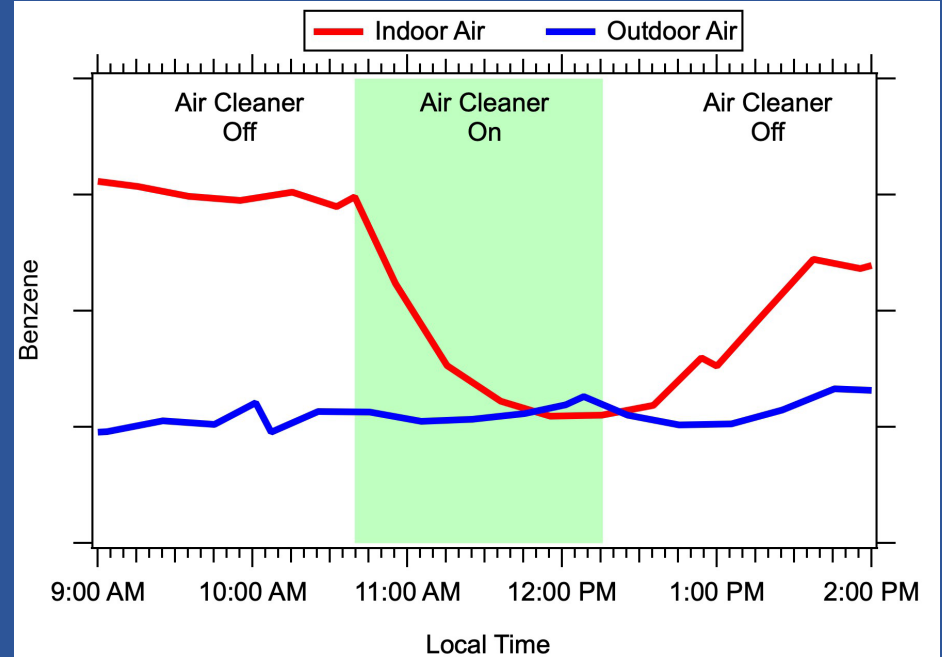
One example: benzene - out of 100s measured



- VOC concentrations returned to normal after ~4-5 weeks
- Decreases took much longer than expected

