$PM_{2.5}$ Source Apportionment at the Port of Tacoma: Preliminary Results

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3 year monitoring study of speciated $PM_{2.5}$ began in 2018

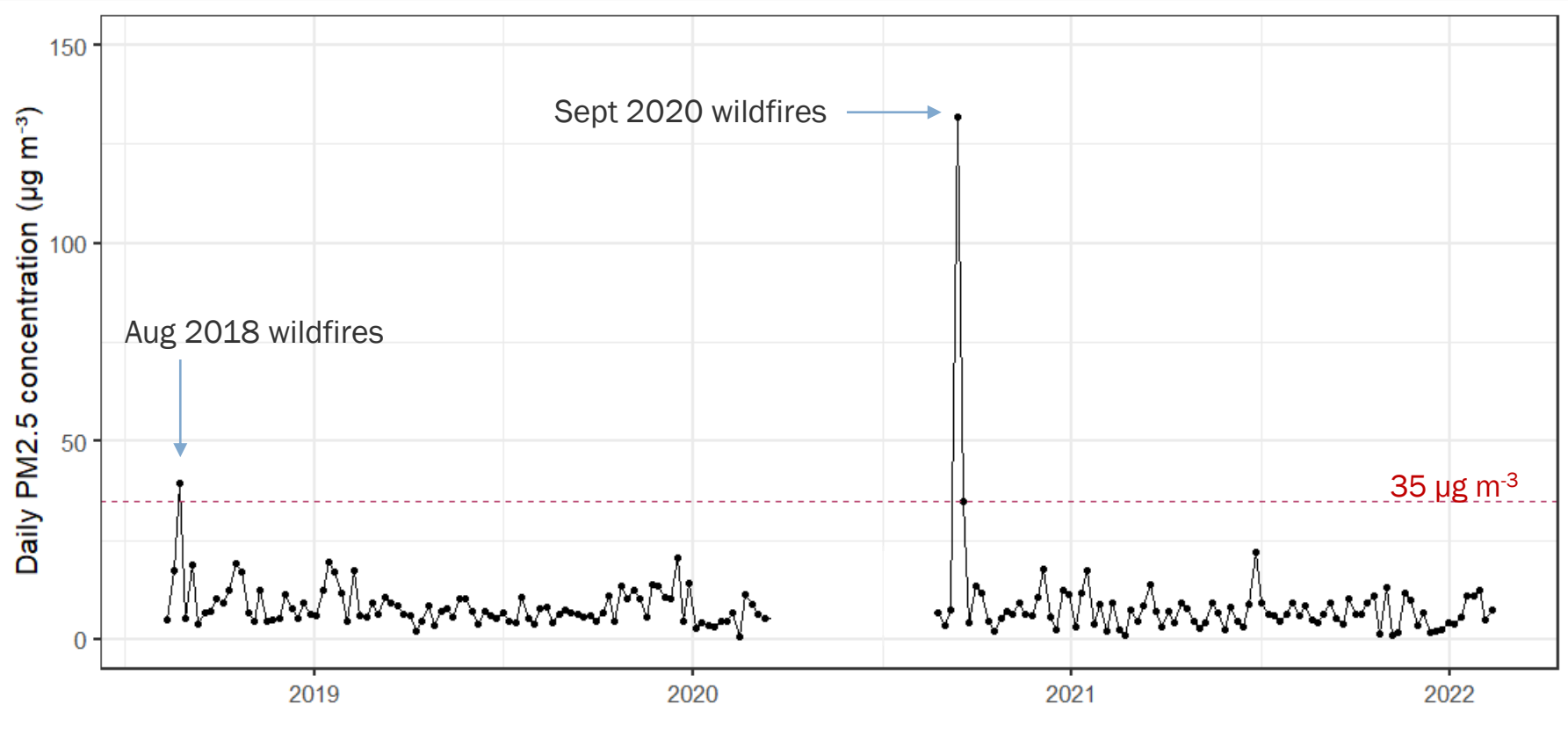
Port of Tacoma

- 2500 acres in Tacoma Tideflats
- Among top ten largest container ports in North America
- Major center for containers, bulk, breakbulk, heavy-lift cargoes, automobiles and trucks
- Industry operations: manufacturing, warehousing, distributing, shipping, metal fabrication/machinery, milling, concrete/steel manufacturing, lumber, oil refining
- BNSF Railway and Union Pacific railroads
- Major roadways (509 and I-5)

