Bernalillo County Wood Burning Assessment

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Overview

- **Definitions**
- **What we know about wood burning**
  - Local impacts
  - Wood Burning Pollutants
  - Hazardous Air Pollutants
- **National Emission Inventory (NEI) Data**
  - Using the NEI to evaluate pollutants and pollution sources
- **Local Monitoring Data**
  - The Local Network
  - What do we see in the data?
- **Conclusion**
- **Potential next steps**
- **Open Discussion**

Definitions

- **What is Biomass?**
- Biomass is fuel that is developed from organic materials. Some examples of biomass fuels are:
  - **scrap lumber;**
  - **forest debris;**
  - certain crops;
  - manure; and
  - some types of waste residues.

https://www.reenergyholdings.com/renewable-energy/what-is-biomass/

- **For this Assessment biomass includes burning:**
  - wood for heat, cooking or ambiance
  - trash and construction waste
  - yard waste such as leaves, branches

- **What is PM$_{2.5}$?**
  - PM$_{2.5}$ is particulate matter 2.5 microns and smaller

HUMAN HAIR
50-70 μm *(microns)* in diameter

PM$_{2.5}$
Combustion particles, organic compounds, metals, etc.
< 2.5 μm *(microns)* in diameter

PM$_{10}$
Dust, pollen, mold, etc.
< 10 μm *(microns)* in diameter

90 μm *(microns)* in diameter
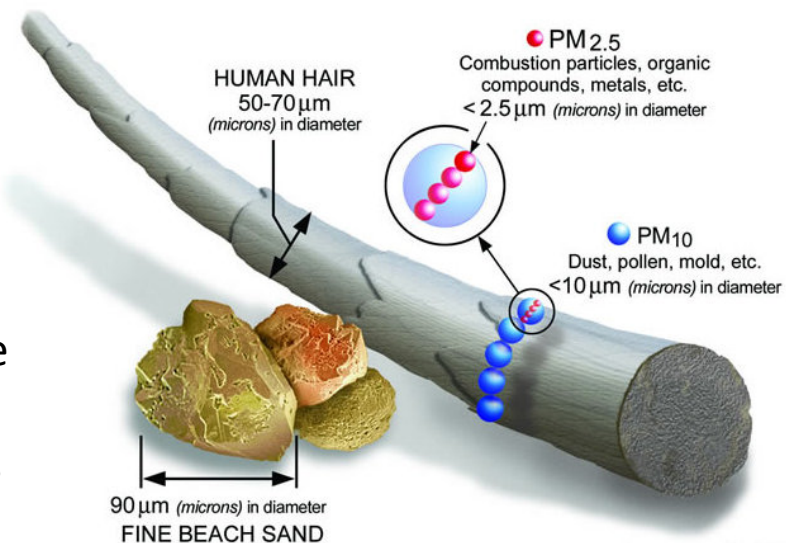FINE BEACH SAND

Image courtesy of the U.S. EPA

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What we know about Wood Burning

- **Wood burning impacts indoor air quality**
  - The NM Department of Health notes that "[d]uring the wintertime, residential wood smoke is the main source of fine particle pollution causing poor air quality inside the home." [1]
  - California ARB and EPA Study: ". . . Indicates that the indoor environment is not highly effective at reducing exposures to black carbon from residential wood smoke. . ."(page 93-94)[2]
- **Local data show increases in**
  - Pollutant values as the temperature decreases
    - Starts in October/November, Ends by April
  - Markers of biomass burning in the winter
    - Black Carbon (BC)
    - Potassium (K)
    - $PM_{2.5}$

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1. NM Department of Health, What You Burn Matters: Minimize the Risk, January 23, 2014, https://nmhealth.org/news/safety/2014/1/?view=32
2. "Assessing Near-Field Exposures from Distributed Residential Wood Smoke Combustion Sources", California Air Resources Board and California Environmental Protection Agency, Tracy Thatcher, Stella Tan, Christopher Malejan, and Courtney Ward, Civil and Environmental Engineering California Polytechnic State University. Thomas Kirchstetter Environmental Energy Technologies Division Lawrence Berkeley National Laboratory, September 2011.

Human Activities

- Wood burning
  - In 1985, 35,000-40,000 cords of wood were burned in Albuquerque[1]
    - Based on average weight = 100,000,000 to 184,000,000 lbs/season in 1985.
    - In 1986, 197,198 cords of wood were harvested in New Mexico[2]
  - National Forest Service alone saw a 12.3% increase in fuelwood harvested from 1986 to 2017[2]

Total cord harvest calculated from New Mexico forests only, Cibola, Gila, Lincoln, and Santa Fe National Forests.

National Forest Service Fuel Wood Harvest 1986-2017
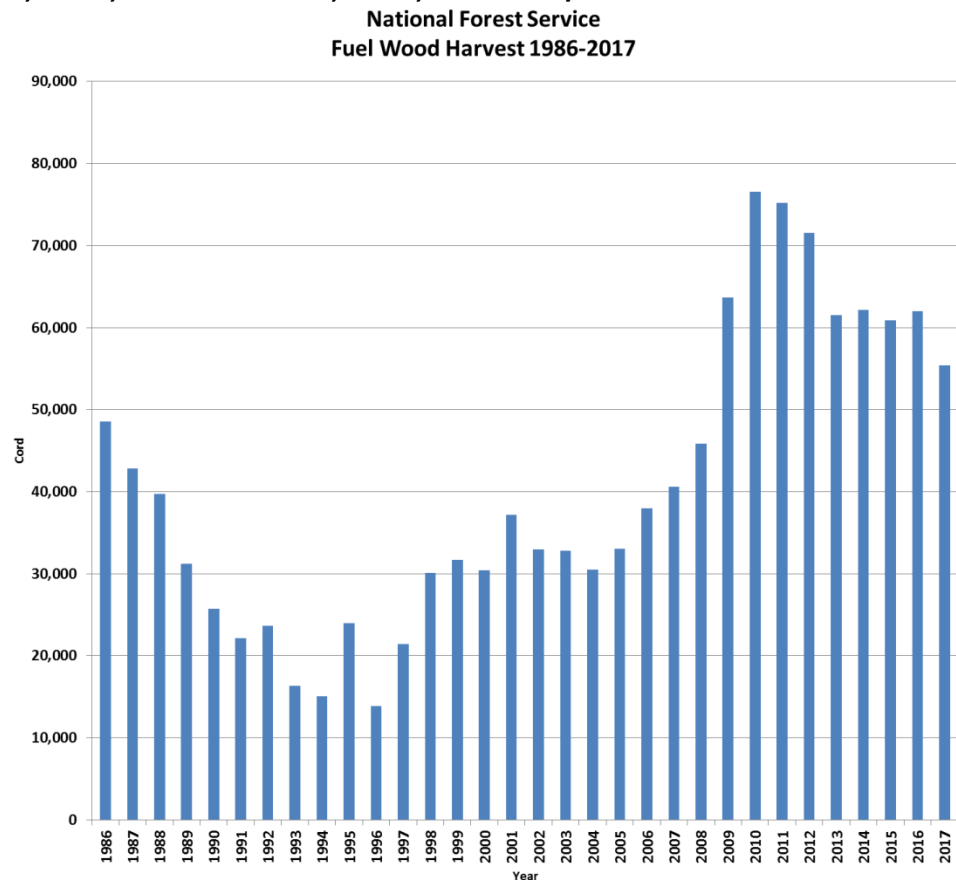
1. Residential Space Heating with Wood: Efficiency and Environmental Performance, Urban Consortium Energy Task Force, City of Albuquerque, Energy Management Division, December 1985.
2. New Mexico's 1986 Fuelwood Harvest., McLain, William H., United States Department of Agriculture Forest Service, Intermountain Research Station, April 1989, https://archive.org/stream/newmexicos1986fu60mcla#page/n3/mode/2up

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Population Growth

- 1985-2017 Bernalillo County grew 49.5%, Sandoval County grew 203.8%, Valencia County grew 107.3%

- The three counties added 359,147 residents from 1985-2017[1], growing from 536,073 to 895,220

- Commuting Time & Vehicle traffic

- Transport
  - what's coming in from outside the county

- Agricultural burning

- Other?

