

Air Quality Assessment in the NM Permian basin: Oil&Gas production impacts

NM legislature, WNR Interim Committee Briefing
October 29, 2025

Researchers contributing to this work are from these Institutions:

Sponsor



UNIVERSITY OF
TORONTO



Fielding
School of Public Health



About me

- Dr. Gunnar W. Schade, Assoc. Prof. (College Station, TX)
- Degrees in Chemistry: MSc 1993, PhD 1997
- 30 years of experience in air quality measurements (and modeling)
 - 20+ years of teaching air quality topics
 - 10 years working on air quality effects of the O&G industry

Disclaimer

I am presenting here in my capacity as an air quality expert. The results and interpretations shown should not be interpreted as reflecting the views of either my university or the sponsor of this research. Neither should any endorsements be inferred.

Results presented will be available in a peer-reviewed report published by HEI in November 2025, with parts also currently in peer review with a scientific journal.

Study Motivation

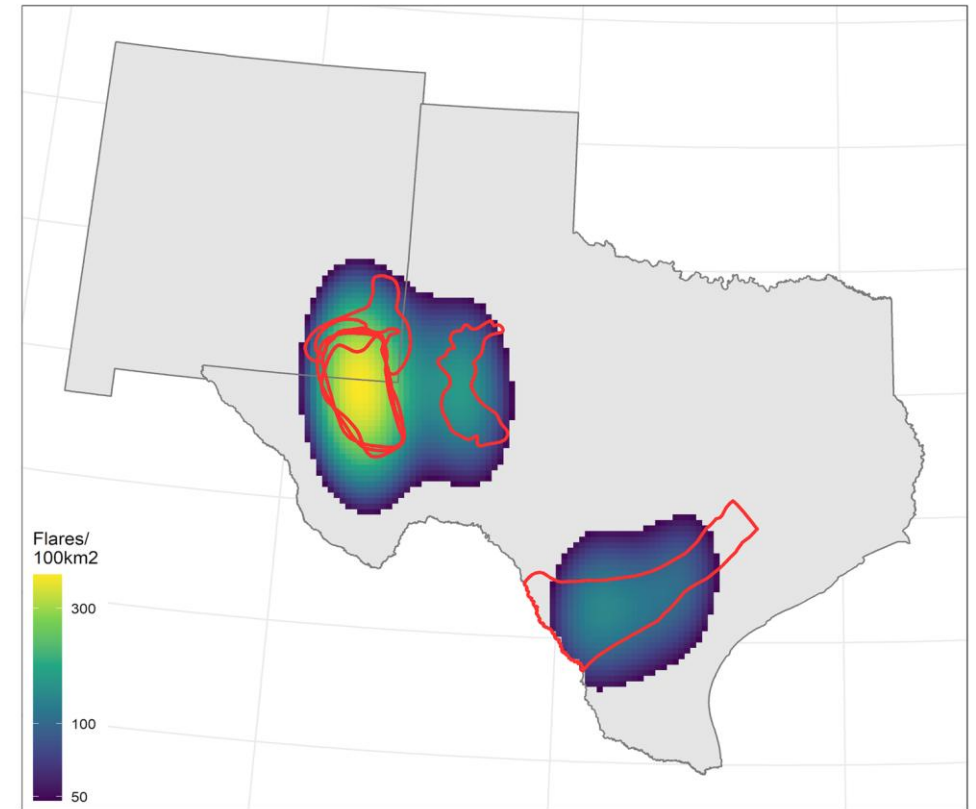
<https://www.heienergy.org/research/air-quality-and-noise>

Production has increased over 8-fold since 2010 at wells located in the Permian Basin and Eagle Ford Shale.



Data from Enverus (based on monthly production values)

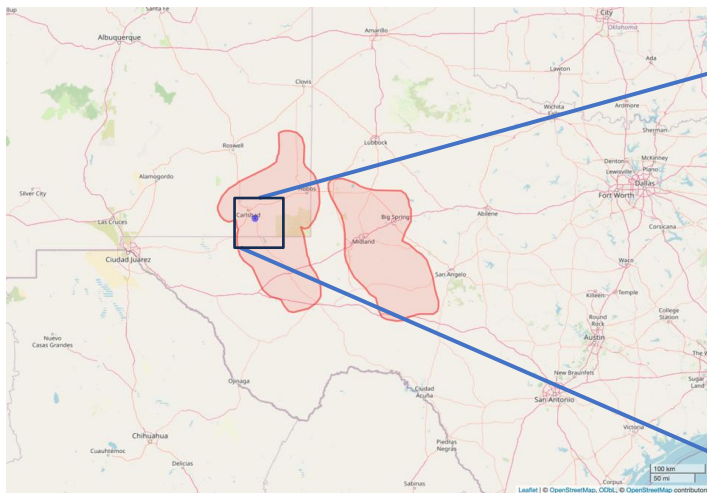
Density of gas flaring in the Permian Basin and the Eagle Ford Shale reflects oil exploration.



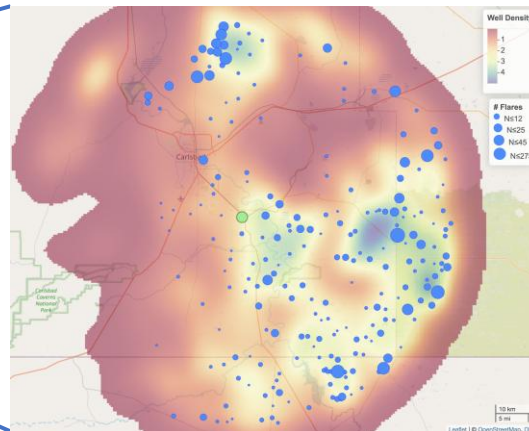
Cushing et al (2021) *Environ. Res. Lett.* **16** 034032

Measurements in the Permian Basin

We collected ambient air pollutant, greenhouse gas, radioactivity, and noise data at high temporal resolution from a stationary monitoring platform in Loving, NM ("LNM").



