Factors Influencing the Contributions of Diesel and Gasoline Exhaust to PM2.5 Emission Inventories

EPA Emission Inventory Conference

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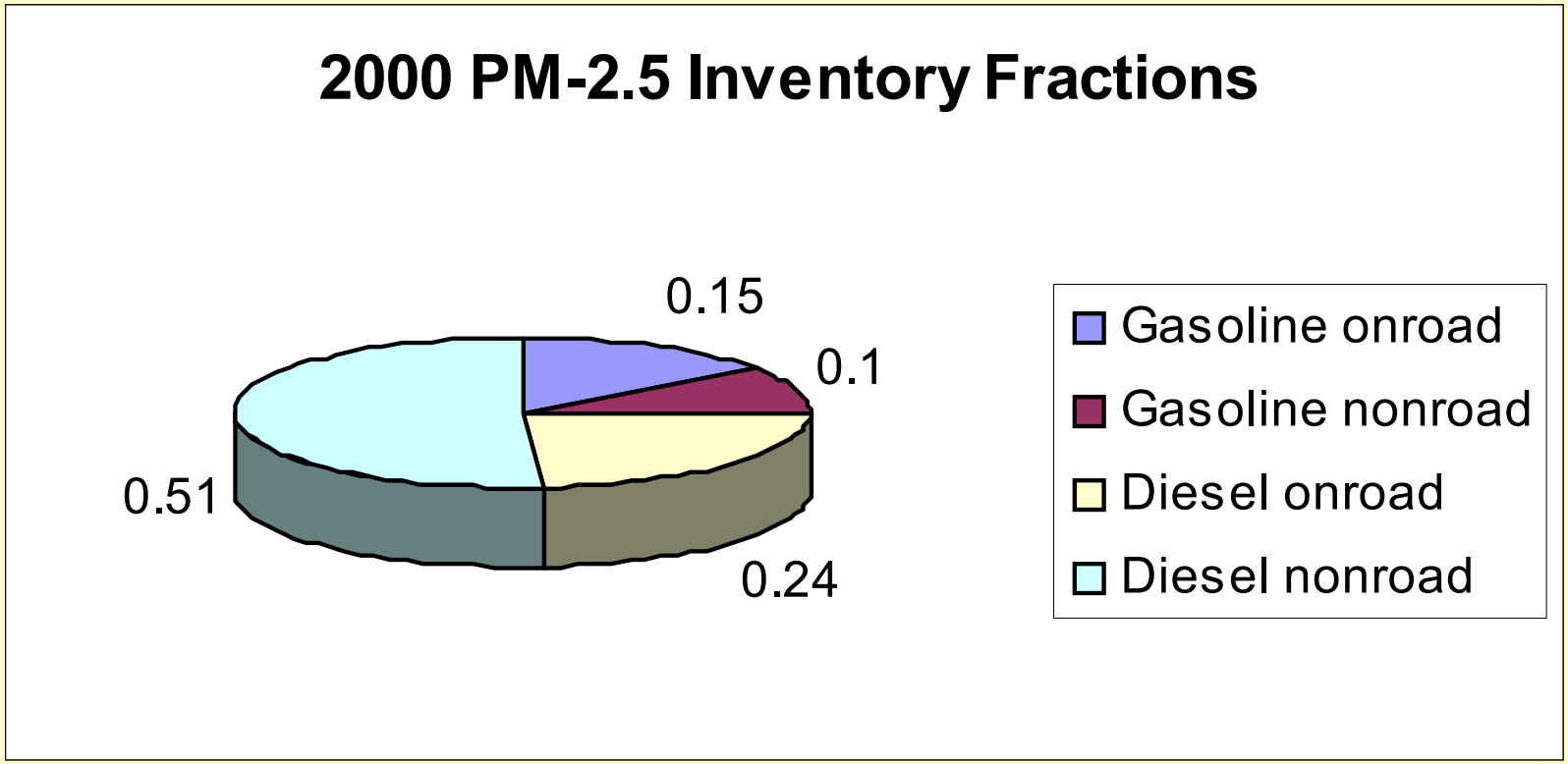
Mobile Source Contribution to Ambient PM-2.5