- If we use the Federal average the 3 Counties would have 86,836 wood burning households.[2]

1. https://factfinder.census.gov
2. https://www.eia.gov/todayinenergy/detail.php?id=15431

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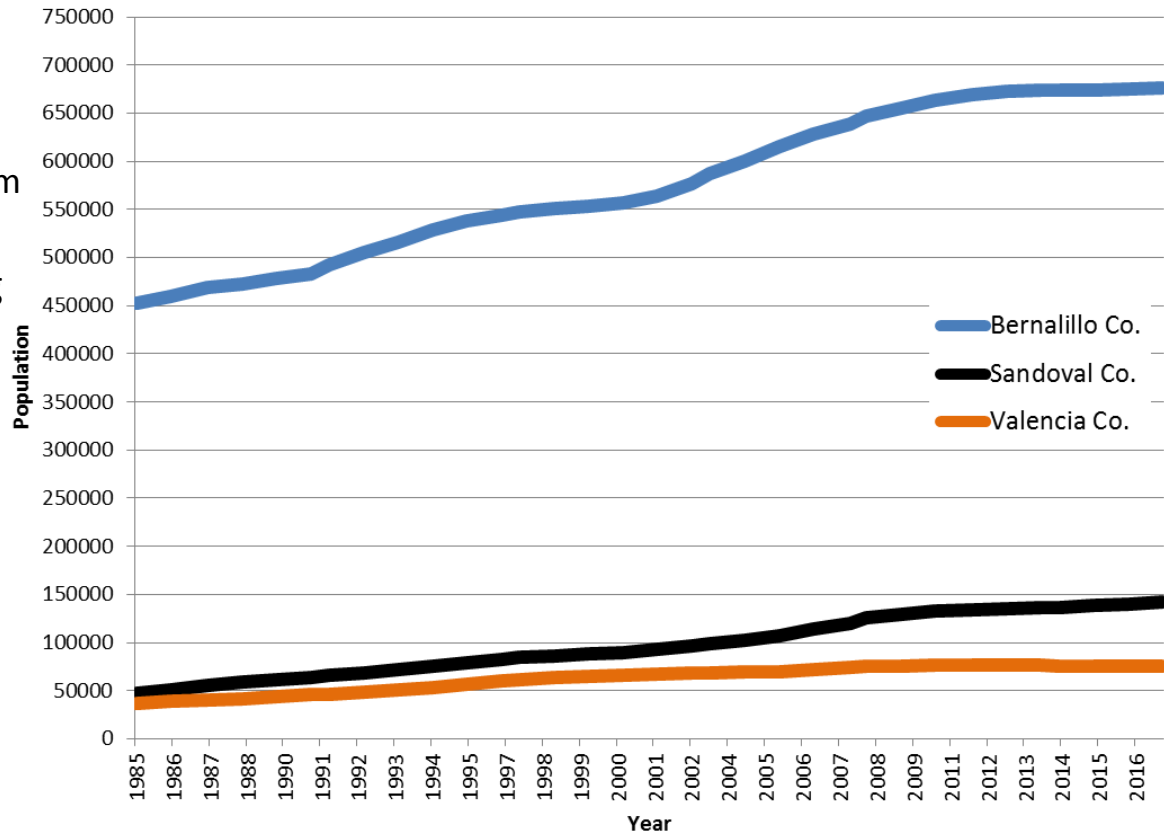
Wood Burning Pollution

- Molds* such as Thermoactinomyces vulgaris, Aspergillus fumigatus and Cladosporium herbarium

- 1993 EPA identified over 70 pollutants from wood burning[1]

  - **Trace elements including heavy metals such as chromium and lead**

  - **Polycyclic Aromatic Hydrocarbons (PAHs)**

    (PAHs) are a group of more than 100 different chemicals that are released from burning coal, oil, gasoline, trash, tobacco, wood, or other organic substances such as charcoal-broiled meat. (https://toxtown.nlm.nih.gov)

    - A Univ. of Stockholm, Sweden study found that ". . . wood-burning homes had . . . roughly 4 times the total PAH cancer potency, compared to non-wood-burning homes."[2]

* Interstitial Lung Disease and Domestic Wood Burning: Ramage, Roggli, bell and Piantadosi, AM REV RESPIR DIS 1988; 137:1229-1232
1. Emissions Characterization and Noncancer Respiratory Effects of Wood Smoke, Timothy V. Larson & Jane Q.Koenig, From Table 2, EPA-453/R-93-036, 46p. (US EPA December 1993)
2. Indoor Levels of Polycyclic Aromatic Hydrocarbons in Homes with or without Wood Burning for Heating, Pernilla Gustafson, Conny Östman and Gerd Sällsten, Department of Occupational and Environmental Medicine, Sahlgrenska Academy, University of Gothenburg, Gothenburg, Sweden, and Department of Analytical Chemistry, Stockholm University, Stockholm, Sweden, 2008

More about PAH

- One primary PAH is **Benzo(a)pyrene** which is produced from the incomplete combustion of organic matter.

  - A Norwegian Institute of Public Health study states: "Benzo(a)pyrene is the most carcinogenic PAH. . . the higher content of PAHs in the wood smoke particles indicates a higher mutagenic potential compared to vehicle exhaust."[1]

  - An EPA study estimates that wood stoves, on average, emit 432 µg/hour of benzo[a]pyrene.[2]

  - You would have to light 27,333 cigarettes to emit as much benzo(a)pyrene as burning one kilogram (2.2 lbs) of wood.[3] If you smoked one pack per day it would take 3.75 years to smoke 27,333 cigarettes.

1. Physicochemical characterisation of combustion particles from vehicle exhaust and residential wood smoke Anette Kocbach1, Yanjun Li, Karl E Yttri, Flemming R Cassee, Per E Schwarze1 and Ellen Namork, Division of Environmental Medicine, Norwegian Institute of Public Health, http://www.particleandfibretoxicology.com/content/3/1/1
2. LONG-TERM PERFORMANCE OF EPA-CERTIFIED PHASE 2 WOODSTOVES, KLAMATH FALLS AND PORTLAND OREGON: 1998-1999, EPA/600/R-00/100, November 2000
3. https://woodsmokepollution.org/toxins.html

Hazardous Air Pollutants

Pounds of Hazardous Air Pollutants per Cord of Wood Burned
Estimated at 1 cord = 2,500 pounds

40,000 cord = 270 tons (540,000 pounds)

40,000 cord = 198 tons (396,000 pounds)

40,000 cord = 80 tons (160,000 pounds)

Emissions Characterization and Noncancer Respiratory Effects of Wood Smoke, Timothy V. Larson & Jane Q. Koenig, From Table 2, EPA-453/R-93-036, 46p. (US EPA December 1993)

Legend:
- Maximum
- Minimum

Y-axis: Pounds (lbs), scale 0 to 14

Categories (x-axis): Aldehydes, Benzene*, Napthalene*, Toluene*, Phenol (and derivatives)*, Catechol (and derivatives), Formaldehyde*, Acetaldehyde*, Propionaldehyde, Acrolein*, Methyl chloride

* HAPs found under the Fuel Comb – Residential – Wood NEI Sector

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The National Emission Inventory (NEI)

- **What is the NEI**
  - a comprehensive and detailed estimate of air emissions of criteria pollutants, criteria precursors, and hazardous air pollutants from air emission sources.
  - Available to everyone at:
    - https://www.epa.gov/air-emissions-inventories/2014-national-emissions-inventory-nei-data
  - We can use the NEI to evaluate sources to help prioritize efforts to reduce pollutants from those sources.
    - For example, under Benzene, Agricultural Burning is a source category for Valencia and Sandoval but not for Bernalillo County.
  - The NEI identifies 33 hazardous air pollutants associated with Residential Wood fuel combustion.
  - Of the 17 fuel combustion sector sources Residential wood burning is 60.8% of the total sector.

What We Are Looking For

- How the **Fuel Comb–Residential–Wood** sector compares to the other NEI source sectors

- Keep in mind that part of the Fuel Comb–Residential–Wood sector is seasonal while the NEI is an annual estimate of emissions.

  - Seasonality of the wood burning may have a greater impact in the short term compared to what the NEI is presenting.