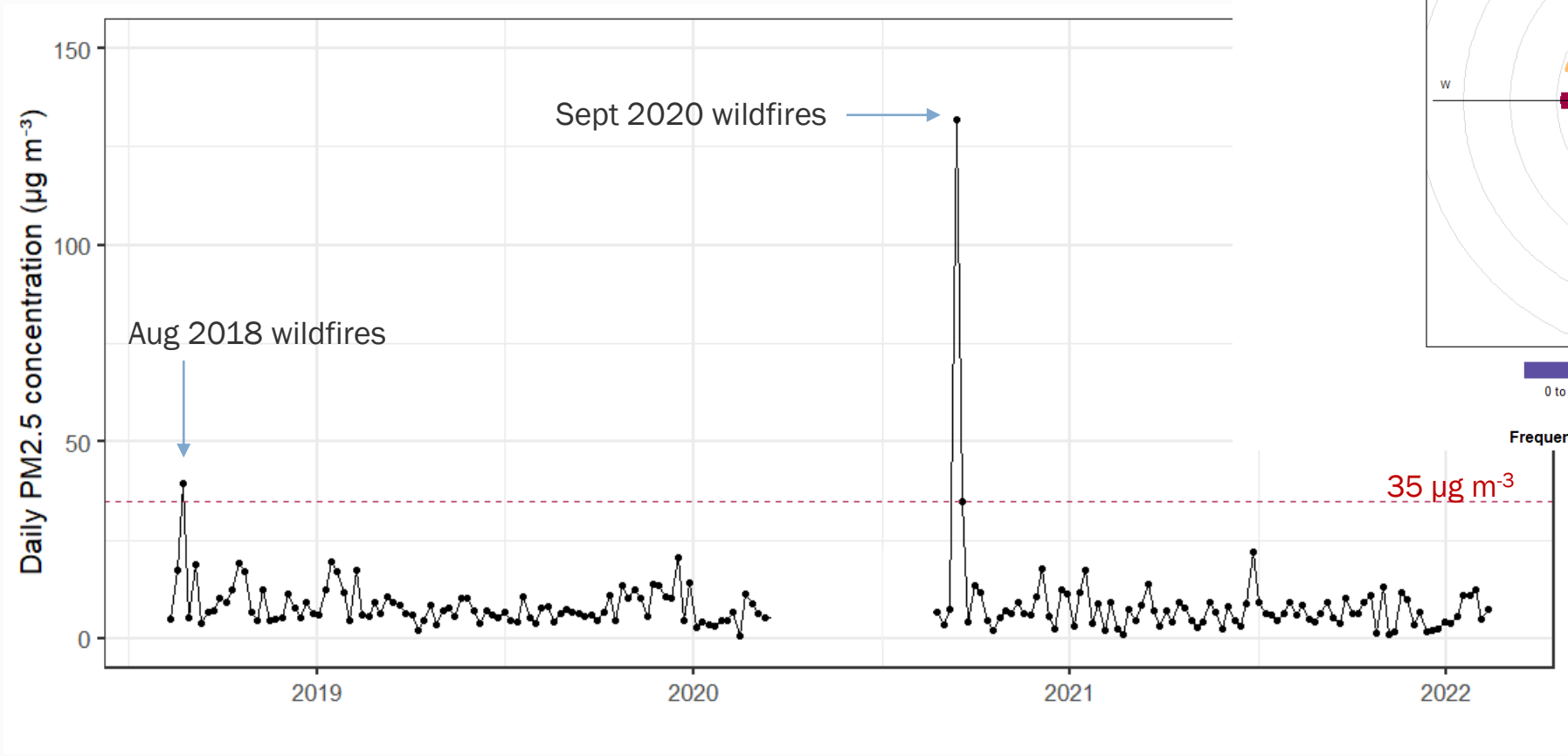
Source apportionment input data: ~3 years of Chemical Speciation Network (CSN) $PM_{2.5}$ data at the Port of Tacoma monitoring site

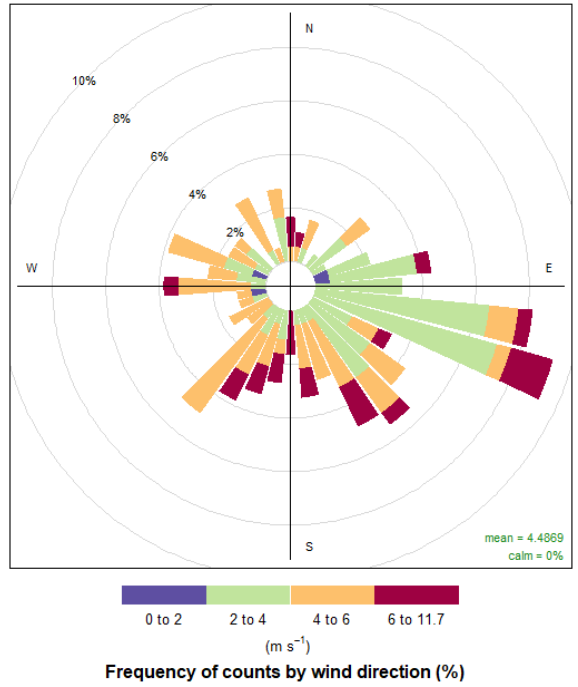
- CSN data is collected every six days
- 24 hour data
- Metals, ions, carbon
- Offline analysis—filters are collected, shipped to UC Davis, analyzed and QA/QC'd
- Aug 2018-Feb 2022 (with a break Mar 2020-Aug 2020 due to covid)
- Also measured at the site: met, BC, nephelometer PM2.5