Eddy County, NM



- Methane (CH₄)
- Volatile organic compounds (VOCs)
 - hydrocarbons
- Nitrogen Oxides (NO_x)
- Ozone (O₃)
- Sulfur Dioxide (SO₂)
- Hydrogen Sulfide (H₂S)
- Carbon Monoxide (CO)
- Carbon Dioxide (CO₂)
- (Black Carbon (BC))
- Airborne Radioactivity
- Noise levels at different frequencies

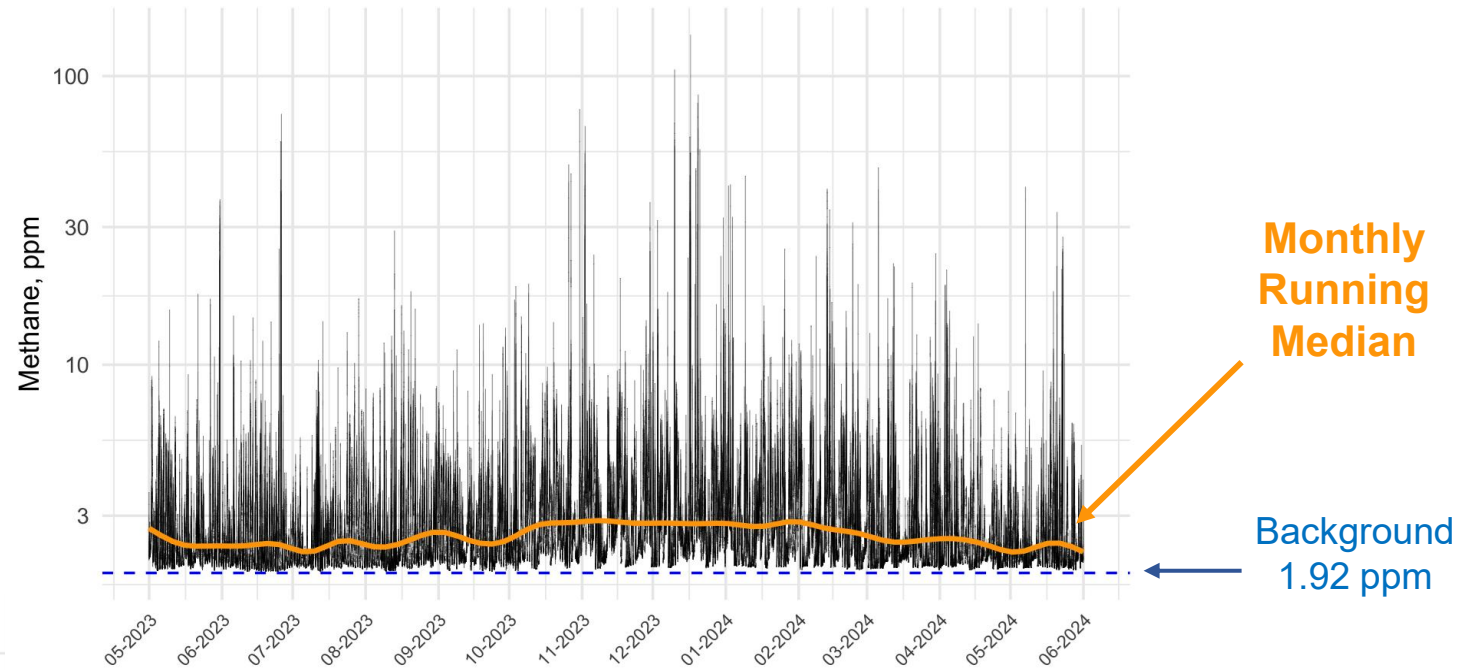
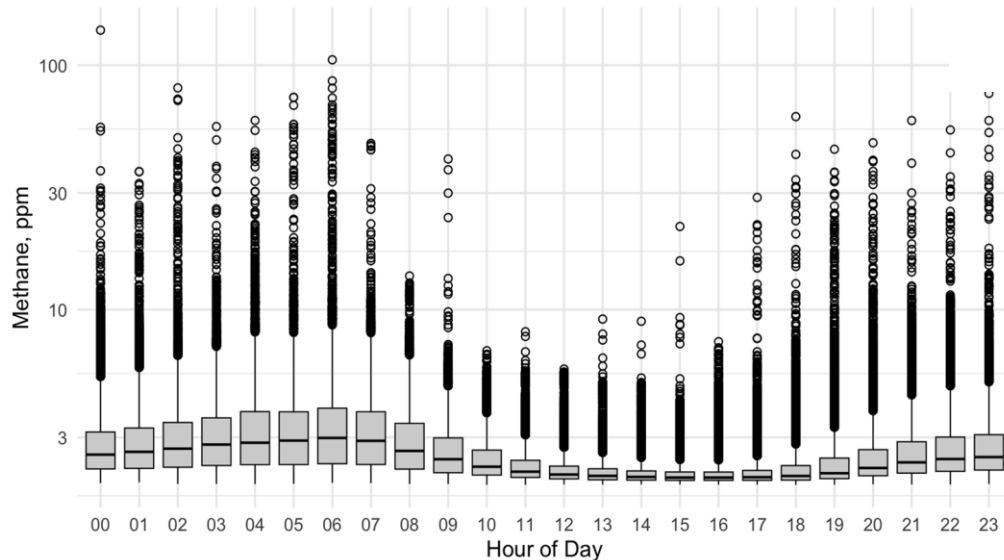


Sampling period: May 1, 2023 through May 31, 2024

Methane at LNM

Methane time series shows:

- Frequent high concentration plumes.
- Seasonal changes, higher concentrations in winter, in part due to reduced atmospheric mixing.