    - Benzene
    - Naphthalene
    - Formaldehyde
    - Acrolein
    - Benzo(a)pyrene

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Annual 2014 NEI Hazardous Air Pollutant Benzene Primary Sources

Top 5 sources are 87.5% of total NEI estimated emissions

Top 10 sources are 96.3% of total NEI estimated emissions

% of Total Pounds

Source	%
Mobile - On-Road Gasoline Light Duty...	45.056%
Mobile - Non-Road Equipment - Gasoline	28.503%
Fuel Comb - Residential - Wood	8.032%
Mobile - Non-Road Equipment - Diesel	3.118%
Miscellaneous Non-Industrial NEC	2.826%
Commercial Cooking	2.258%
Waste Disposal	2.014%
Mobile - On-Road Diesel Heavy Duty Vehicles	1.615%
Gas Stations	1.571%
Mobile - Aircraft	1.305%
Mobile - On-Road Gasoline Heavy Duty...	1.042%
Industrial Processes - Storage and Transfer	1.002%
Fires - Prescribed Fires	0.557%
Bulk Gasoline Terminals	0.532%
Fires - Wildfires	0.175%
Solvent - Consumer & Commercial Solvent...	0.138%
Mobile - On-Road Diesel Light Duty Vehicles	0.137%
Fuel Comb - Industrial Boilers, ICEs - Oil	0.049%
Fuel Comb - Industrial Boilers, ICEs - Natural...	0.026%
Mobile - Non-Road Equipment - Other	0.016%
Fuel Comb - Residential - Natural Gas	0.010%
Fuel Comb - Electric Generation - Oil	0.005%
Fuel Comb - Comm/Institutional - Natural Gas	0.004%
Industrial Processes - Petroleum Refineries	0.003%
Mobile - Locomotives	0.003%
Fuel Comb - Electric Generation - Natural Gas	0.002%
Fuel Comb - Residential - Other	0.000%
Fuel Comb - Industrial Boilers, ICEs - Other	0.000%
Fuel Comb - Comm/Institutional - Other	0.000%
Solvent - Industrial Surface Coating &...	0.000%
Fuel Comb - Comm/Institutional - Oil	0.000%
Fuel Comb - Residential - Oil	0.000%

In the area around Klamath Falls (population approximately 21,200), Oregon, wood stoves are estimated to emit eight tons of benzene during the wood burning season . . .

[I]f all the wood burning appliances were to be changed to non-wood-burning heating sources, benzene emissions from residential heating would be near zero.

Fact Sheet, Air Toxics monitoring in Klamath Falls, Oregon DEQ, 2014,http://www.oregon.gov/deq/FilterDocs/FSKlamathFallsAirToxics.pdf

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Annual 2014 NEI Hazardous Air Pollutant Naphthalene Primary Sources

Top 5 sources are 93.3% of total NEI estimated emissions

Top 10 sources are 99% of the total emissions
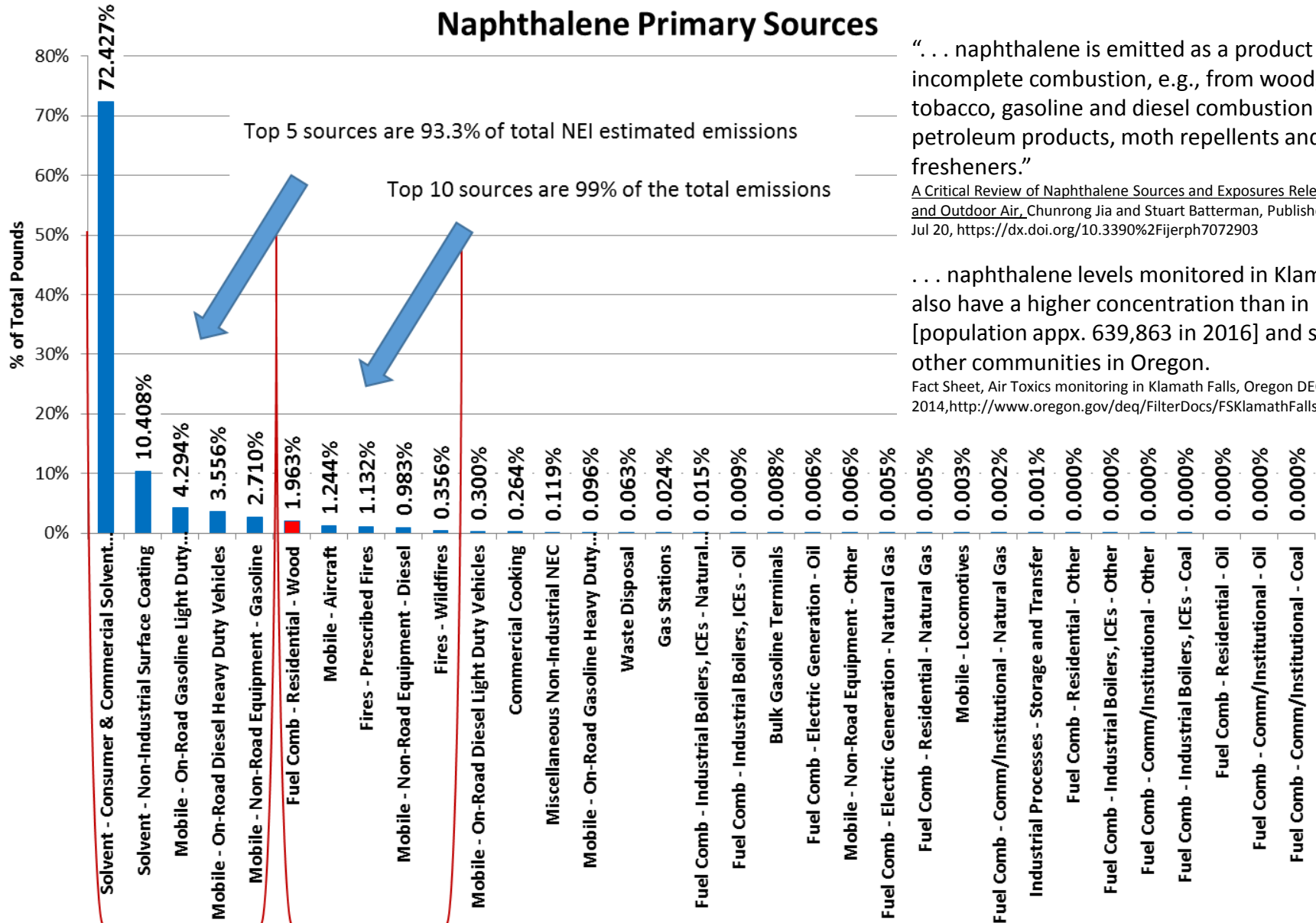
"... naphthalene is emitted as a product of incomplete combustion, e.g., from wood, straw, tobacco, gasoline and diesel combustion ... petroleum products, moth repellents and air fresheners."
A Critical Review of Naphthalene Sources and Exposures Relevant to Indoor and Outdoor Air, Chunrong Jia and Stuart Batterman, Published online 2010 Jul 20, https://dx.doi.org/10.3390%2Fijerph7072903

... naphthalene levels monitored in Klamath Falls also have a higher concentration than in Portland [population appx. 639,863 in 2016] and several other communities in Oregon.
Fact Sheet, Air Toxics monitoring in Klamath Falls, Oregon DEQ, 2014,http://www.oregon.gov/deq/FilterDocs/FSKlamathFallsAirToxics.pdf

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Annual 2014 NEI Hazardous Air Pollutant Formaldehyde Primary Sources