- Mobile sources presently contribute 20% of PM-2.5 emission inventories (excluding natural/miscellaneous sources)
- Diesel vehicles/engines are responsible for 75% of mobile source emissions
- Gasoline vehicle/engines are responsible for 25% of mobile source emissions
- Does not account for secondary PM such as nitrate, sulfate, organics

EPA PM-2.5 Mobile Source National Emission Inventories - Emission Trends Data



Inventory Model

- MOBILE on-highway model
  - Defines “fleet average” emission rate (g/mile) by vehicle category (e.g. LDGV, HDDV)
  - Inventory generated by multiplying total miles
- NONROAD model
  - Generates inventory directly
    - Population * hours of operation * emission factor
    - construction, farm, lawn/garden, recreational marine

PM-2.5 Emission Inventory

- **EPA PM-2.5 models do not include**
  - **High load conditions (heavy accelerations)**
  - **Malfunctioning vehicles, “smokers”**
  - **Vehicle deterioration**
  - **Temperature effects (ambient temperatures)**
  - **Effects of oxygenated fuel**
- **Not clear if gasoline or diesel have more high emitters**

EPA PM-2.5 Emission Inventories

- Diesel
  - Nonroad inventory larger than on-road
  - EPA has regulated onroad diesel PM extensively, very little on nonroad
  - Considerably less data available for nonroad
- Gasoline
  - Onroad has been decreasing with time
  - Nonroad is important, data are limited
    - 2 stroke engines burning oil

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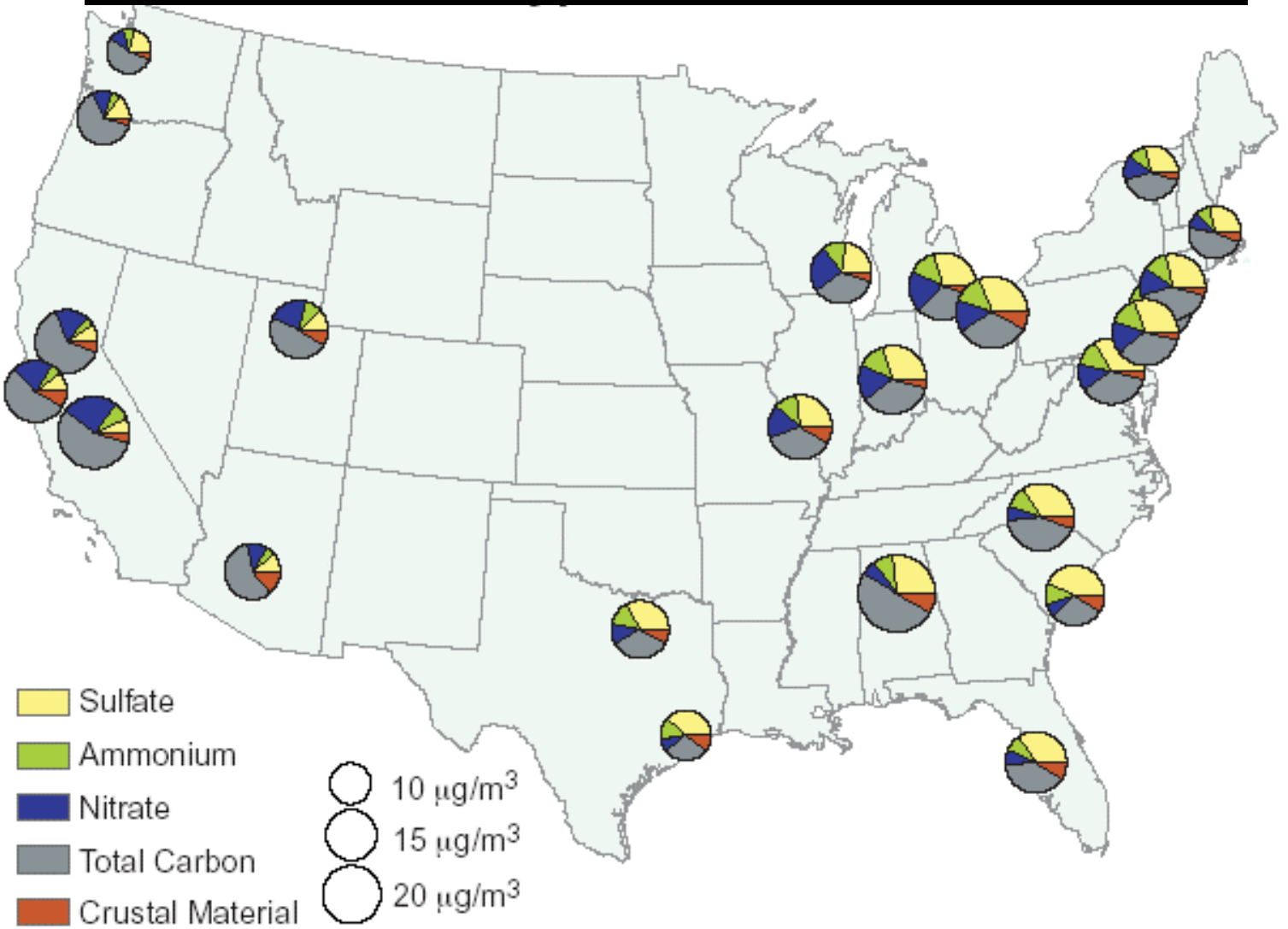
Carbonaceous PM is important in urban areas (as are sulfates)!