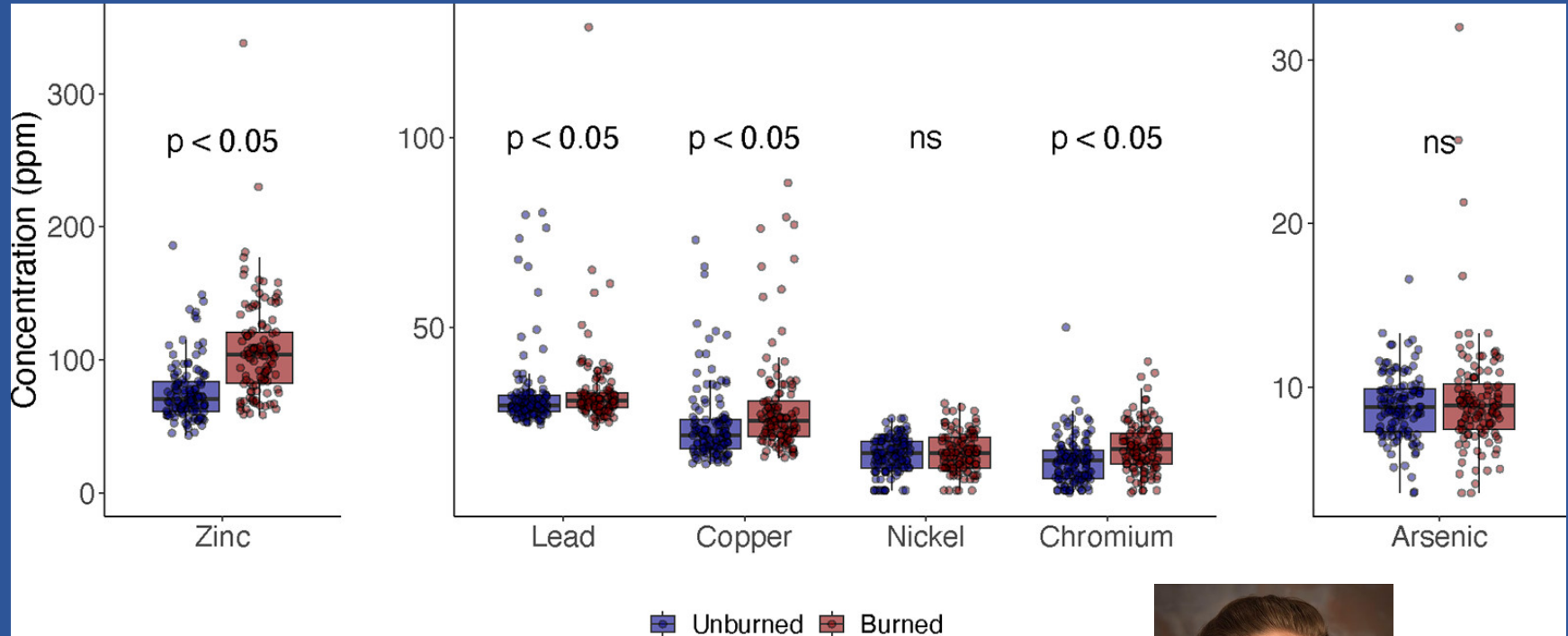


Air Cleaners – How to Protect Yourself

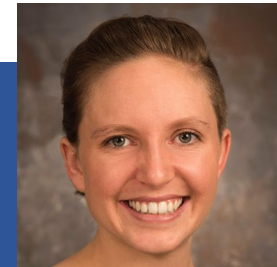


- Air cleaners with activated carbon are very effective at removing indoor VOCs
- But: when you turn the cleaner off, the VOCs return

Analysis of Soil Samples



- No large enhancements in heavy metals
- Note: most homes were newer than Altadena



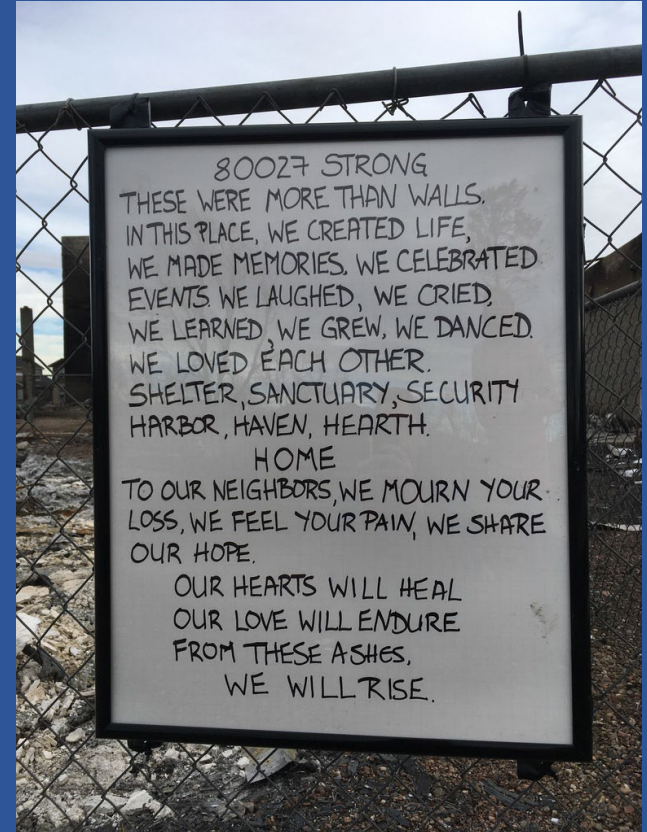
Sierra Jech

Conclusions

- Post-fire smoke impacts are a new issue to consider for the release of toxics into the environment
- Lab work is needed on the toxics from the burning of man-made fuels
- Research is needed on the cleaning of smoke-impacted homes