Top 5 sources are 88.3% of total NEI estimated emissions

Top 10 sources are 97.6% of total NEI estimated emissions

Source	% of Total Pounds
Biogenics - Vegetation and Soil	68.990%
Mobile - Non-Road Equipment - Diesel	7.050%
Mobile - On-Road Diesel Heavy Duty Vehicles	5.391%
Mobile - On-Road Gasoline Light Duty Vehicles	3.956%
Fuel Comb - Residential - Wood	2.981%
Mobile - Aircraft	2.738%
Fuel Comb - Electric Generation - Other	2.667%
Mobile - Non-Road Equipment - Gasoline	2.262%
Fires - Prescribed Fires	0.945%
Mobile - Non-Road Equipment - Other	0.689%
Commercial Cooking	0.546%
Mobile - On-Road Diesel Light Duty Vehicles	0.448%
Fuel Comb - Industrial Boilers, ICEs - Natural Gas	0.300%
Fires - Wildfires	0.297%
Miscellaneous Non-Industrial NEC	0.281%
Mobile - On-Road Gasoline Heavy Duty Vehicles	0.222%
Fuel Comb - Residential - Natural Gas	0.104%
Fuel Comb - Comm/Institutional - Natural Gas	0.045%
Fuel Comb - Electric Generation - Natural Gas	0.031%
Fuel Comb - Industrial Boilers, ICEs - Oil	0.022%
Mobile - Locomotives	0.014%
Fuel Comb - Electric Generation - Oil	0.008%
Fuel Comb - Residential - Other	0.004%
Fuel Comb - Comm/Institutional - Other	0.003%
Industrial Processes - Storage and Transfer	0.002%
Solvent - Non-Industrial Surface Coating	0.001%
Fuel Comb - Industrial Boilers, ICEs - Other	0.001%
Fuel Comb - Industrial Boilers, ICEs - Coal	0.000%
Fuel Comb - Residential - Oil	0.000%
Waste Disposal	0.000%
Fuel Comb - Comm/Institutional - Oil	0.000%
Solvent - Industrial Surface Coating & Solvent Use	0.000%
Fuel Comb - Comm/Institutional - Coal	0.000%

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Annual 2014 NEI Hazardous Air Pollutant Acrolein Primary Sources

Top 5 sources are 84.8% of total NEI estimated emissions

Top 10 sources are 98.9% of total NEI estimated emissions
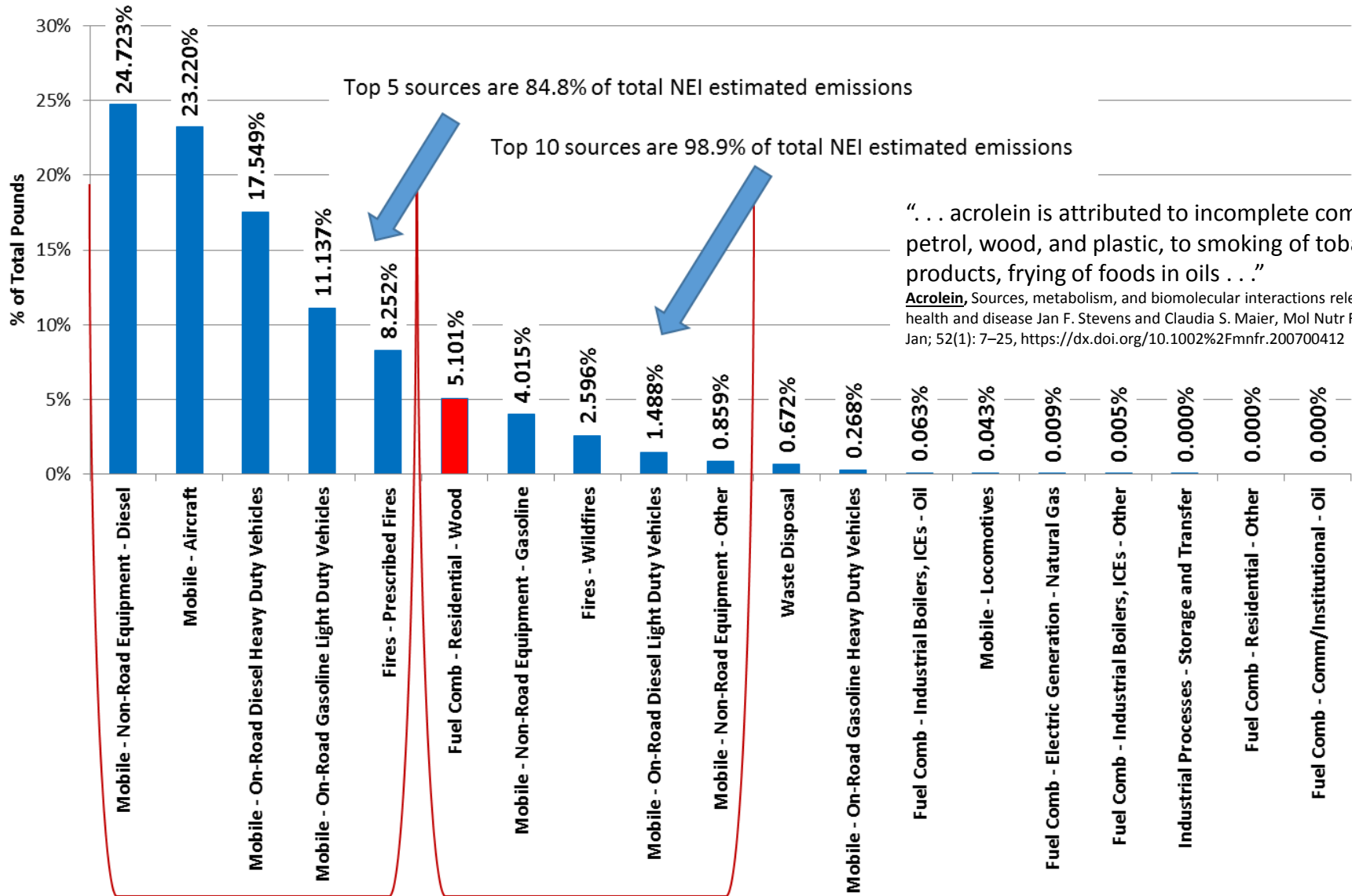
". . . acrolein is attributed to incomplete combustion of petrol, wood, and plastic, to smoking of tobacco products, frying of foods in oils . . ."

Acrolein, Sources, metabolism, and biomolecular interactions relevant to human health and disease Jan F. Stevens and Claudia S. Maier, Mol Nutr Food Res. 2008 Jan; 52(1): 7–25, https://dx.doi.org/10.1002%2Fmnfr.200700412

% of Total Pounds

Source	%
Mobile - Non-Road Equipment - Diesel	24.723%
Mobile - Aircraft	23.220%
Mobile - On-Road Diesel Heavy Duty Vehicles	17.549%
Mobile - On-Road Gasoline Light Duty Vehicles	11.137%
Fires - Prescribed Fires	8.252%
Fuel Comb - Residential - Wood	5.101%
Mobile - Non-Road Equipment - Gasoline	4.015%
Fires - Wildfires	2.596%
Mobile - On-Road Diesel Light Duty Vehicles	1.488%
Mobile - Non-Road Equipment - Other	0.859%
Waste Disposal	0.672%
Mobile - On-Road Gasoline Heavy Duty Vehicles	0.268%
Fuel Comb - Industrial Boilers, ICEs - Oil	0.063%
Mobile - Locomotives	0.043%
Fuel Comb - Electric Generation - Natural Gas	0.009%
Fuel Comb - Industrial Boilers, ICEs - Other	0.005%
Industrial Processes - Storage and Transfer	0.000%
Fuel Comb - Residential - Other	0.000%
Fuel Comb - Comm/Institutional - Oil	0.000%

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Annual 2014 NEI Hazardous Air Pollutant Benzo(a)pyrene Primary Sources