~3 years of CSN data



~3 years of CSN data



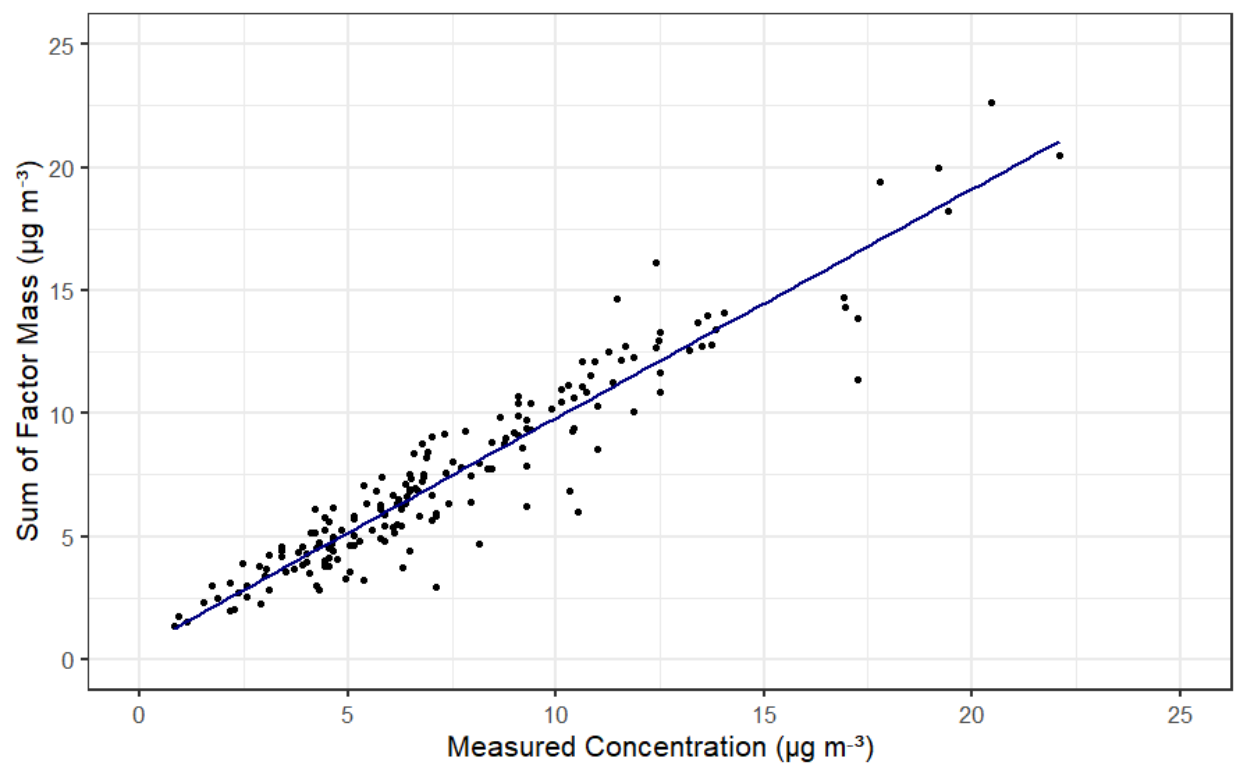


Source apportionment: what is Positive Matrix Factorization (PMF)?

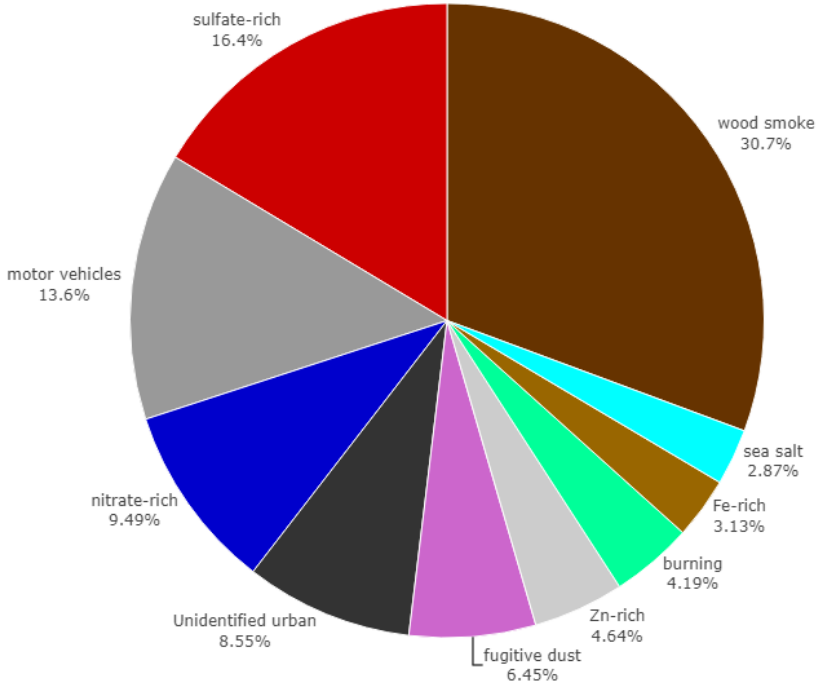
- A receptor model that quantifies the contribution of sources to samples based on the composition of the sources
- A mathematical tool that decomposes a measured dataset of speciated sample data into factor contributions and factor profiles
- A PMF “factor” is:
  - A single source (industrial facility)
  - A source category (similar chemical fingerprints and emission factors—cars, wood smoke, sea salt, nitrate-rich)
  - Multiple sources or source categories grouped together

