UCLA School of Public Health

MEASURING SELF-POLLUTION IN SCHOOL BUSES USING A TRACER GAS TECHNIQUE

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BACKGROUND

- The ARB has declared diesel exhaust particulate to be a toxic air contaminant
- Some children spend 3 hours a day on school buses
- Children may be exposed to high concentrations of diesel particles and gases during bus commutes
- Inadequate data concerning children's in-vehicle exposure on diesel school buses in CA

OBJECTIVES

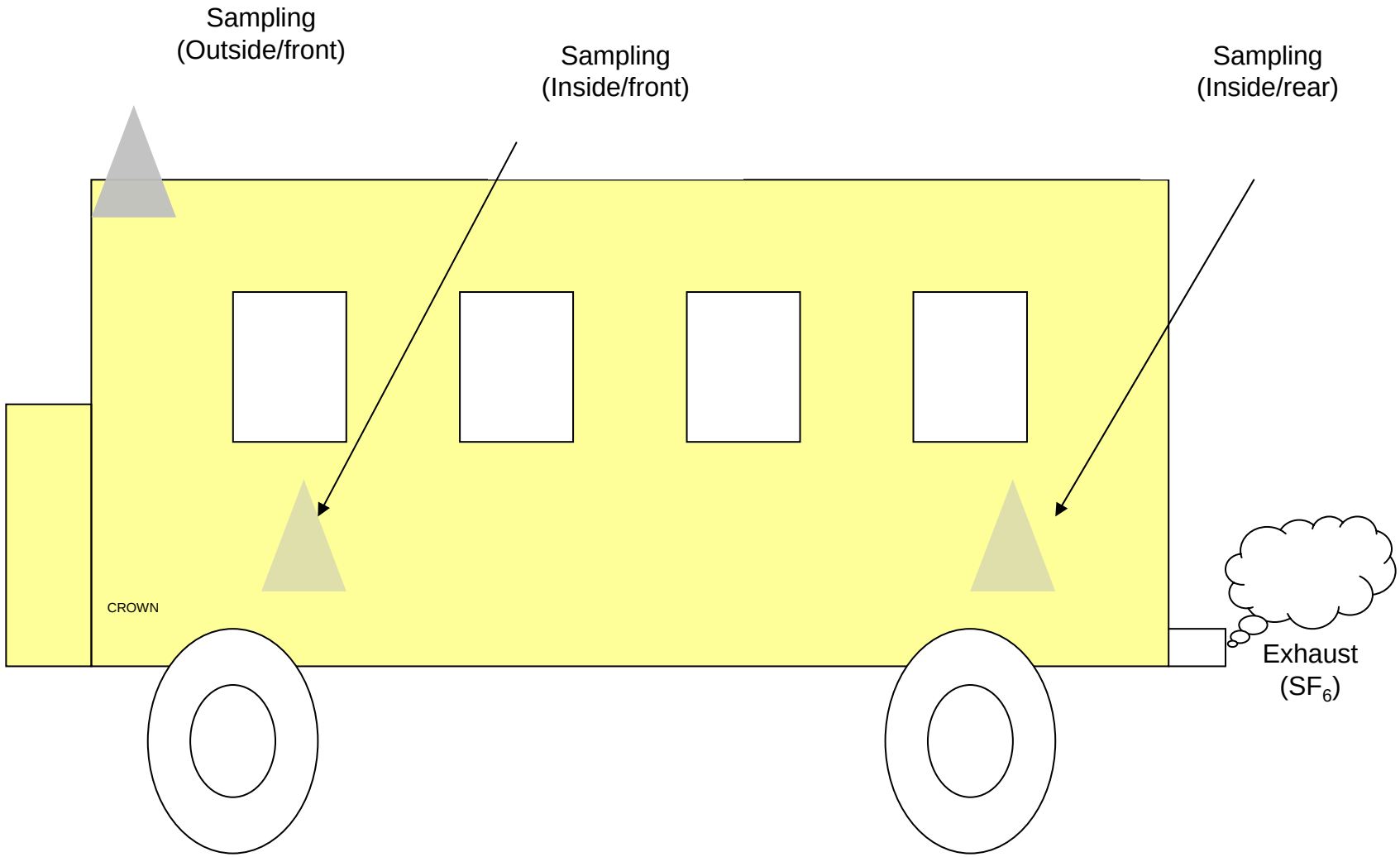
- Quantify the introduction of a bus's own exhaust into the passenger compartment
- Determine the percentage of diesel exhaust-related pollutant concentrations inside the cabin originating from a bus’s own exhaust
- Study the correlation between self-pollution and diesel-related pollutants and “background” pollutants