Top 5 sources are 93.3% of total NEI estimated emissions

Top 10 sources are 99.1% of total NEI estimated emissions
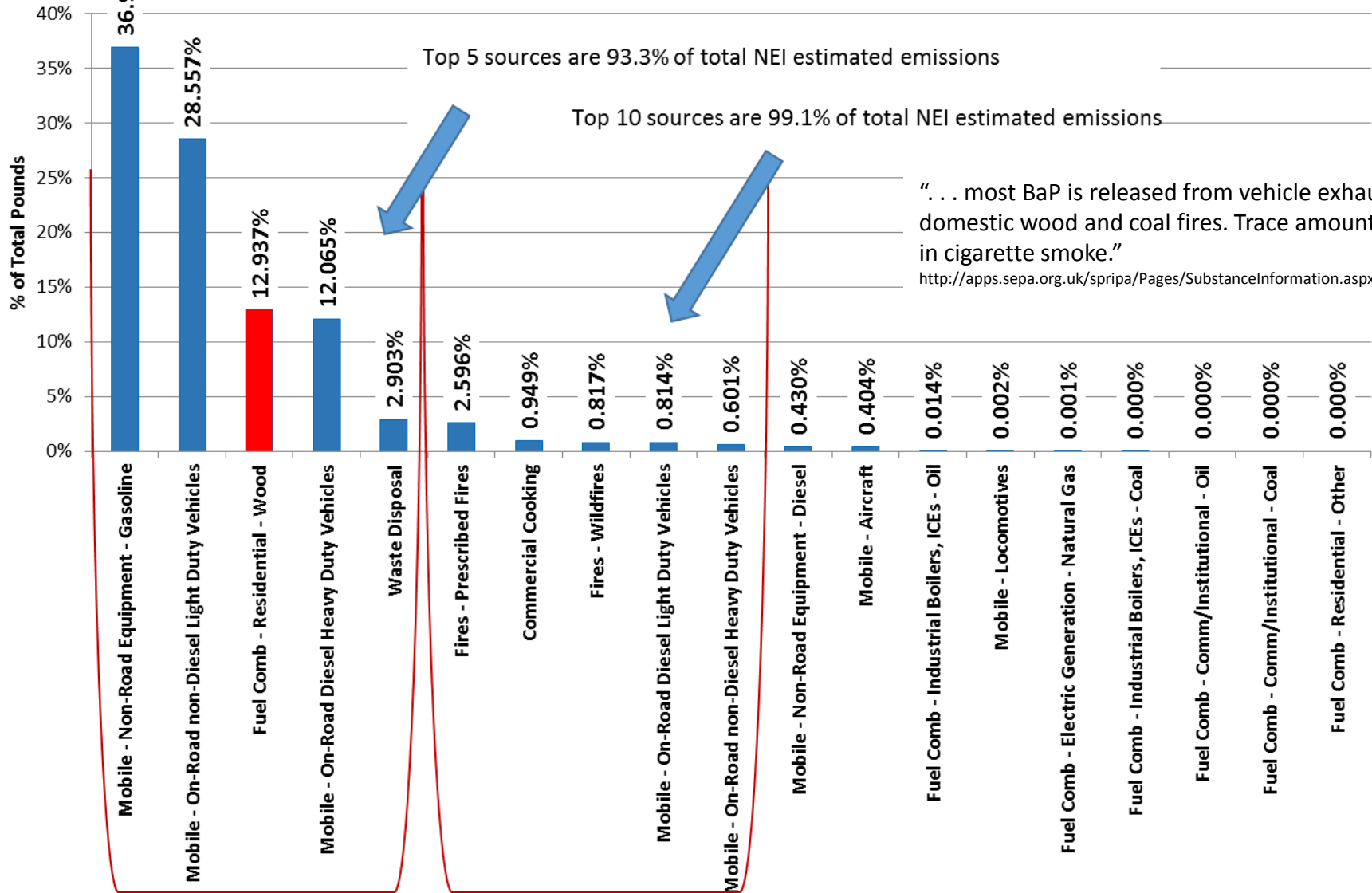
". . . most BaP is released from vehicle exhausts and domestic wood and coal fires. Trace amounts are found in cigarette smoke."
http://apps.sepa.org.uk/spripa/Pages/SubstanceInformation.aspx?pid=22

% of Total Pounds

| Source	%
Mobile - Non-Road Equipment - Gasoline	36.911%
Mobile - On-Road non-Diesel Light Duty Vehicles	28.557%
Fuel Comb - Residential - Wood	12.937%
Mobile - On-Road Diesel Heavy Duty Vehicles	12.065%
Waste Disposal	2.903%
Fires - Prescribed Fires	2.596%
Commercial Cooking	0.949%
Fires - Wildfires	0.817%
Mobile - On-Road Diesel Light Duty Vehicles	0.814%
Mobile - On-Road non-Diesel Heavy Duty Vehicles	0.601%
Mobile - Non-Road Equipment - Diesel	0.430%
Mobile - Aircraft	0.404%
Fuel Comb - Industrial Boilers, ICEs - Oil	0.014%
Mobile - Locomotives	0.002%
Fuel Comb - Electric Generation - Natural Gas	0.001%
Fuel Comb - Industrial Boilers, ICEs - Coal	0.000%
Fuel Comb - Comm/Institutional - Oil	0.000%
Fuel Comb - Comm/Institutional - Coal	0.000%
Fuel Comb - Residential - Other	0.000%

Additional Hazardous Air Pollutants

- There are 28 additional Hazardous Air Pollutants found under the **Fuel Comb–Residential–Wood** NEI Sector

NEI Pollutant	Rank of Fuel Comb - Residential - Wood	% of all Source Categories		
Cresol/Cresylic Acid (Mixed Isomers)	1	90.9%		
o-Xylene	1	59.8%		
Phenol	1	45.8%		
Acenaphthylene	1	31.1%		
Benzo[e]Pyrene	2	35.7%		
Perylene	2	31.2%		
Benzo(a)Fluoranthene	2	23.6%	18 are in the top 5	
Phenanthrene	2	16.5%		
Anthracene	3	12.8%		
1,3-Butadiene	3	6.8%		
Methylchrysene	3	1.8%		
Benzo[b]Fluoranthene	4	6.5%		
Benzo[k]Fluoranthene	4	5.5%		
Dibenzo[a,h]Anthracene	5	11.1%		24 are in the top 10
Fluorene	5	9.3%		
Acenaphthene	5	8.6%		
Indeno[1,2,3-c,d]Pyrene	5	3.1%		
Mercury	5	2.4%		
Benz[a]Anthracene	6	3.1%		
Acetaldehyde	6	1.5%		
Manganese	6	0.3%		
Cadmium	6	0.1%		
Chrysene	7	3.6%		
Benzo[g,h,i,]Perylene	7	0.6%		
Fluoranthene	11	0.6%		
Pyrene	11	0.4%		
Nickel	12	0.1%		
Toluene	14	0.4%		