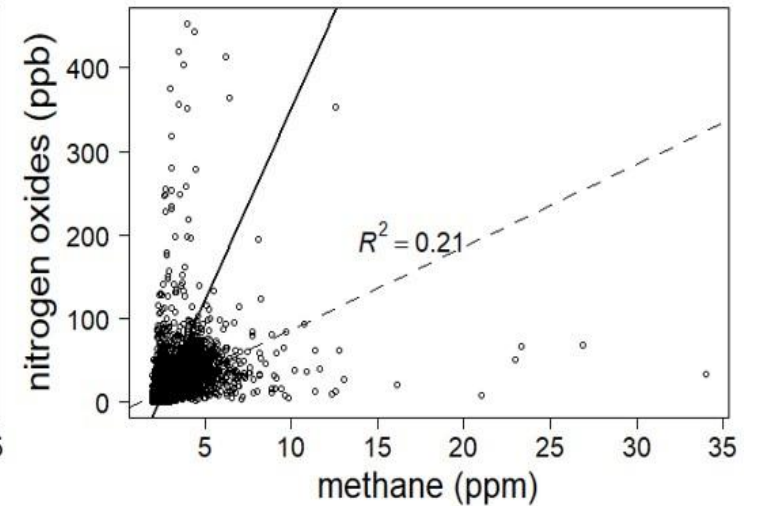
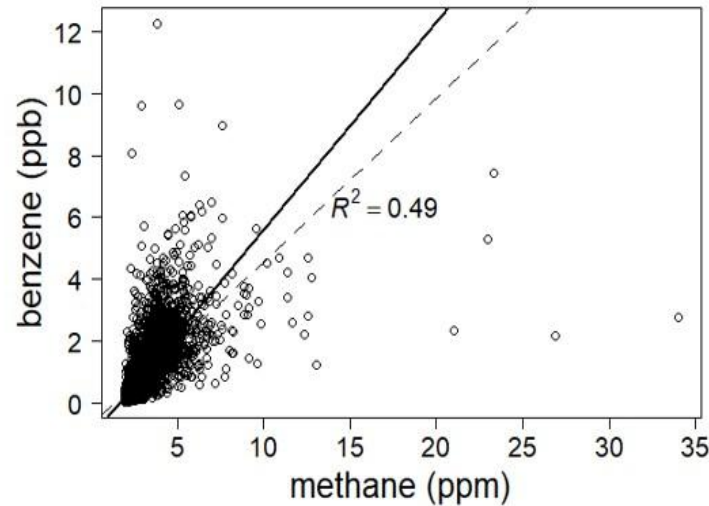
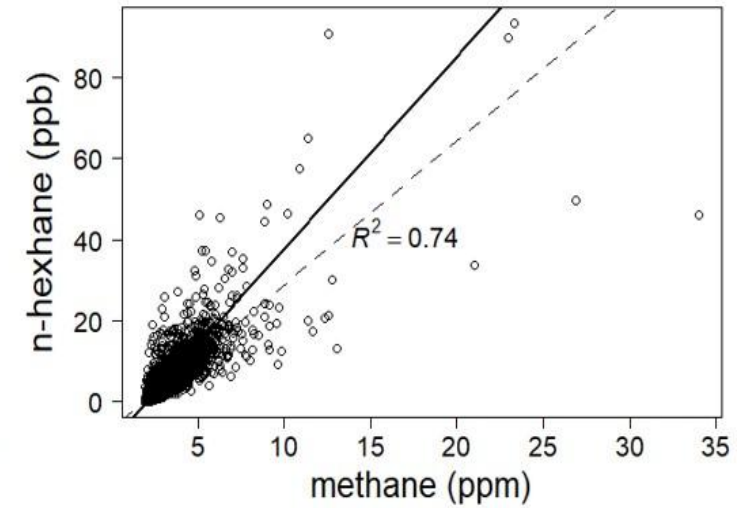
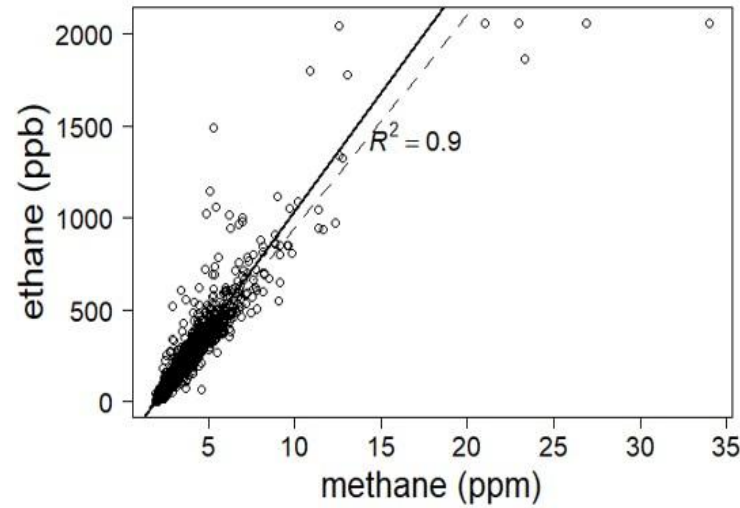


- Methane plumes, depicted as circles (top 2.5% of each hour's data), are seen at all times of day.
- Median levels at night are 3 ppm, 50% above background.

Methane and Other Compounds

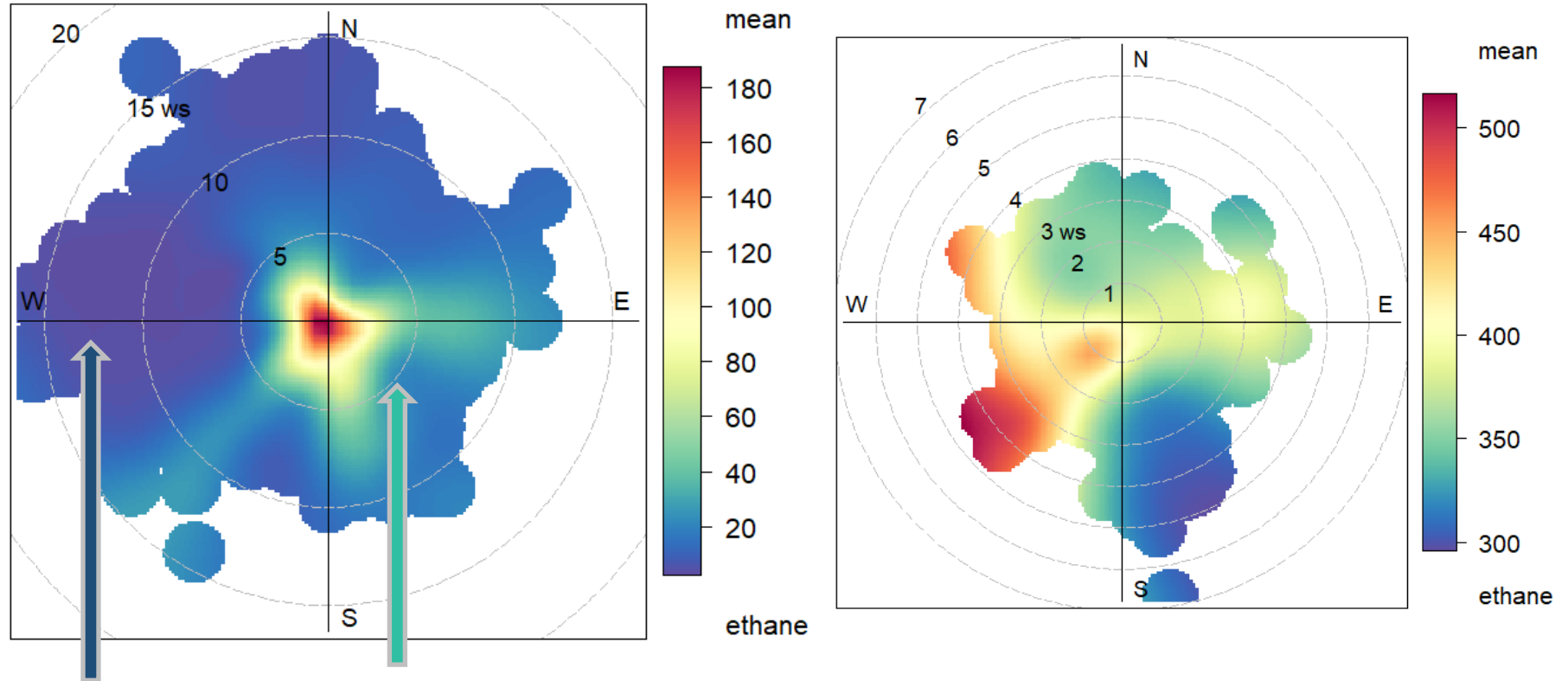
Methane correlated with most other compounds:

- Highest correlation with ethane
- Data show methane always appears with ethane, the logical conclusion is that the measured methane came almost entirely from UOGD sources, not from other methane-emitting activities.