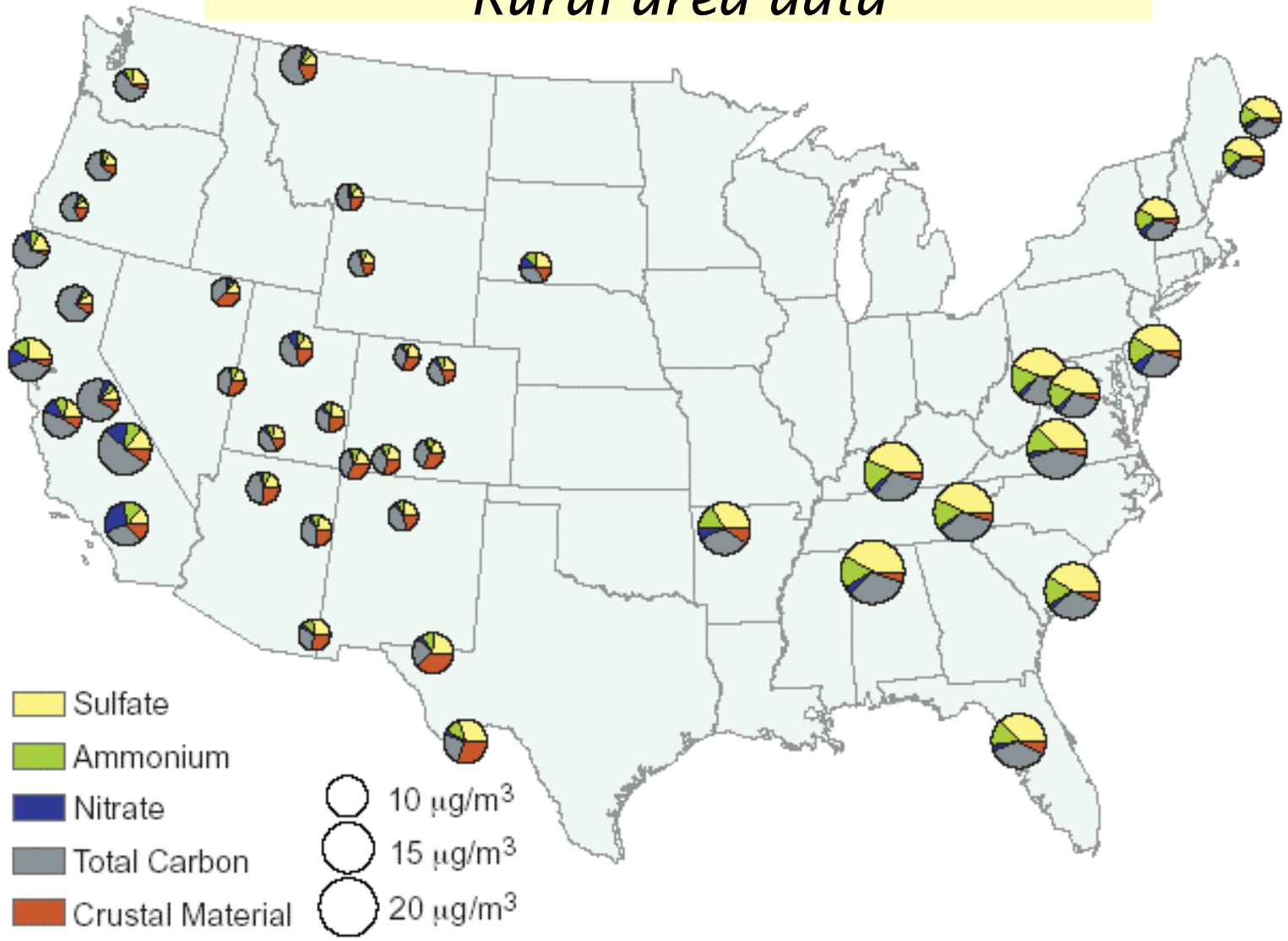


Source: EPA Speciation Network, 2001.

From: "Latest Findings on National Air Quality: 2001 Status and Trends"