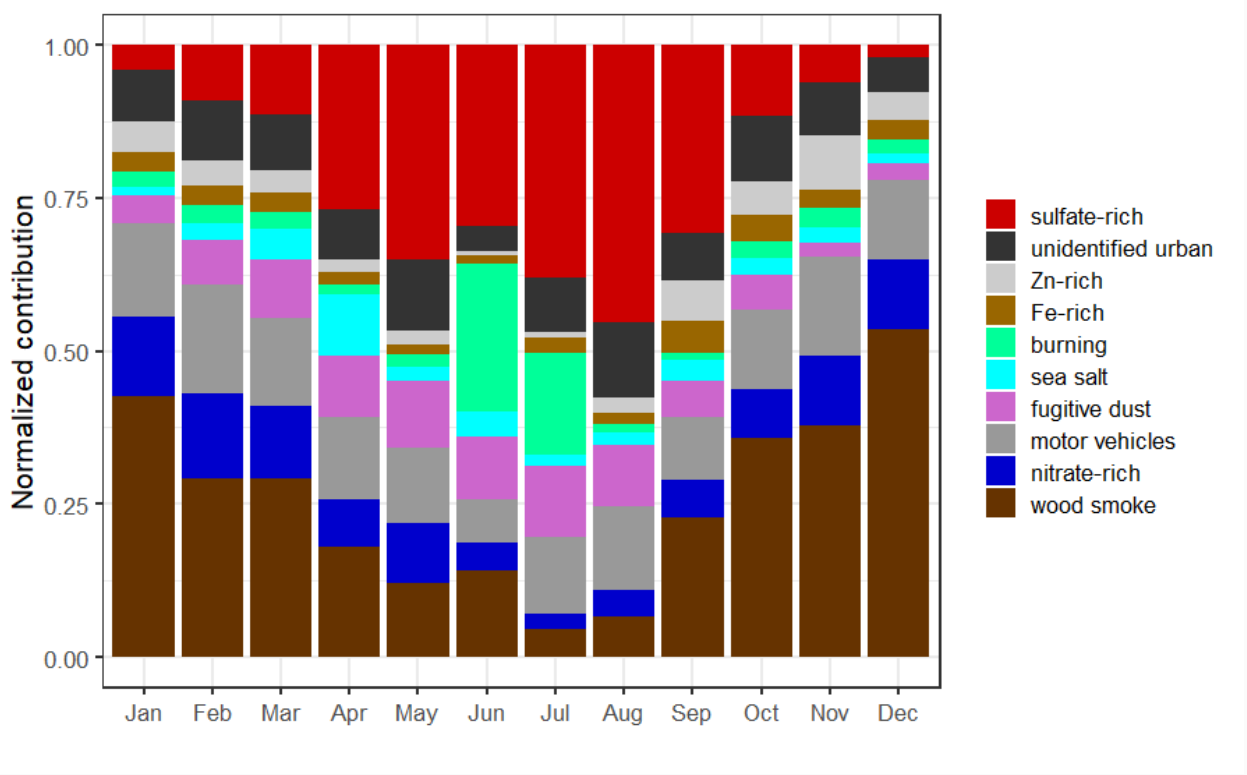
What factors did PMF find at Port of Tacoma?

- Ran the model multiple times
- Removed 4 days impacted by wildfires based on error analysis
- Optimal solution: 10 factors that described ~90% of the measured PM2.5