Ethane at LNM

- Ethane is an important example of a pollutant directly emitted from O&G-related activities
- Ethane has negligible contributions from non-O&G exploration or combustion sources, and is largely preserved during transport due to its months-long atmospheric lifetime.



clean air (<10 ppb), polluted continental air (30-60 ppb)

- These polar plots show the wind directional dependence of ethane abundance in ppb
- Highest levels occurred at low wind speeds (<5 m/s) advected from all directions.
- Ethane events (highest 10%) predominantly occurred under very low wind speed conditions (1–3 m s⁻¹).
- Highest levels were observed in airflow from the SW suggesting intermittent or episodic emissions contributing to extreme ethane levels.
- Likely sources were a nearby well-pad with a tank battery and an intermittent flare in the immediate SW.

Air pollutant Sources at LNM

Fugitive emissions dominated by alkanes, benzene

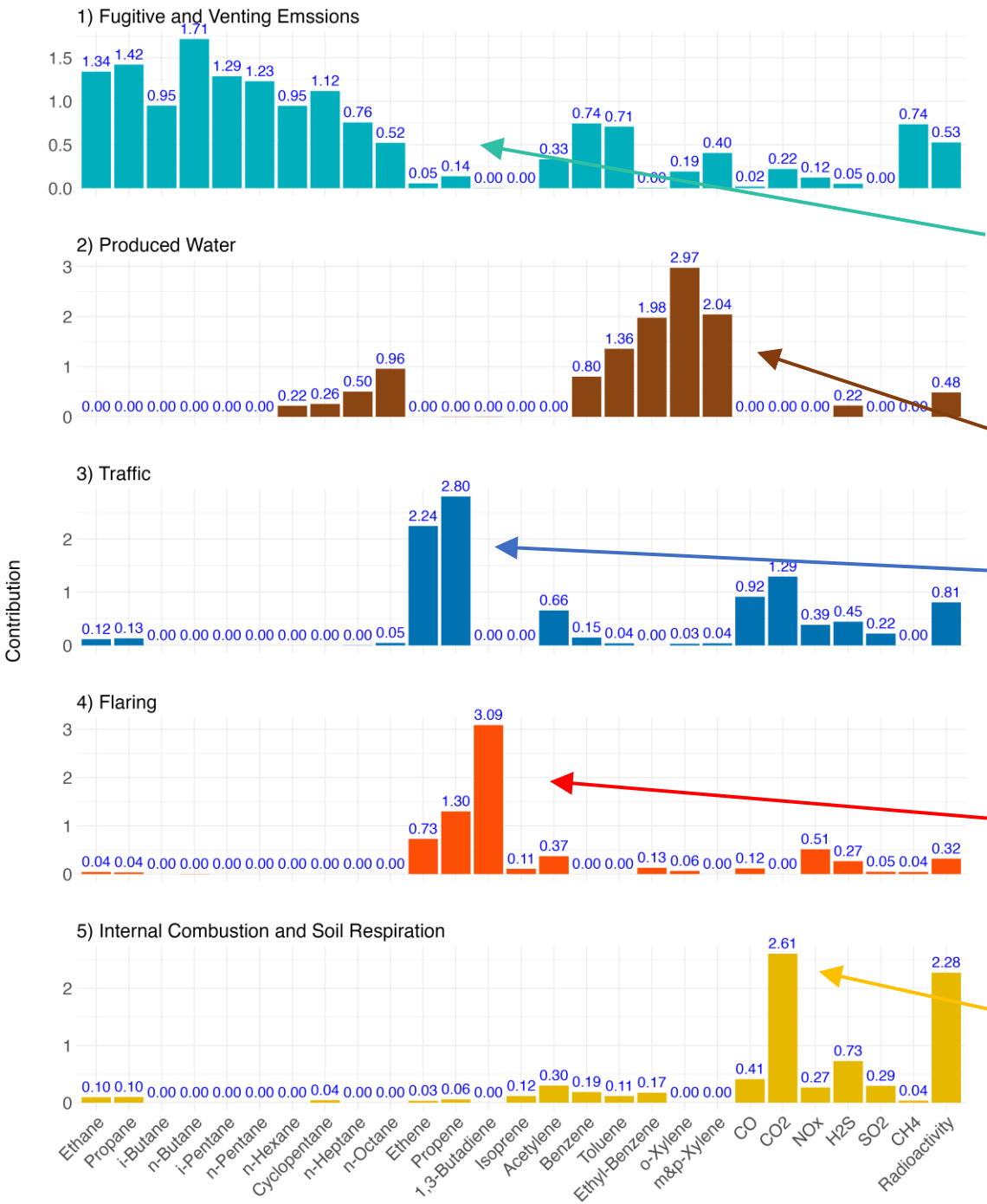
Produced water, high in BTEX

Traffic, high in alkenes, acetylene

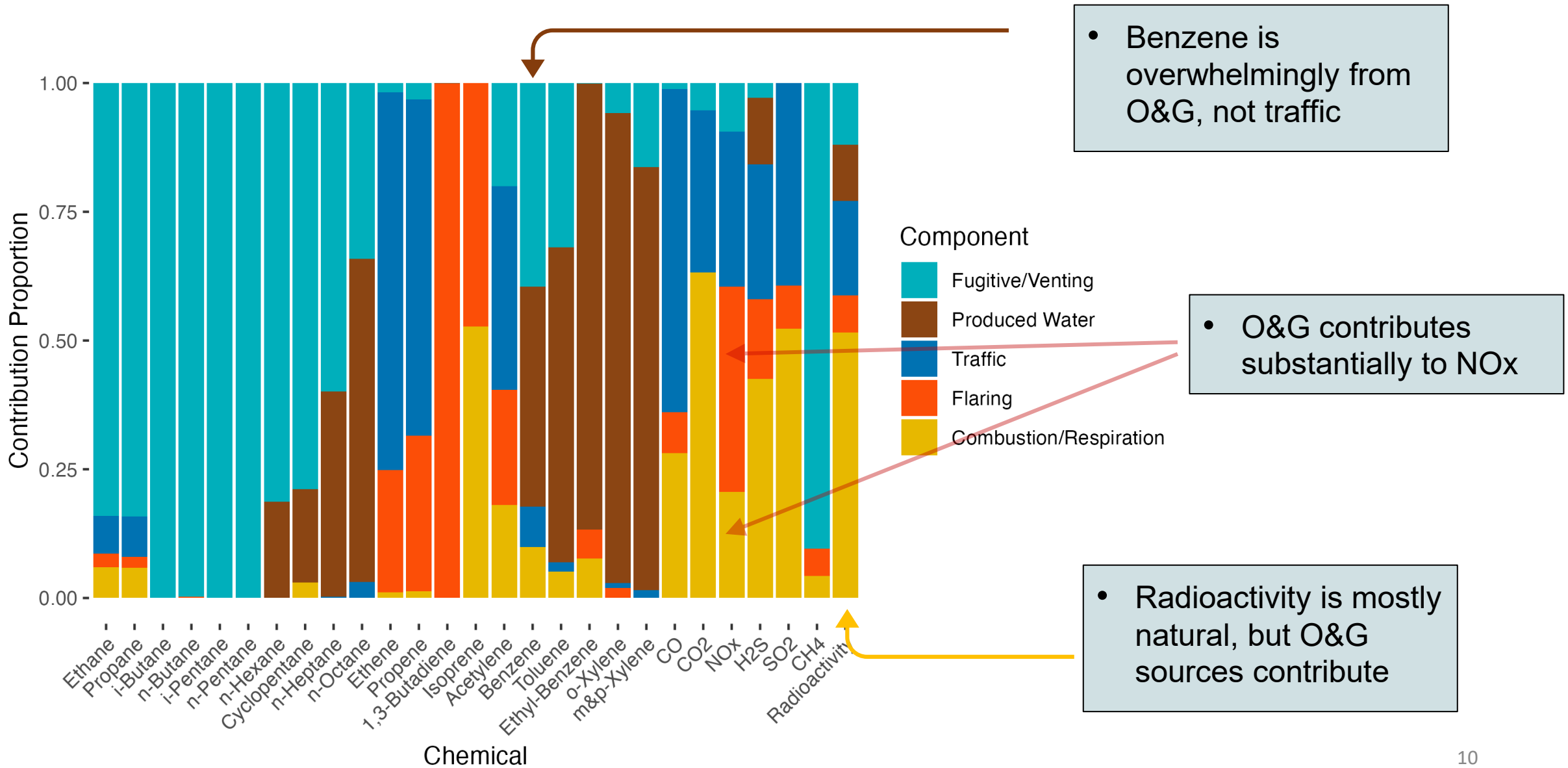
Flaring, high in alkenes, NO_x

Combustion/soil respiration, high in CO₂, radioactivity

- NMF 5-factor source profiles explained 95% of the overall variance in the data.
- Determined sources included:
 - O&G fugitive emissions
 - Produced water ponds (outgassing)
 - Traffic emissions
 - Flaring
 - Combustion from engines, turbines, compressors; soil emissions

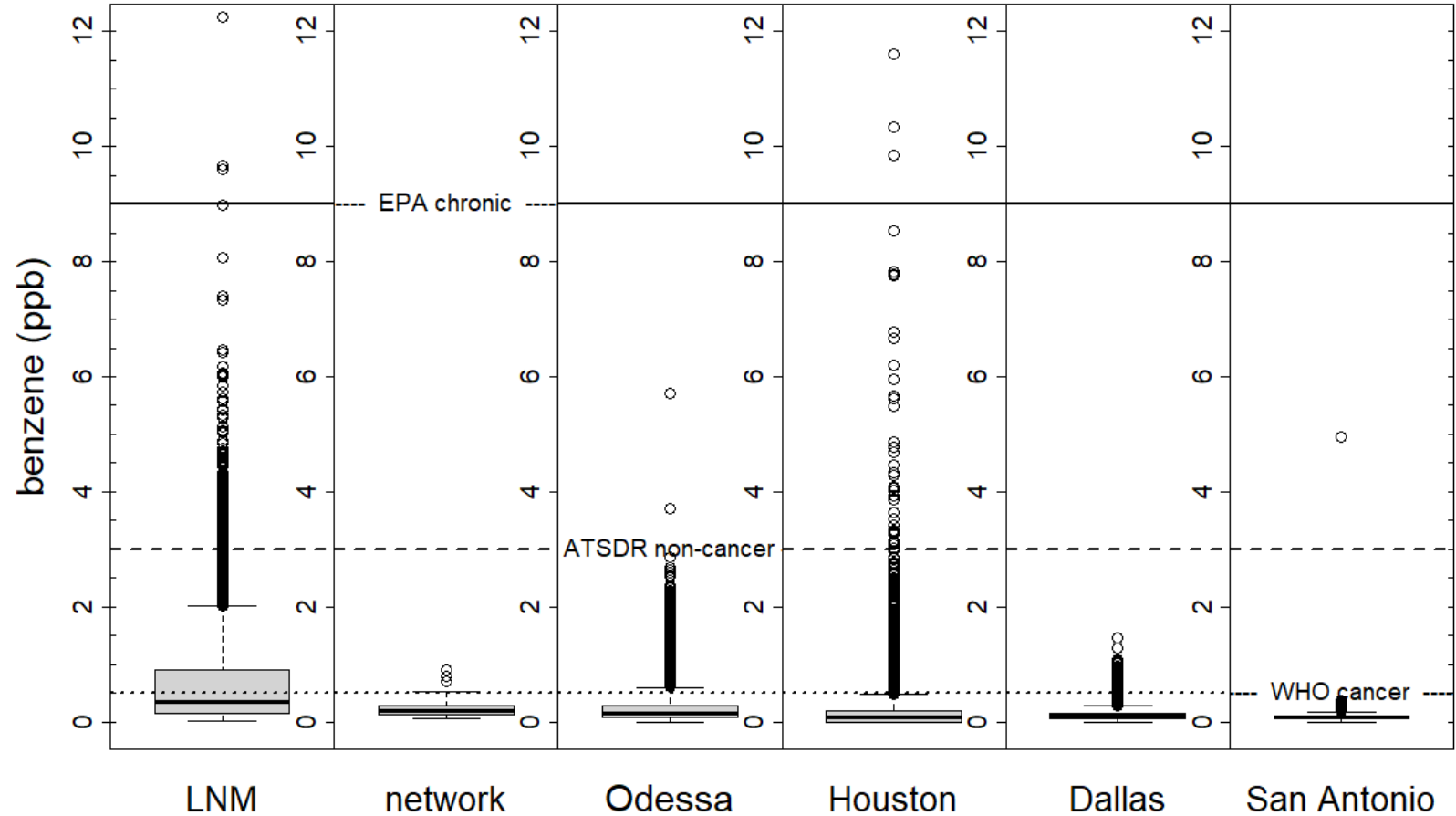
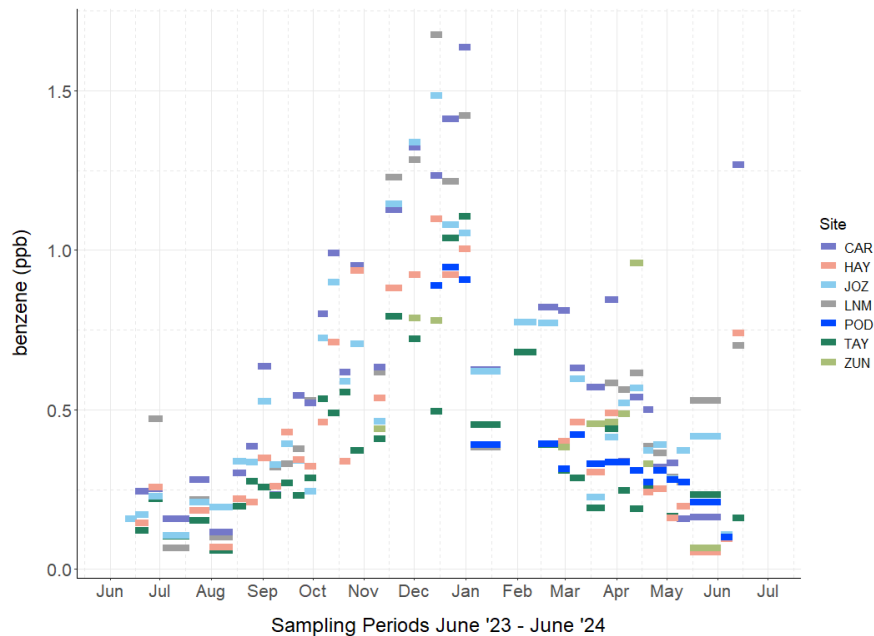