Carbonaceous PM is also important in rural areas

Rural area data

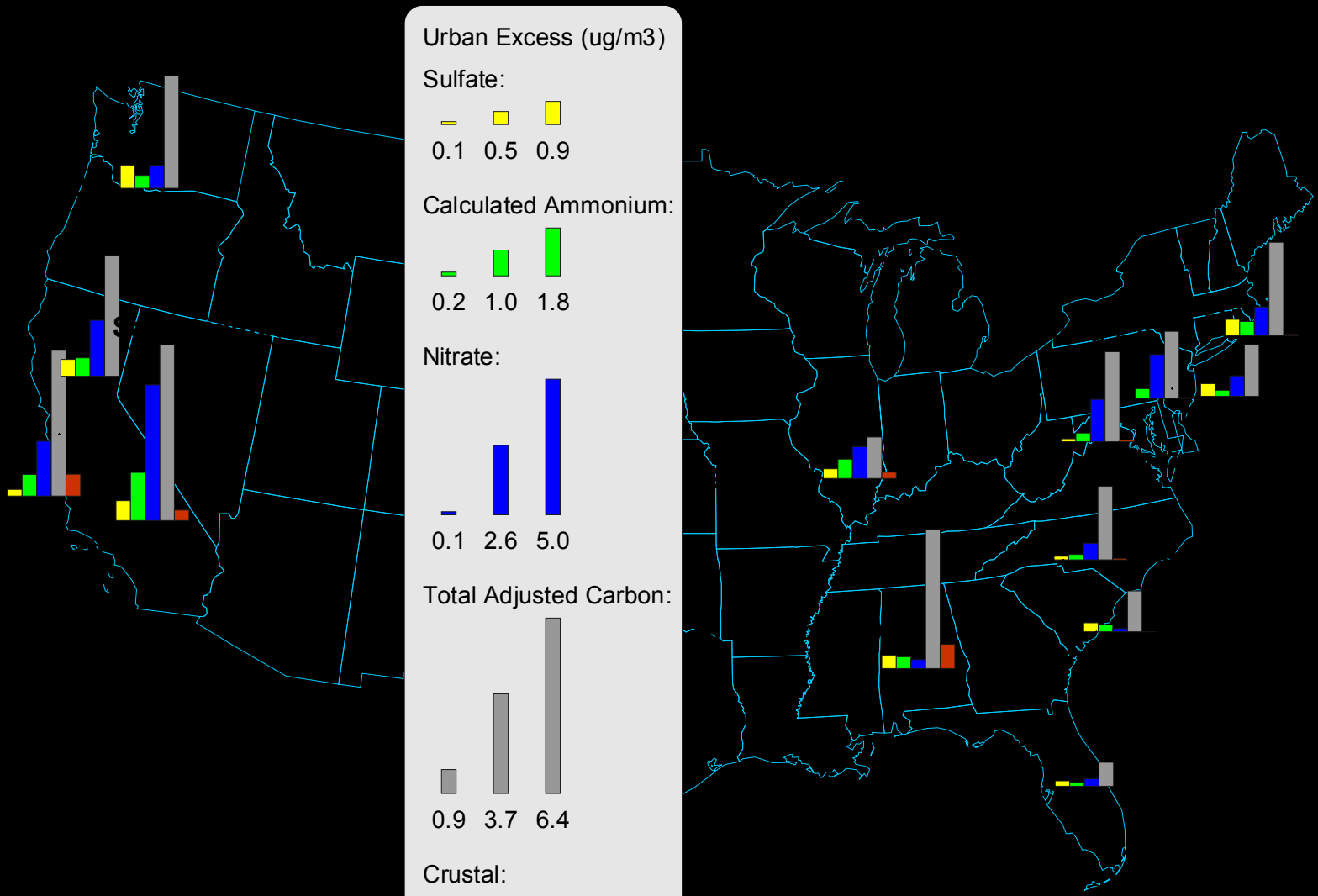


Source: IMPROVE Network, 1999

From: "Latest Findings on National Air Quality: 2001 Status and Trends"

There is an excess of carbon and other components of PM2.5 in urban areas (OAQPS AWMA paper: Tesh Rao, Neil Frank)

STN urban measurement minus nearby IMPROVE regional background



Preliminary estimates based on Jan-Nov 2001 data

Carbonaceous PM

- Carbonaceous PM is a large part of PM-2.5, especially in urban areas
- Where does it come from? How much from mobile sources?
  - Gasoline/diesel vehicles
  - wood smoke/coal combustion
  - charcoal type cooking
  - natural sources (trees, vegetation)?
- Mobile sources emit a lot
- How much is directly emitted PM included in emission inventories?
- How much is secondary PM formed in the atmosphere?

PM Source Apportionment Studies

- Conflicting Results
- Northern Front Range Air Quality Study - Denver shows gasoline>diesel
- Similar results found for studies in Phoenix
- G. Cass/J. Schauer California studies show diesel>gasoline
- New DOE/NREL work in CA using NFRAQ/J. Schauer investigators

Source Signature - Diesel Issues

- Onroad and nonroad PM emissions different
  - widely varying technology especially for nonroad which includes smaller diesel engines and commercial marine/locomotives
- Onroad and nonroad diesel fuel are greatly different