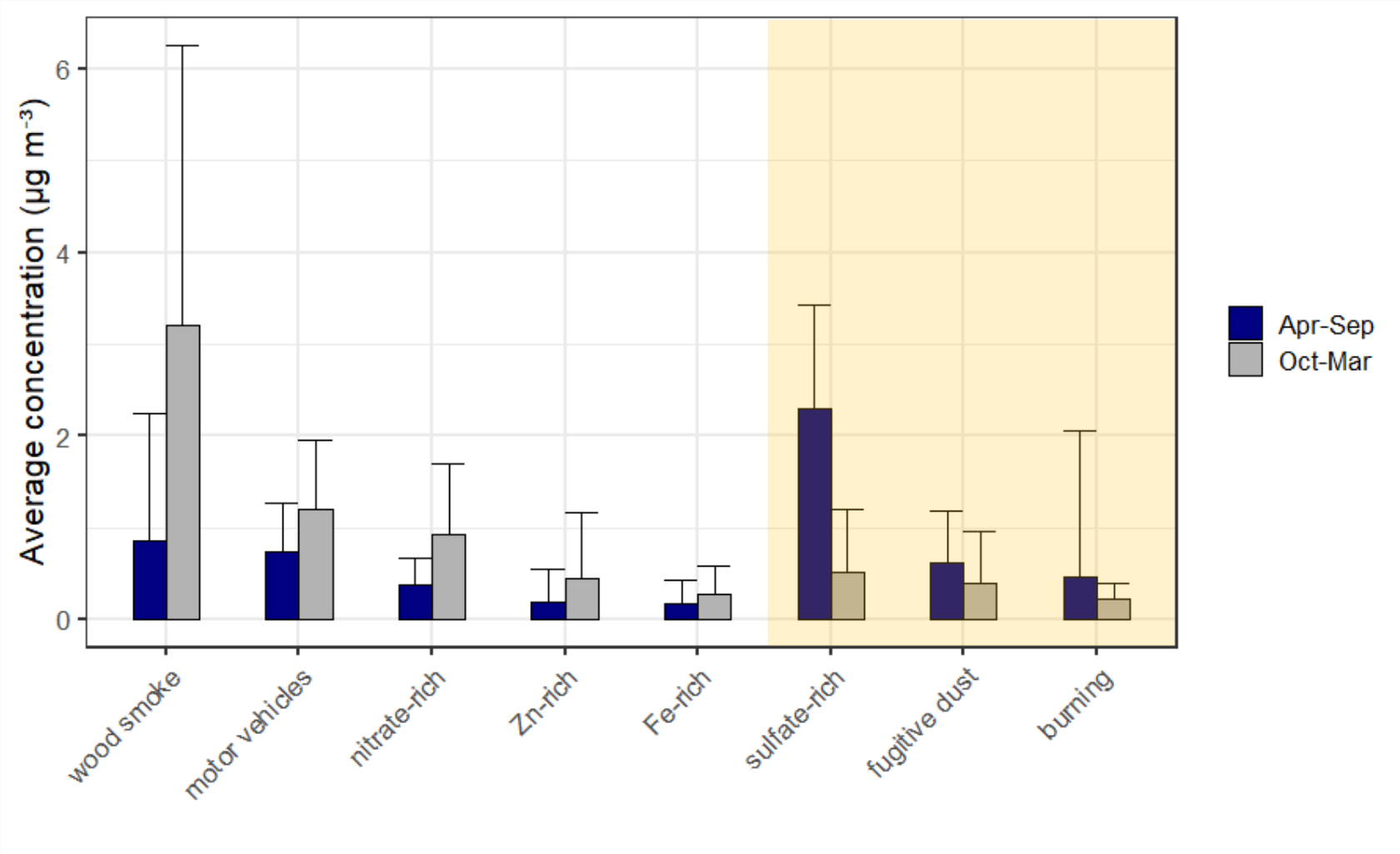


Identified factors include $PM_{2.5}$ associated with wood smoke, vehicles, industrial sources, and biogenic sources