Chemical fingerprint



Benzene Temporal Trends and Comparisons

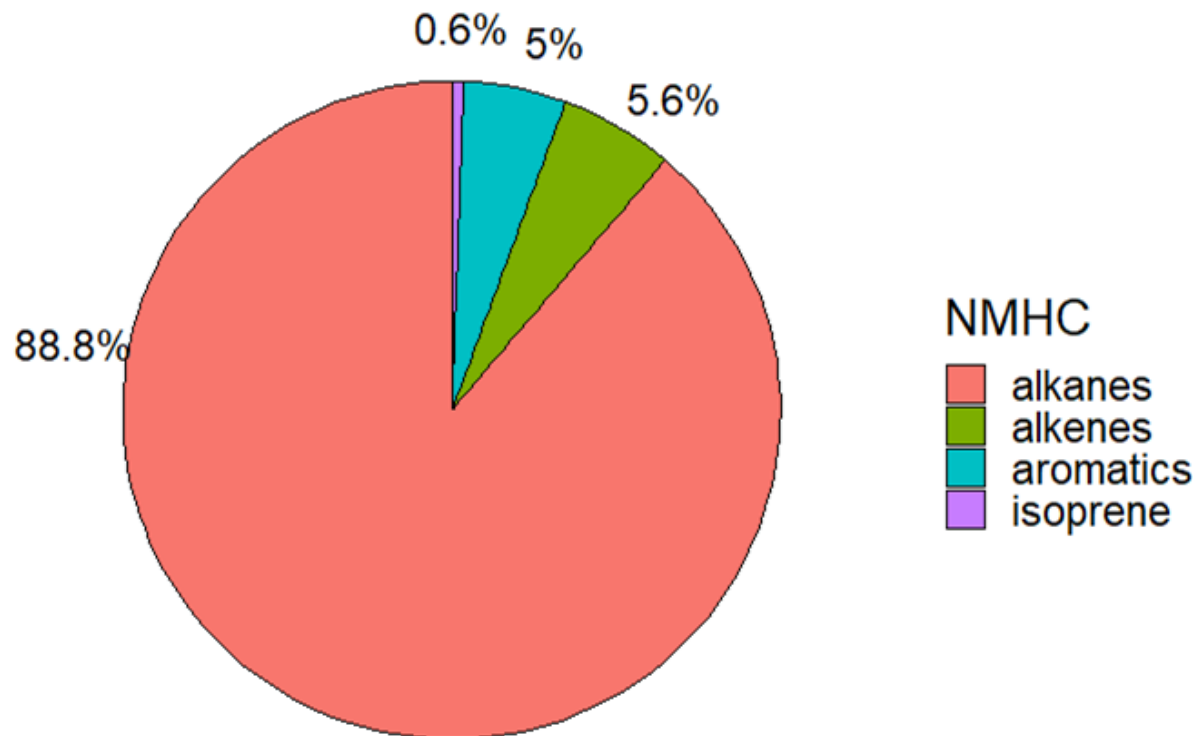
Seasonal changes of benzene abundances across the Permian Basin passive sampling sites.



Site-level benzene distributions comparing LNM to passive monitoring, and to urban sites in TX.

Non-Methane Hydrocarbons Drive Ozone Formation

Measured hydrocarbon OH radical reactivity
→ ozone formation potential

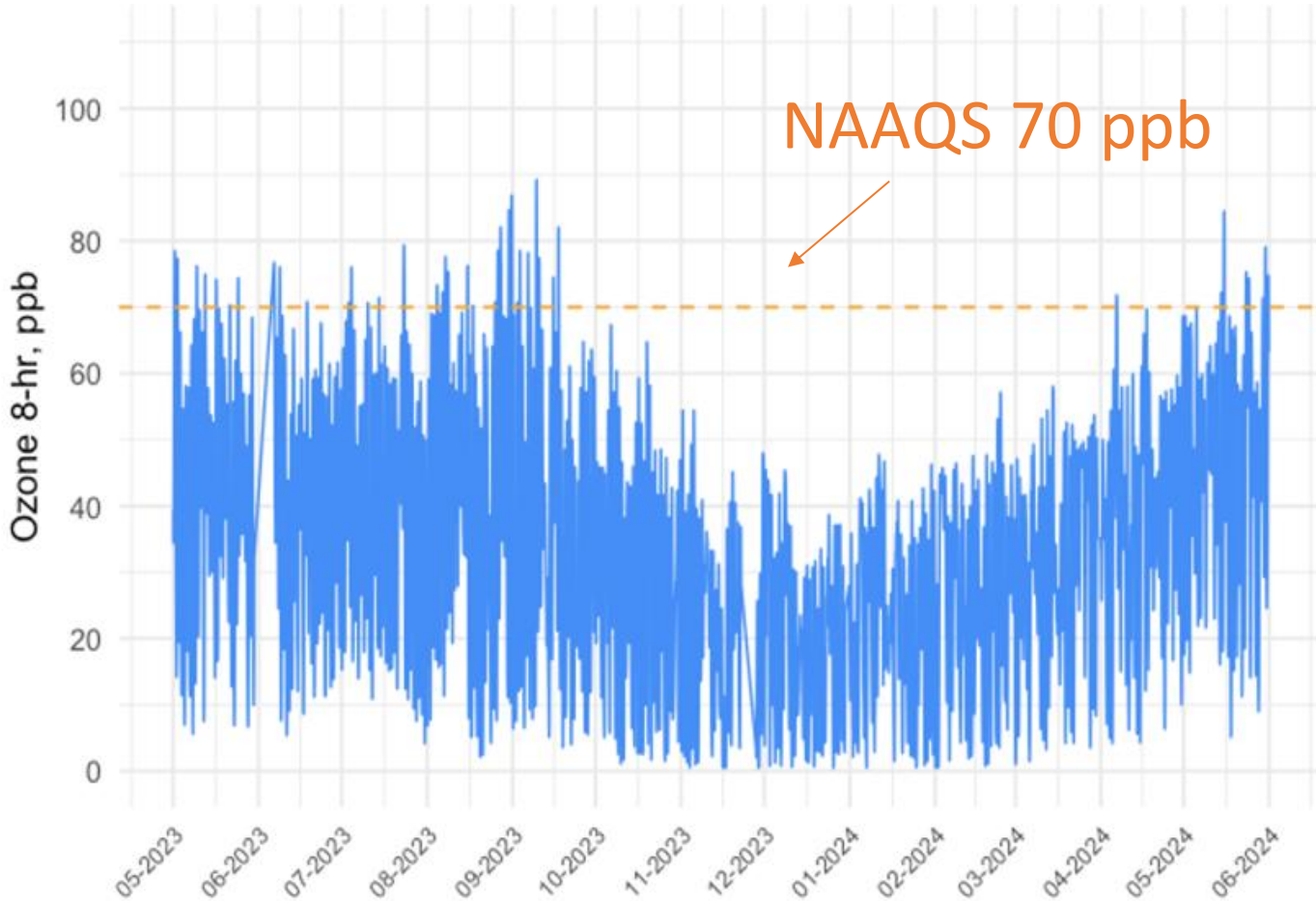


- The largest contributor to regional photochemical ozone formation is petroleum hydrocarbons.
- Combined, hydrocarbons associated with oil and gas production contribute more than 90% to the measured ozone formation potential.