  - nonroad fuel less refined (less hydrotreating) and, thus, has different PAH compounds
- Separate source signatures for onroad and nonroad useful

Diesel Source Signatures

- Receptor models have employed PAH and other organic compounds (semi-volatiles)
  - Northern Front Range Air Quality Study uses detailed PAH signatures PAH profile sensitive to fuel processing
  - Technologies for removing sulfur also alter aromatic content of fuel
  - Majority of diesel PM PAH from fuel
- Fuel considerations may be important in Chemical Mass Balance (CMB)

Source Signature - Gasoline Issues

- Onroad technology all similar
  - fuel composition varies
  - high emitters can burn oil
- Nonroad technology - from small to big engines - technology different from onroad
- Nonroad 2-stroke gasoline engines burn oil
- Nonroad gasoline PM is a large contributor compared to onroad
- Separate source signatures useful

Source Signature - Other Issues

- Do VOCs photochemically react to form secondary PM?
  - Gas chamber studies
  - Issue for high molecular weight VOCs
- If so, how can CMB and multivariate source apportionment account for secondary PM formation from VOCs?
- Are secondary organics important?

Conclusions

- **Mobile source PM is a major contributor to ambient PM**
- Not clear whether diesel or gasoline PM is greater contributor
- Need to account for high emitters in inventories
- Need better source apportionment studies