APPROACH

- Results are part of a project to characterize the range of children's pollutant exposure during school bus commutes (Fitz et al., 2003)
- Measurements using several school buses under realistic operating conditions (routes, time)
- Tracer gas (SF_6) was metered, using a mass flow controller, into the bus's exhaust system
- On-board measurements with 10-second time resolution

MEASUREMENTS

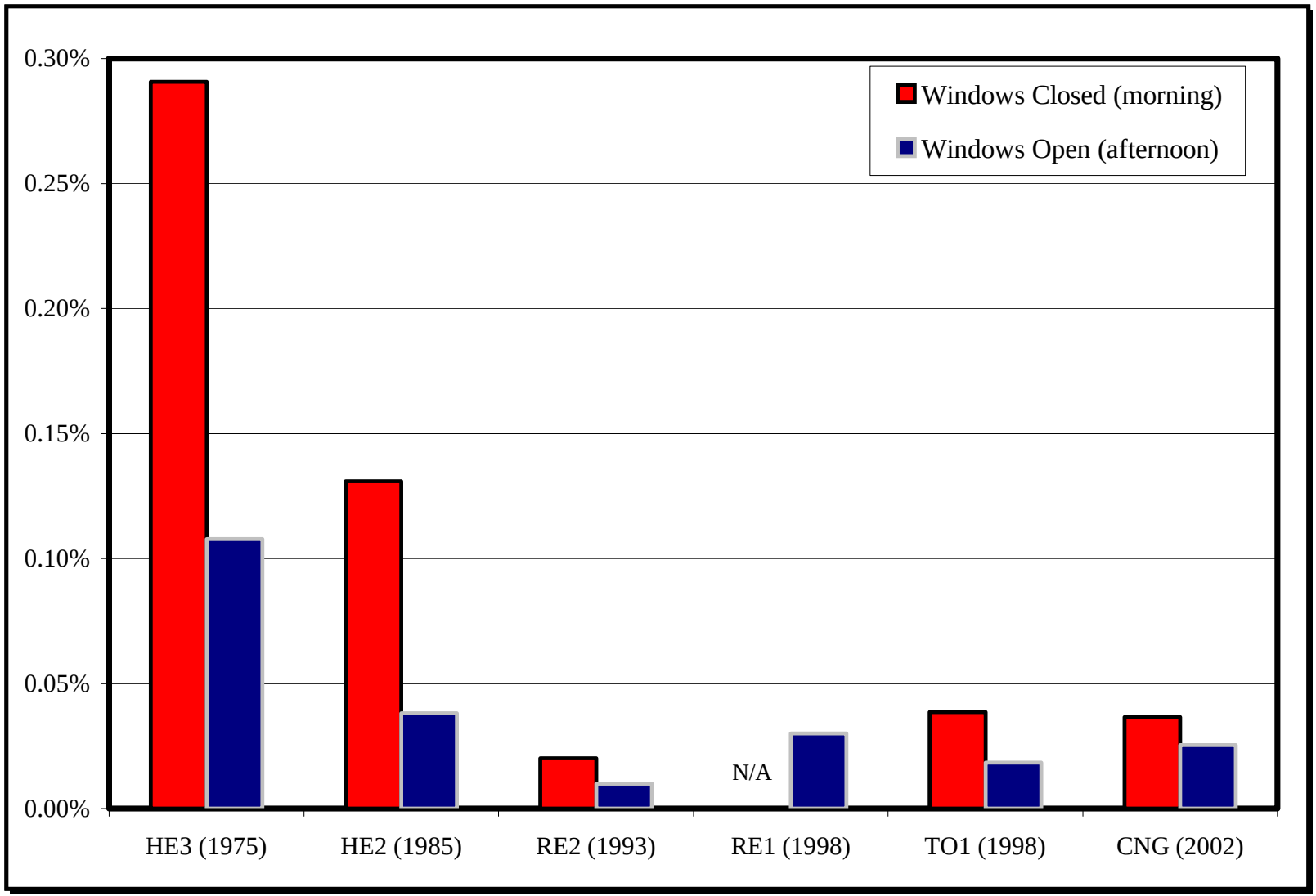
- Real-time measurements:
  - SF_6 (AeroVironment Model CTA 1000 analyzer).
  - Black Carbon (Magee Scientific Aethalometers).
  - $PM_{2.5}$ (8520 DustTrak Aerosol Monitors).
- Six school buses:
  - Four conventional diesel buses (1975 to 1998)
  - One 1998 particulate trap outfitted diesel bus
  - One 2002 CNG bus
- Measurements during ten morning and ten afternoon bus commutes from South Central Los Angeles (LA) to the west side of LA