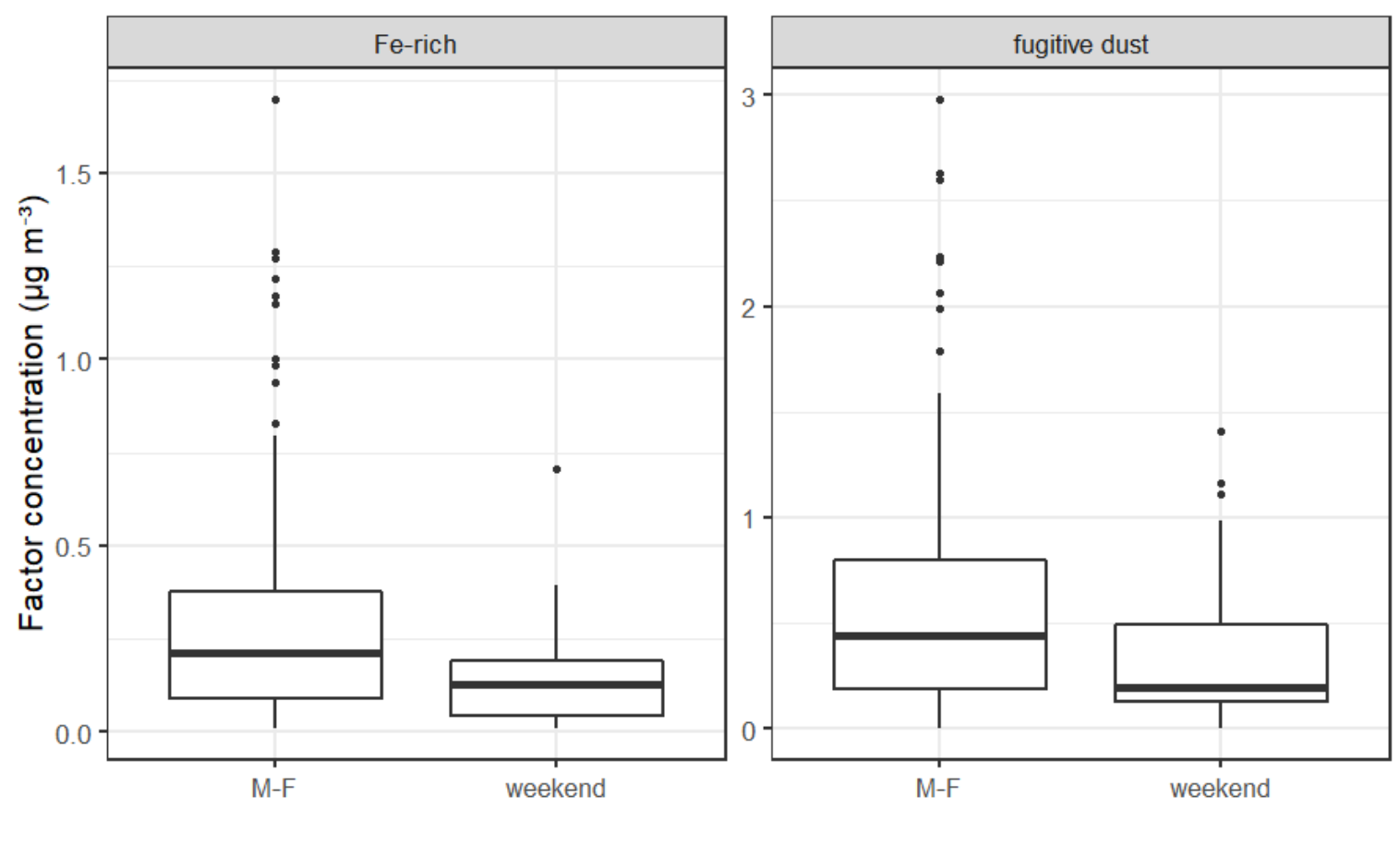




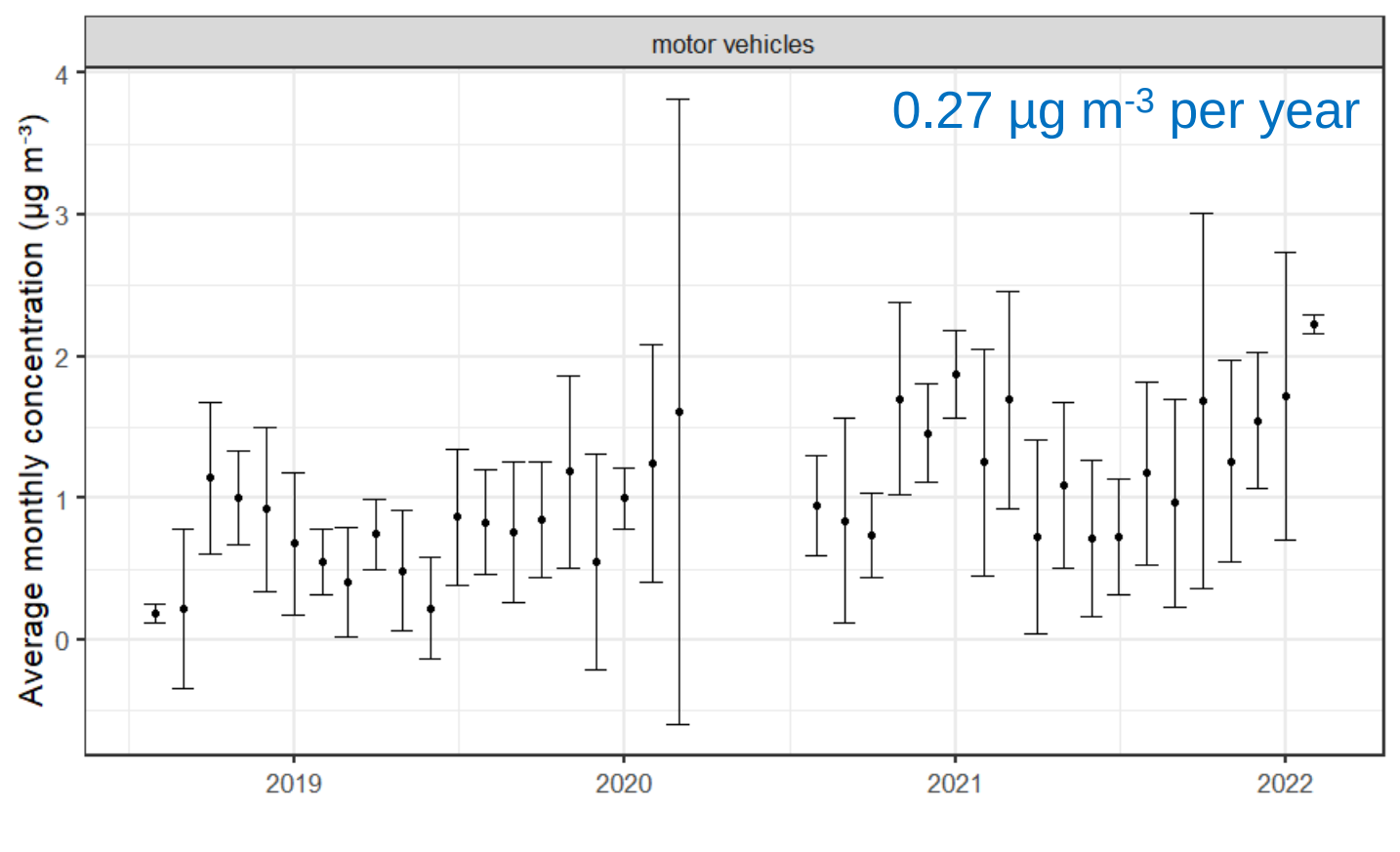
Seasonal variability



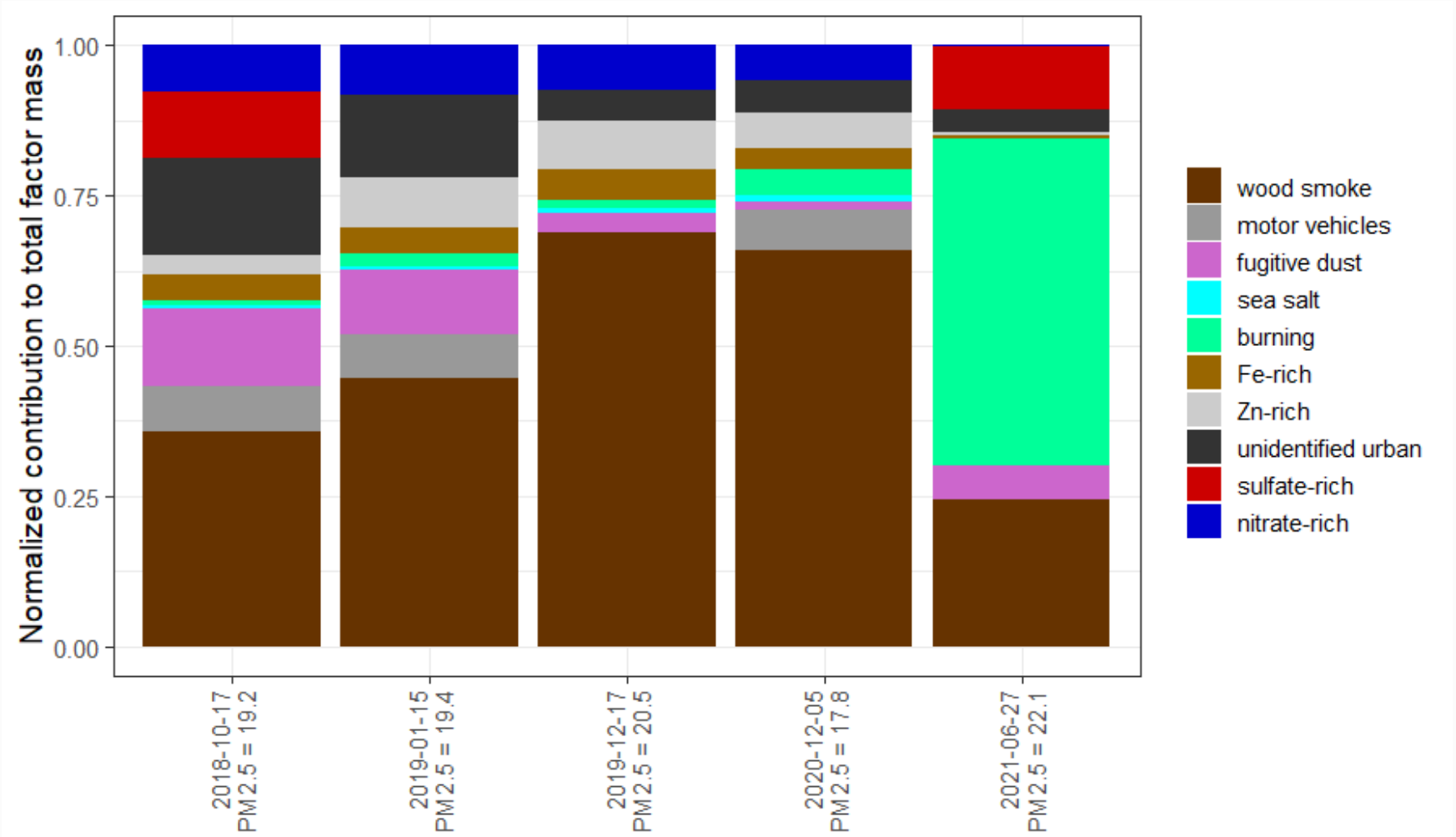