Ozone is high ...

- During daytime, especially noon to 6 pm, mostly for clear-skies
- On spring and summer days, from April into October:
 - when it is dry, i.e. humidity is low
 - when temperatures exceed 90 deg F.
 - when winds are weak
 - and air moves slowly out of southerly to easterly directions
- Typically, since 2018, southeast NM has exceeded the 70-ppb threshold for ozone levels about 20-30 days each year
 - The annual, 4th-highest daily 8-h maximum enters the legal limit calculations for the National Ambient Air Quality Standard (NAAQS)

Ozone at LNM



8-Hour averaged data

39 days above the 70 ppb NAAQS
during our sampling period ('23-'24)

Split into calendar years:

2023: 31 days

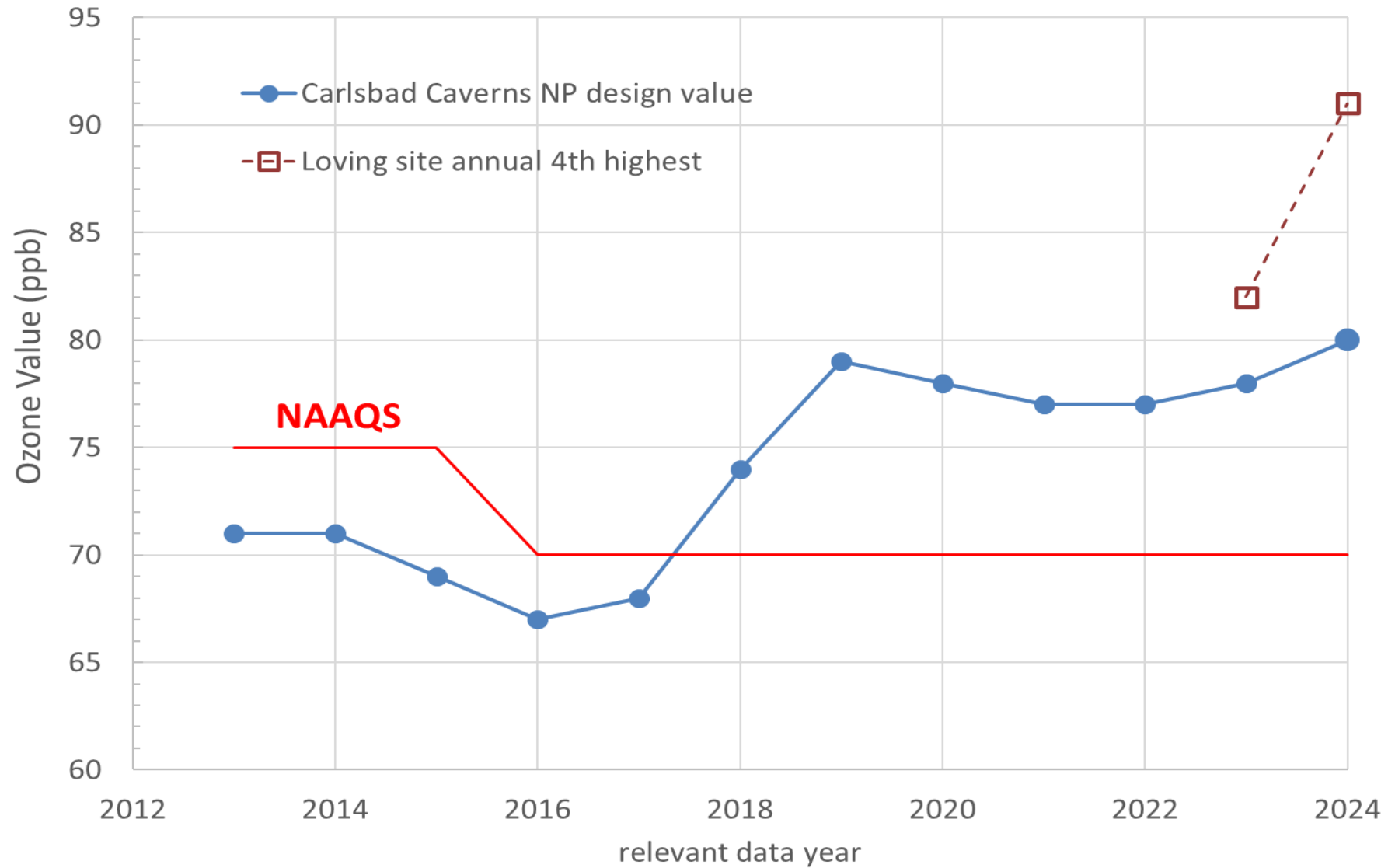
2024: 44 days

Days above the old NAAQS (75 ppb):