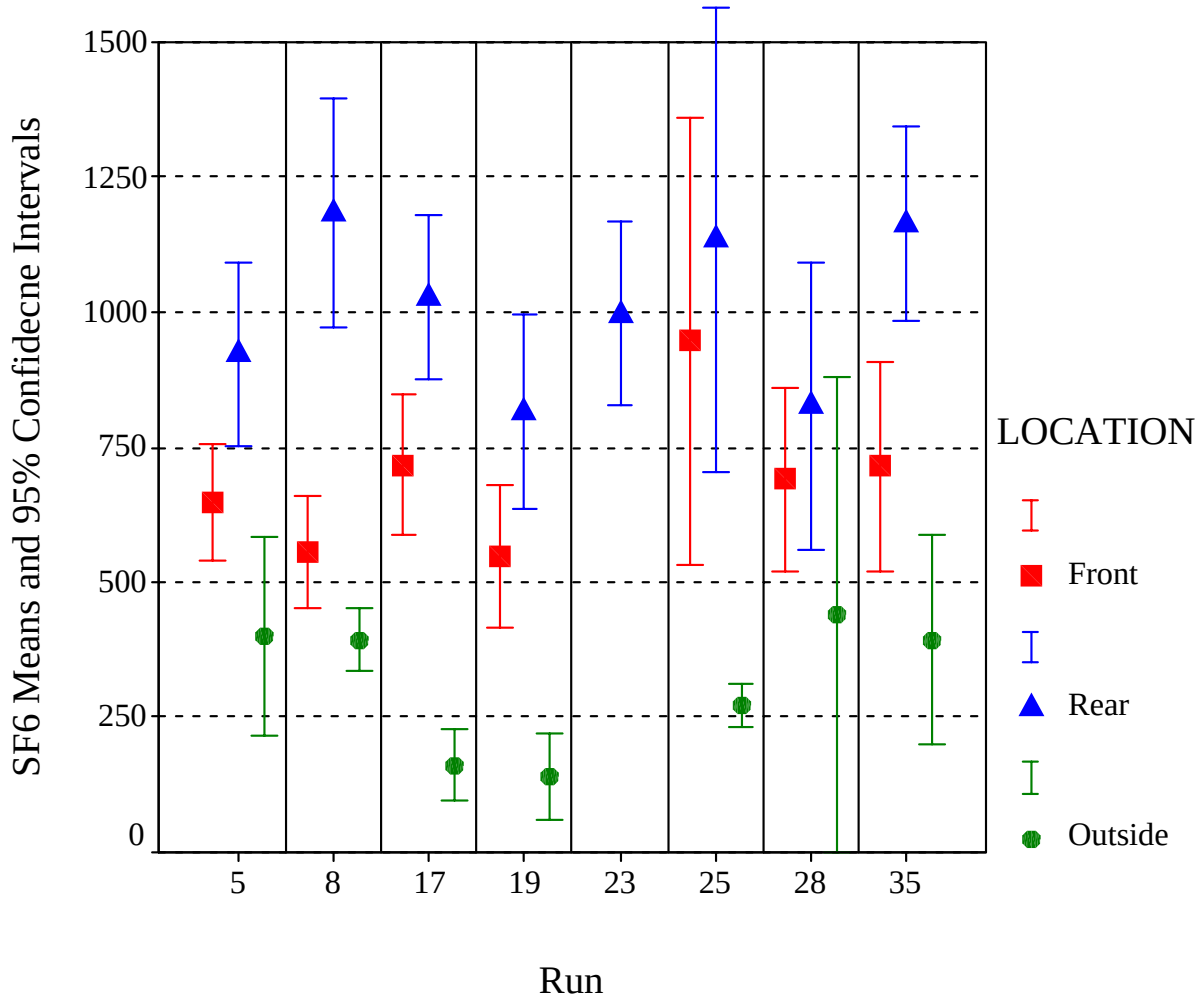
Mechanisms of self-pollution were not part of this study