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Local Monitoring Data

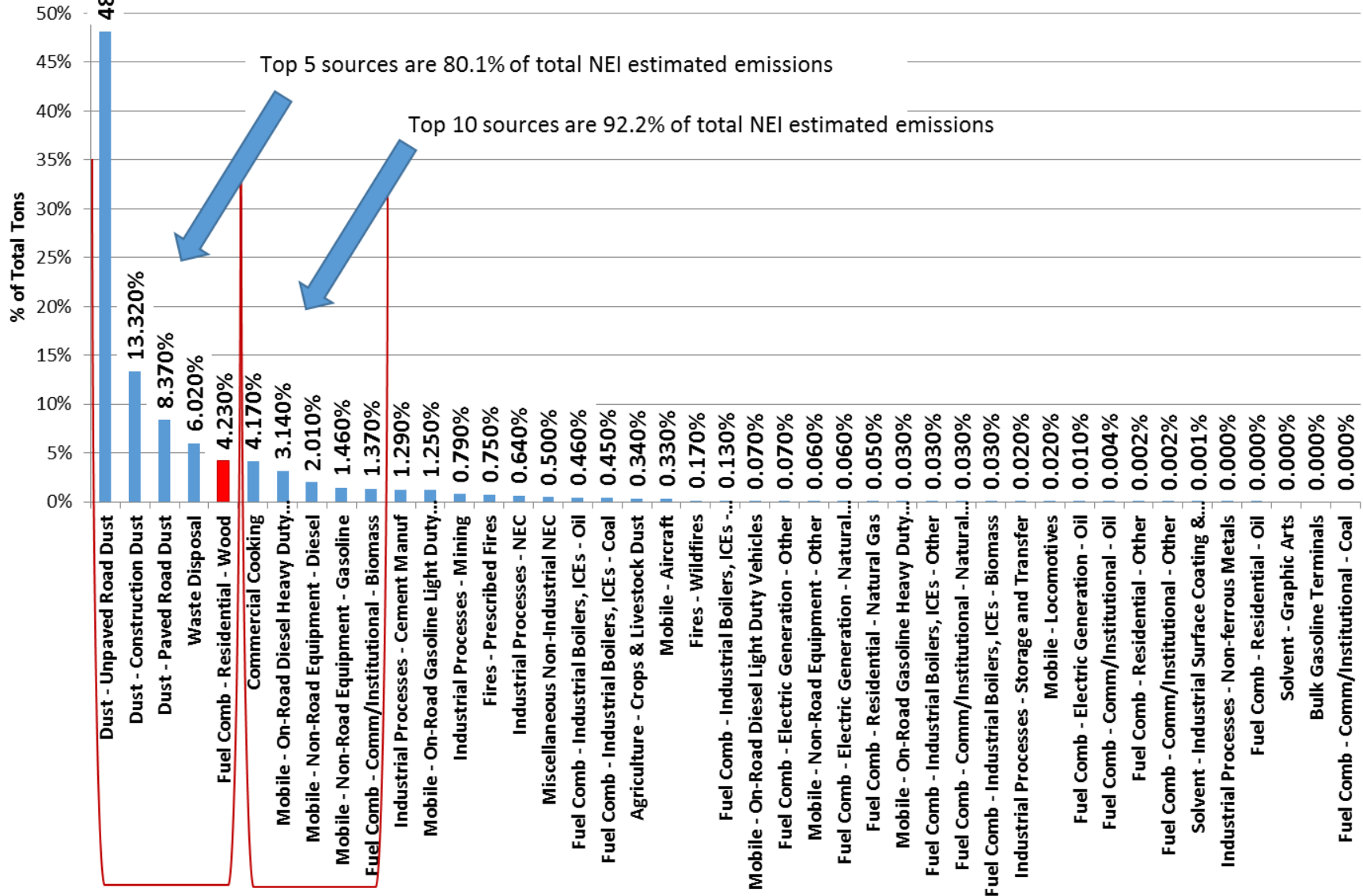| Site	Del Norte (2ZM)	South Valley (2ZV)	Far NE Heights (2ZF)
PM2.5 Hourly	X	X	X
Black Carbon Hourly	X	X	X
Potassium 24 hour, one sample every 3rd day	X		
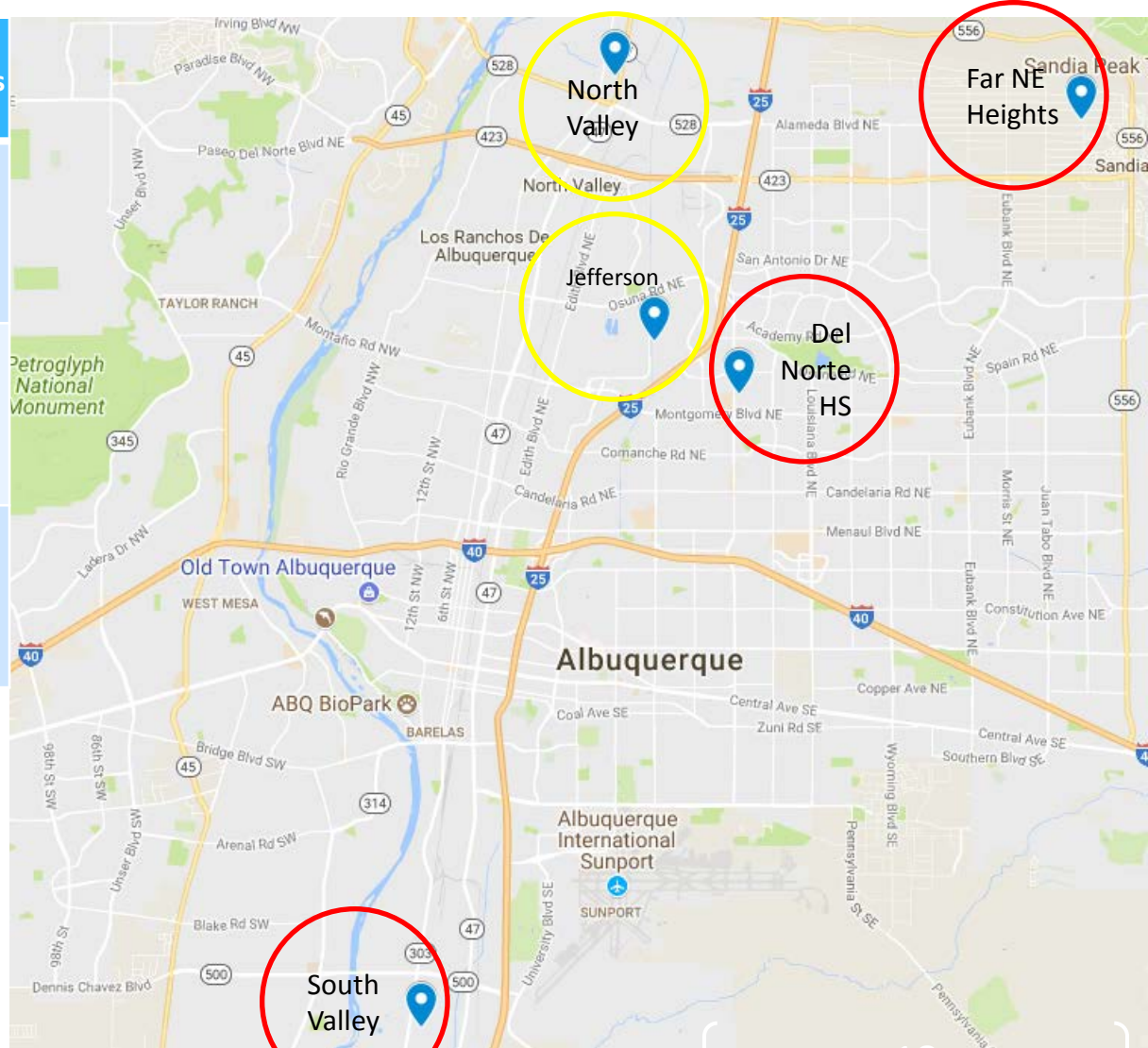
- North Valley and Jefferson started PM$_{2.5}$ this year.
- As of 2018 Bernalillo County has 5 PM$_{2.5}$ sites, this is **50%** of all the PM$_{2.5}$ monitors in New Mexico.

What We Are Looking For

- Increased markers of $PM_{2.5}$, Black Carbon and Potassium during the winter time wood burning season

- Late evening and early morning increases in these wood burning markers
  - Indicates wood burning activities after the evening and before the morning commuting time period

- Increased frequency in EHD's email alerts
  - winter period (Dec. 2016-Jan. 2017) EHD had 165 email alerts
  - summer period (June-July 2017) EHD had 50 email alerts.

Annual 2014 NEI Criteria Air Pollutant PM$_{2.5}$ Primary Sources

Top 5 sources are 80.1% of total NEI estimated emissions

Top 10 sources are 92.2% of total NEI estimated emissions

% of Total Tons

Source	%
Dust - Unpaved Road Dust	48.170%
Dust - Construction Dust	13.320%
Dust - Paved Road Dust	8.370%
Waste Disposal	6.020%
Fuel Comb - Residential - Wood	4.230%
Commercial Cooking	4.170%
Mobile - On-Road Diesel Heavy Duty...	3.140%
Mobile - Non-Road Equipment - Diesel	2.010%
Mobile - Non-Road Equipment - Gasoline	1.460%
Fuel Comb - Comm/Institutional - Biomass	1.370%
Industrial Processes - Cement Manuf	1.290%
Mobile - On-Road Gasoline Light Duty...	1.250%
Industrial Processes - Mining	0.790%
Fires - Prescribed Fires	0.750%
Industrial Processes - NEC	0.640%
Miscellaneous Non-Industrial NEC	0.500%
Fuel Comb - Industrial Boilers, ICEs - Oil	0.460%
Fuel Comb - Industrial Boilers, ICEs - Coal	0.450%
Agriculture - Crops & Livestock Dust	0.340%
Mobile - Aircraft	0.330%
Fires - Wildfires	0.170%
Fuel Comb - Industrial Boilers, ICEs -...	0.130%
Mobile - On-Road Diesel Light Duty Vehicles	0.070%
Fuel Comb - Electric Generation - Other	0.070%
Mobile - Non-Road Equipment - Other	0.060%
Fuel Comb - Electric Generation - Natural...	0.060%
Fuel Comb - Residential - Natural Gas	0.050%
Mobile - On-Road Gasoline Heavy Duty...	0.030%
Fuel Comb - Industrial Boilers, ICEs - Other	0.030%
Fuel Comb - Comm/Institutional - Natural...	0.030%
Fuel Comb - Industrial Boilers, ICEs - Biomass	0.030%
Industrial Processes - Storage and Transfer	0.020%
Mobile - Locomotives	0.020%
Fuel Comb - Electric Generation - Oil	0.010%
Fuel Comb - Comm/Institutional - Oil	0.004%
Fuel Comb - Residential - Other	0.002%
Fuel Comb - Comm/Institutional - Other	0.002%
Solvent - Industrial Surface Coating &...	0.001%
Industrial Processes - Non-ferrous Metals	0.000%
Fuel Comb - Residential - Oil	0.000%
Solvent - Graphic Arts	0.000%
Bulk Gasoline Terminals	0.000%
Fuel Comb - Comm/Institutional - Coal	0.000%