Which $PM_{2.5}$ sources exhibit day of week variability?



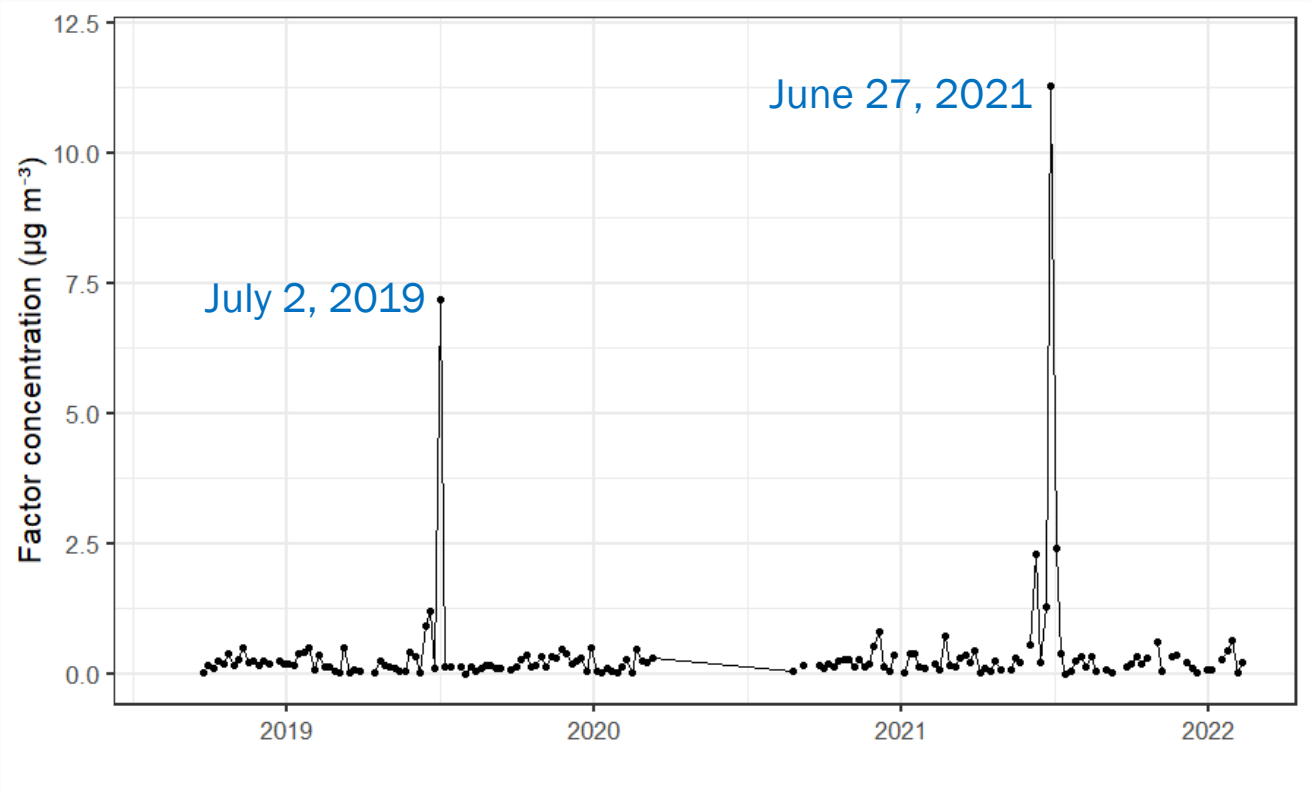
Increasing trend: $PM_{2.5}$ associated with motor vehicles