2023: 17 days

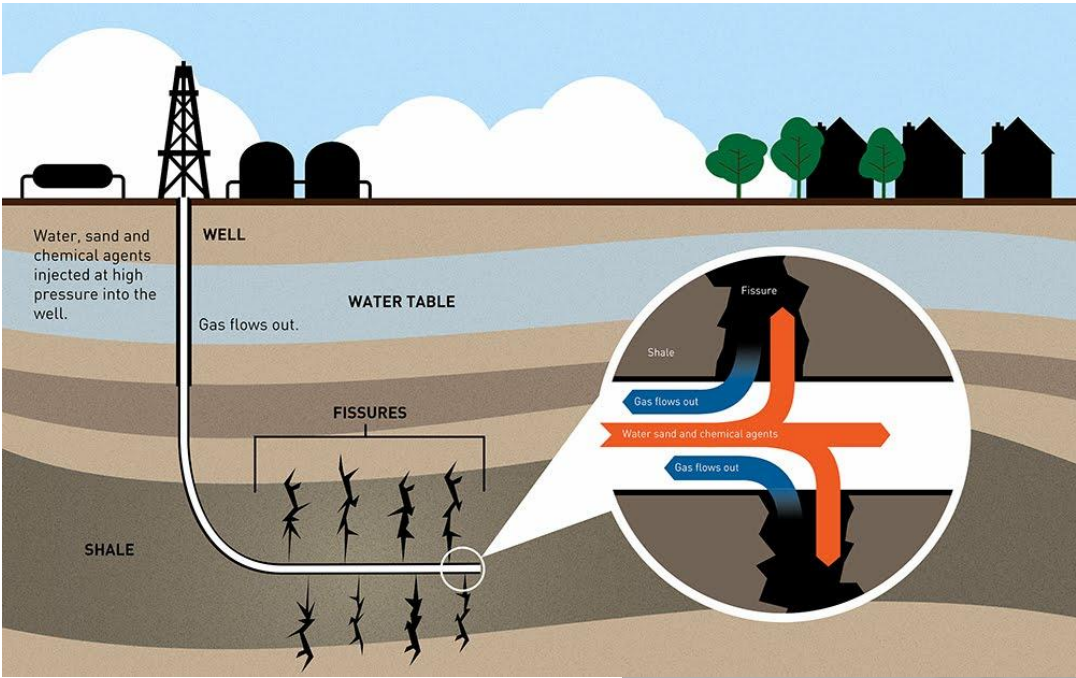
2024: 19 days

Ozone in SE New Mexico



Historic ozone design value development (blue dots and line) at the Carlsbad Caverns National Park site, used by EPA as the relevant regulatory reference site for southeast New Mexico.

Hydraulic Fracturing and Radioactivity Mobilization

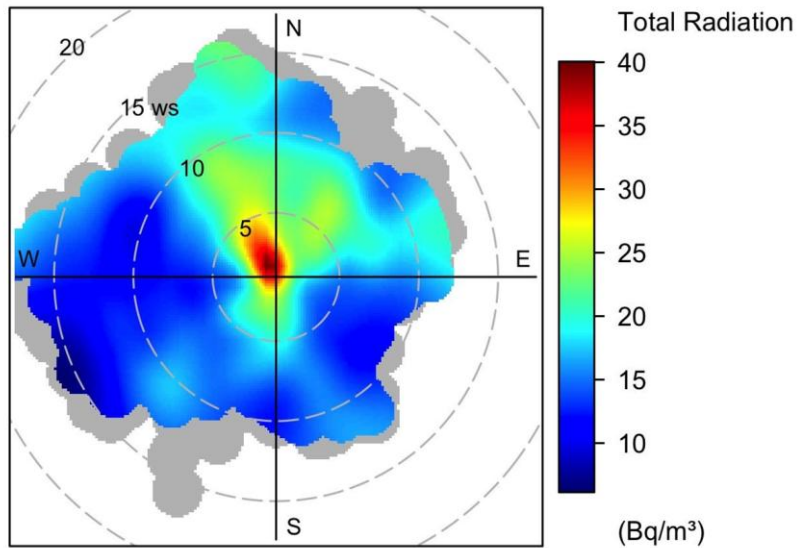


Methane (1-10%)
VOCs (1-10%)
CO, CO₂
NO_x
Radon (100%)



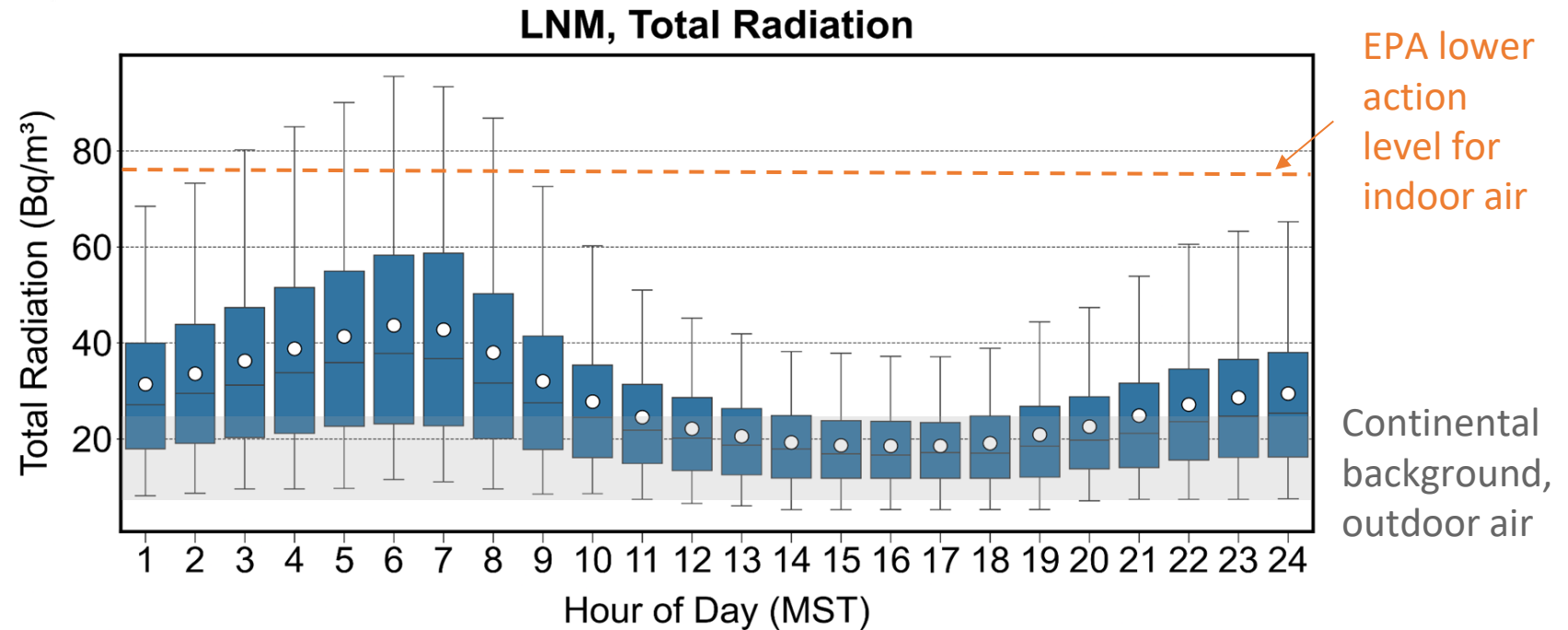
Methane
VOCs
Radon

Total Radioactivity at LNM



- Highest during low to moderate NW to NE winds.
- Winter values more variable and approximately 2x higher than in summer.

- Total radiation approx. two times typical background.
- Radiation builds up at night, 2-3 times higher during early morning hours.



Summary

- **Based on the continuous air monitoring in Loving, NM, 2023 through 2024:**
 - Oil and gas development completely dominates methane emissions in the area. Methane plumes are a good indicator for industry-related pollutant emissions.
 - Eddy County, NM has been exceeding the ozone NAAQS. Our and others' data suggest the regional ozone problem is largely due to very significant VOC and NOx emissions from O&G.
 - Comparing our data with other prior monitoring results suggests that ozone pollution levels are not decreasing, defying trends seen in most of the USA.
- **Stationary and distributed monitoring in the larger Carlsbad area suggests:**
 - High hydrocarbon levels, including air toxics such as benzene
 - strong seasonal changes in all hydrocarbons
 - concentrations are higher than in large metropolitan areas in TX and CO
 - levels increase with proximity and density to O&G exploration sites (data not shown here)