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What did we see in the data

- **44.6% average increase in PM$_{2.5}$** from summer to winter (excl. Foothills)

2015-2016 data	Del Norte HS Average µg/m³	South Valley Average µg/m³	Foothills Average µg/m³
Summer (Mar-Aug)	4.7	5.5	5.3
Winter (Sep-Feb)	6.5	8.3	4.7
% Increase	**38.3%**	**50.9%**	**-11.3%**

- **104% average increase in Black Carbon** from summer to winter (excl. Foothills)

2015-2016 data	Del Norte HS Average µg/m³	South Valley Average µg/m³	Foothills Average µg/m³
Summer (Mar-Aug)	0.280	0.406	0.144
Winter (Sep-Feb)	0.567	0.835	0.223
% Increase	**102.5%**	**105.6%**	54.9%

- **101.3% increase** in **Potassium** from summer to winter

2015-2016 data, Del Norte HS	Average Potassium µg/m³
Summer (Mar-Aug)	0.0169
Winter (Sep-Feb)	0.0339
% Increase	**101.3%**

Potassium corrected to remove crustal portion

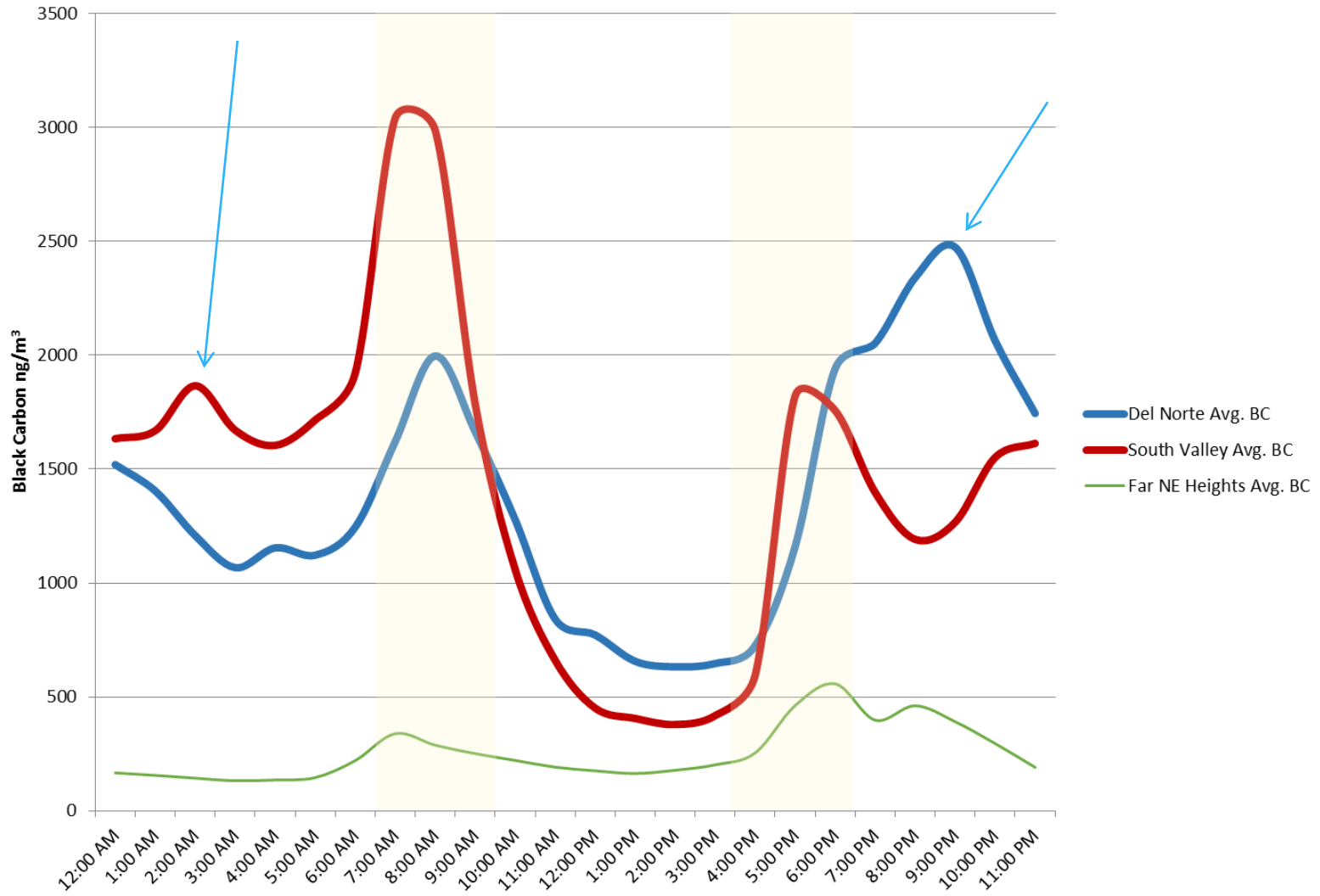# What did we see in the data

- Evening and early morning impact on fine particulates
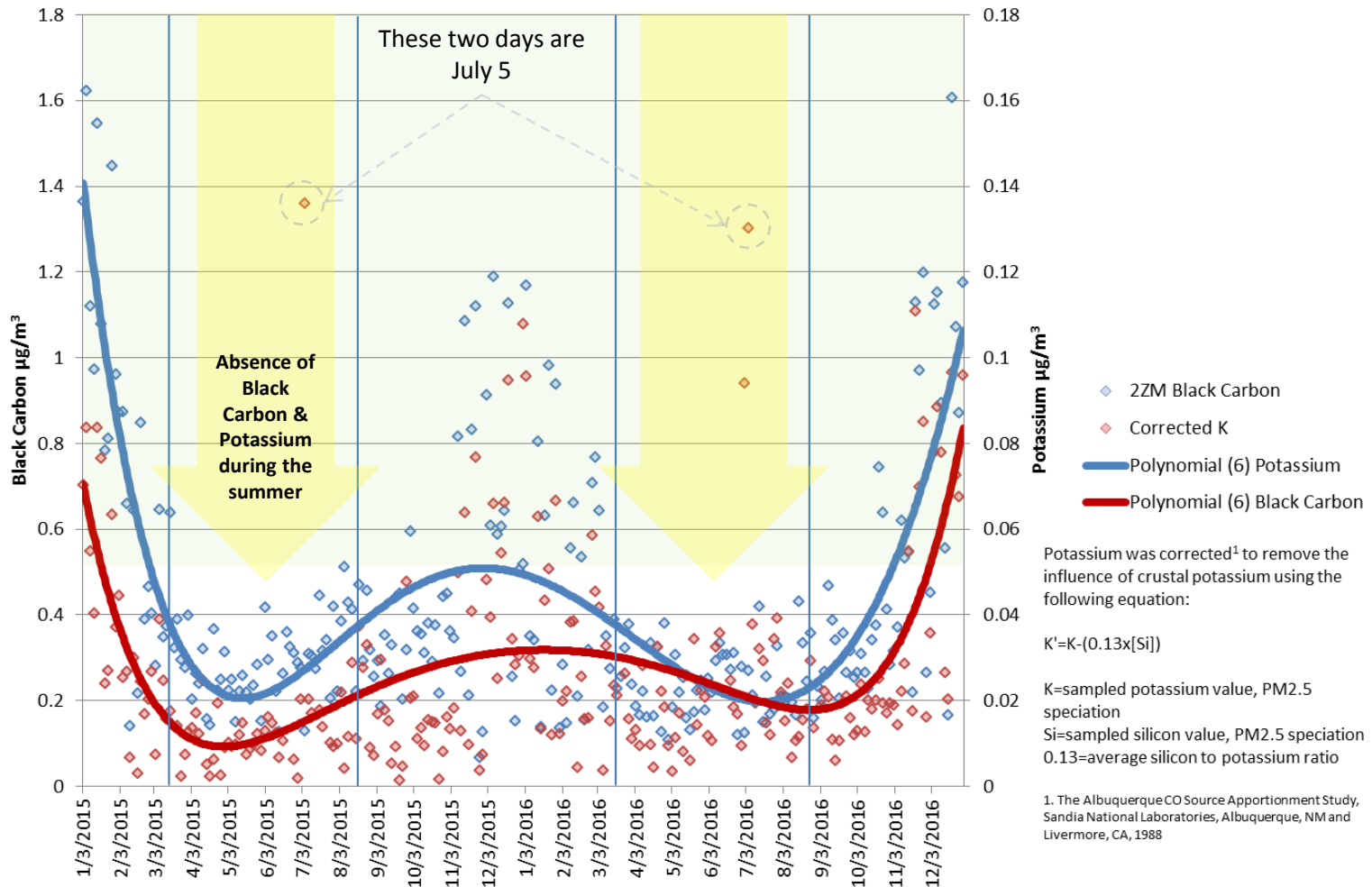
December 2017 Averaged Hourly PM$_{2.5}$
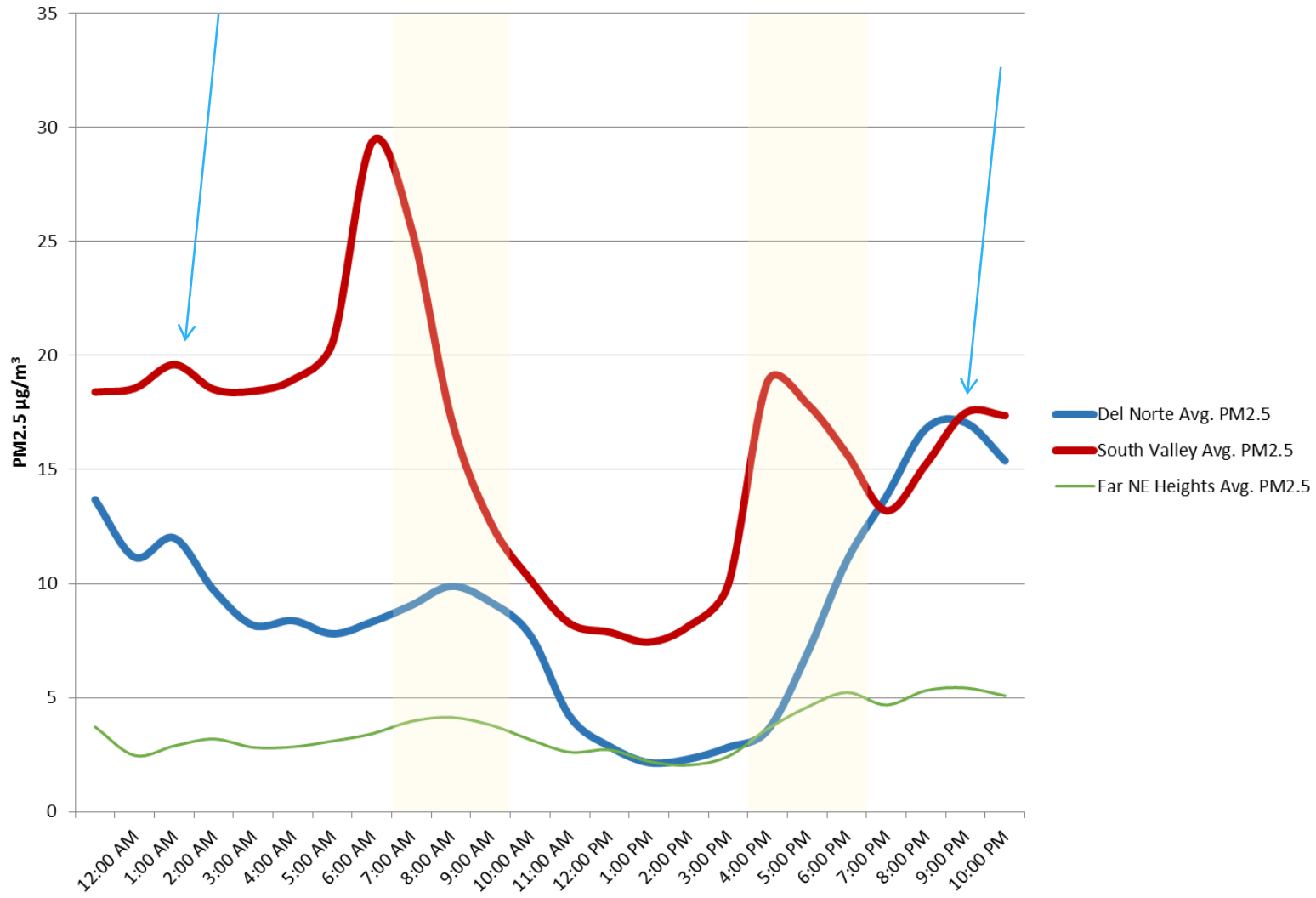
What did we see in the data

- Evening and early morning impact on Black Carbon

December 2017 Averaged Hourly Black Carbon

Seasonal Variations

2ZM Black Carbon and Corrected Potassium
January 1, 2015-December 31, 2016

These two days are July 5

Absence of Black Carbon & Potassium during the summer

- 2ZM Black Carbon
- Corrected K
- Polynomial (6) Potassium
- Polynomial (6) Black Carbon

Potassium was corrected[1] to remove the influence of crustal potassium using the following equation:

$$K'=K-(0.13x[Si])$$

K=sampled potassium value, PM2.5 speciation
Si=sampled silicon value, PM2.5 speciation
0.13=average silicon to potassium ratio

1. The Albuquerque CO Source Apportionment Study, Sandia National Laboratories, Albuquerque, NM and Livermore, CA, 1988