RESULTS

Percentage of Bus's Own Exhaust Entering the Cabin

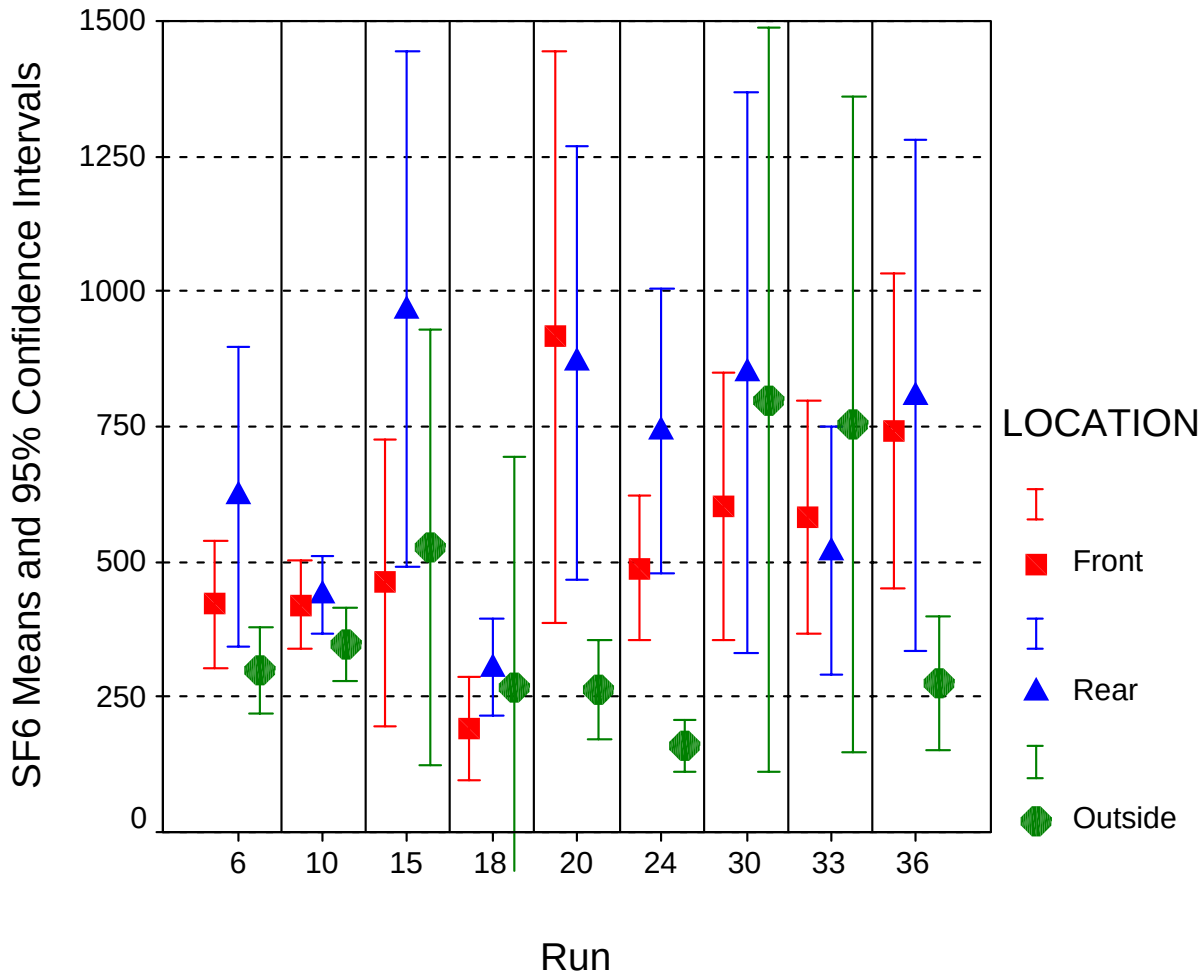


Means and 95% C.I. - Windows Closed



HE2: Run 5; HE3: Run 8; RE2: Runs 17, 19, 23, and 25; TO1: Run 28; CNG: Run 35

Means and 95% C.I. - Windows Open



HE2: Run 6; HE3: Run 10; RE1: Run 15; RE2: Runs 18, 20, and 24; TO1: Runs 30 and 33; CNG: Run 36

SUMMARY

- Several routes are responsible for self-pollution (SP)
- Windows closed lead to higher self-pollution
- Older buses showed a larger percentage of their own exhaust entering into the cabin (up to ten times higher than newer buses)
- Exposure to pollutants from the bus's own emissions are higher at the rear of the cabin (windows closed)
- Higher correlations between SP and BC ($r = 0.5$) than between SP and $PM_{2.5}$ ($r = 0.3$)

CONCLUSIONS

- Self-pollution varies significantly between buses and also depends on window position
- Up to 0.3% of a bus's own exhaust can be found inside its cabin
- Buses that exhibit high emissions and high self-pollution also exhibit the highest average within-cabin concentrations of black carbon (25% variance explained by self-pollution)
- Vehicle-related pollutant exposure inside buses is a function of the amount of exhaust entering the cabin from a bus itself. This effect may be the dominant factor for within cabin exposure with windows closed

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