Acknowledgements

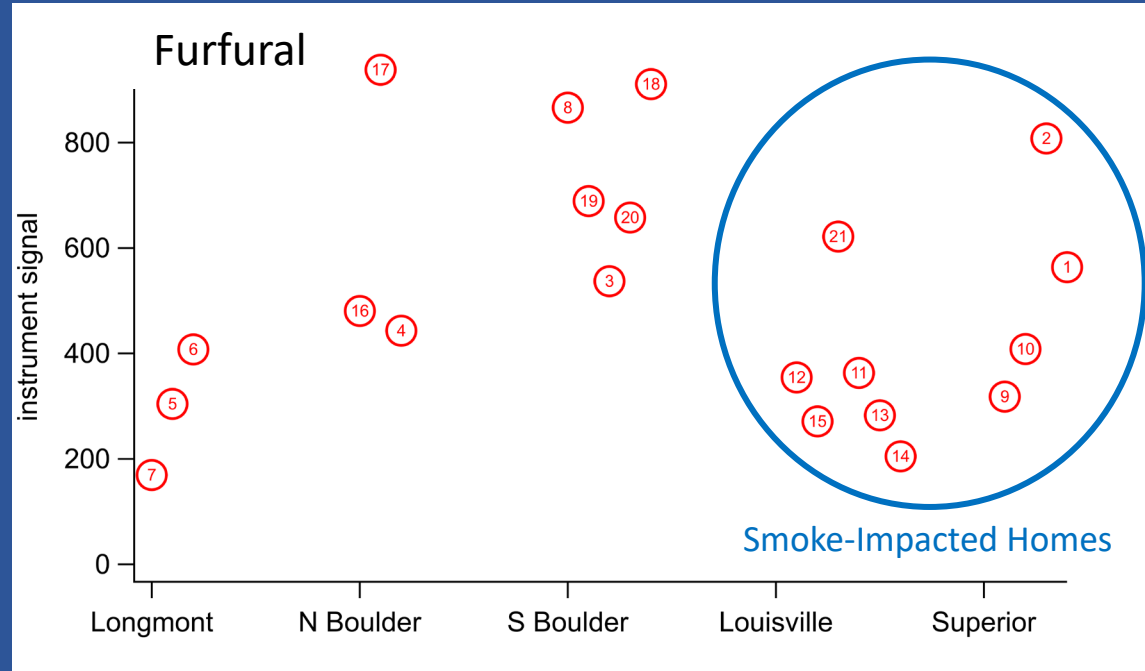
- Homeowners and residents
- Funding: CIRES RAPID, NSF RAPID, Sloan Foundation



Published Papers

- Silberstein, J. M., Mael, L. E., Frischmon, C. R., Rieves, E. S., Coffey, E. R., Das, T., Dresser, W., Hatch, A. C., Nath, J., Pliszka, H. O., Reid, C. E., Vance, M. E., Wiedinmyer, C., De Gouw, J. A., and Hannigan, M. P.: **Residual impacts of a wildland urban interface fire on urban particulate matter and dust: a study from the Marshall Fire**, *Air Qual Atmos Health*, 16, 1839–1850, doi.org/10.1007/s11869-023-01376-3, 2023.
- Jech, S., Adamchak, C., Stokes, S. C., Wiltse, M. E., Callen, J., VanderRoest, J., Kelly, E. F., Hinckley, E.-L. S., Stein, H. J., Borch, T., and Fierer, N.: **Determination of Soil Contamination at the Wildland-Urban Interface after the 2021 Marshall Fire in Colorado, USA**, *Environ. Sci. Technol.*, acs.est.3c08508, doi.org/10.1021/acs.est.3c08508, 2024.
- Dresser, W., Silberstein, J. M., Reid, C. E., Vance, M. E., Wiedinmyer, C., Hannigan, M., and de Gouw, J. A.: **Volatile Organic Compounds inside Homes Impacted by Smoke from the Marshall Fire**, *ES&T Air*, 2, 4–12, doi.org/10.1021/acsestair.4c00259, 2025.
- Reid, C. E., Finlay, J., Hannigan, M., Rieves, E. S., Walters, H., Welton-Mitchell, C., Wiedinmyer, C., de Gouw, J. A., and Dickinson, K.: **Physical health symptoms and perceptions of air quality among residents of smoke-damaged homes from a Wildland Urban Interface (WUI) fire**, *ES&T Air*, 2, 13–23, doi.org/10.1021/acsestair.4c00258, 2025.

Measurements in Multiple Homes in Boulder County



Early February: VOCs are similar in homes near the burnt area and elsewhere in Boulder County

Ambient Measurements Reveal the Sources of Lingering Smells

Burnt fence

Landscape timber

Burnt mulch

Inside a home



With Abby Koss (Tofwerk)