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Conclusions

- **The NEI and the local monitoring data point toward wood burning as an impact on area residents**

- **Black Carbon and Potassium show wood burning activity**

- **NEI data clearly identifies the Fuel Comb–Residential–Wood Sector as a significant source of air pollutants**

  - Due to the seasonality of wood burning the impact could be more significant than the NEI data presents

Potential Next Steps

- Wood Burning Activity Survey
- Levoglucosan, Mannosan, Galactosan (anhydrous sugars)
  - Organic compounds closely related to biomass burning
  - Ratios can help determine wood/biomass types burned
  - Able to use existing sampling equipment
  - Laboratory analysis by Gas Chromatograph

Advanced Real-Time Measurement of Black Carbon

with Aethalometer® Model AE33

- Dual Spot™ Technology for filter loading effect compensation
- Source apportionment – Real-time Biomass burning vs. Fossil fuel determination
- Full spectrum 7-Wavelenght analysis
- Remote management and data transfer
- Connect with TCA-08 for "OC/EC" analysis

- Spectrum Wavelength Aethalometer
  - instrument measuring concentrations of light absorbing particles
  - 7 different wavelength channels based on differences in particle size and material, including black carbon and CO_2 (additional sensor).
  - Potential for identifying particulate sources based on wavelength UV absorption
  - This could help differentiate wood burning and traffic contributions

- Mobile autoGC monitoring
  - Provide data on up to 57 different hydrocarbon pollutants including benzene, toluene, and formaldehyde (https://cas-en.com/turn-key-systems/pams/)
  - Some systems are easy to set up and easy to use

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Open Discussion