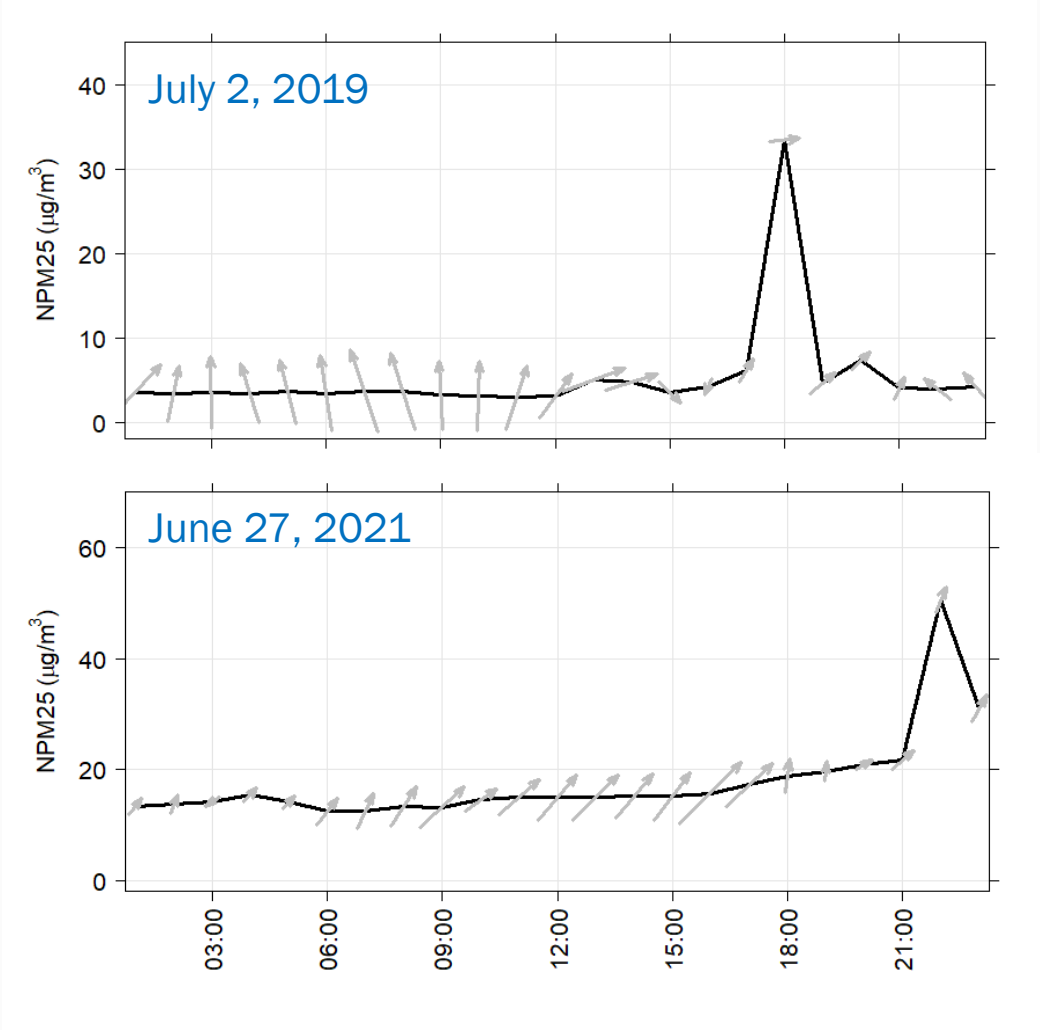


What sources contribute most to higher concentrations of $PM_{2.5}$?



$PM_{2.5}$ associated with burning





Summary

- Identified sources at the Port of Tacoma include $PM_{2.5}$ associated with wood smoke, industrial activities, motor vehicles, biogenic sources.
- $PM_{2.5}$ associated with wood smoke contributes the most to average $PM_{2.5}$ mass