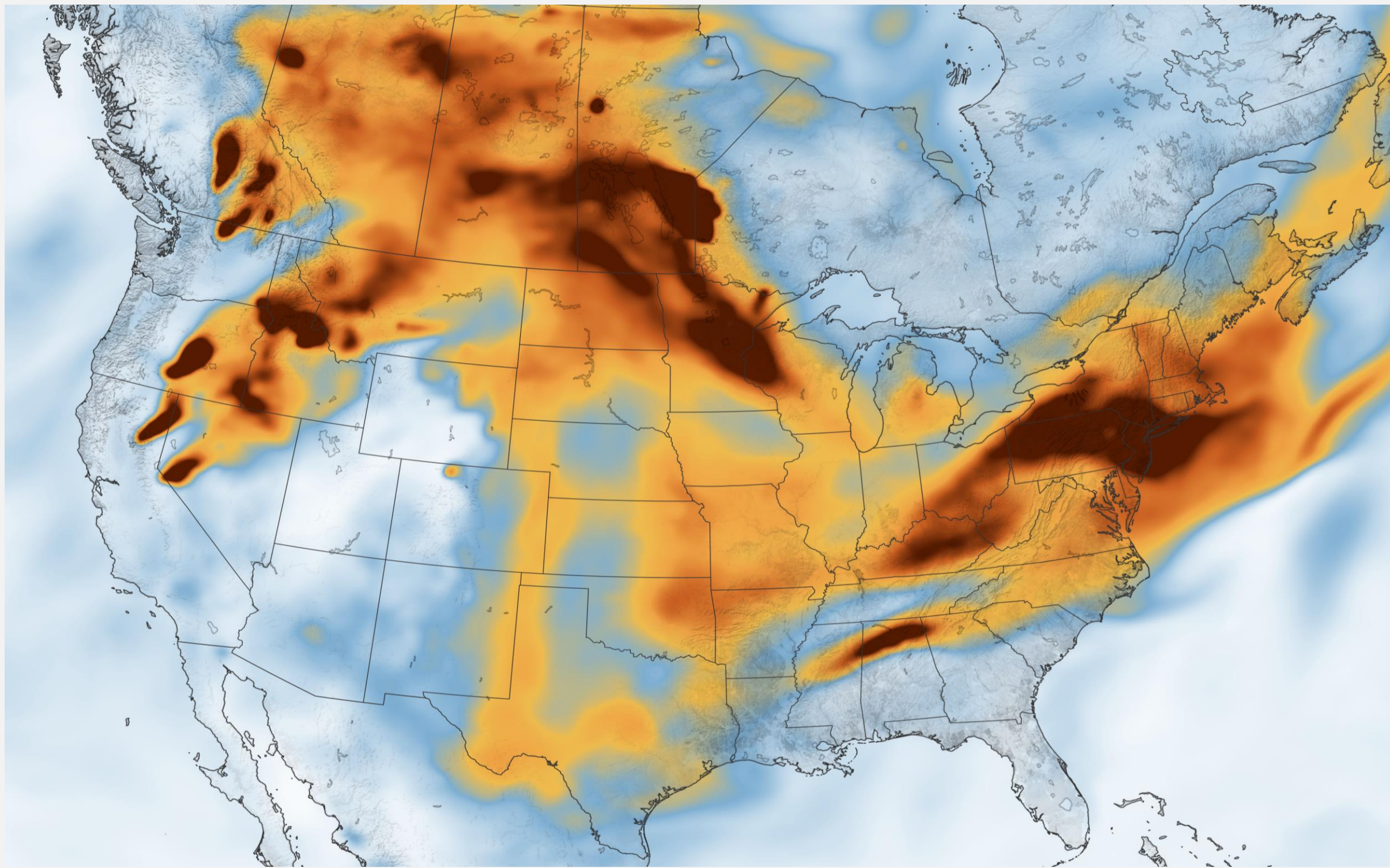


Risk of Postoperative Complications and Exposure to Air Pollution: Validating EPA Monitor Data as a Scalable Alternative to Address-Level Air Pollution Models

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Wildfires smoke events are no longer confined to Western North America, as demonstrated by this NASA Satellite image of wildfire smoke from July 2021 (8).

Methods: Testing Single-Monitor vs. Census Tract

- Data source: UU's local MPOG registry + Epic, from Jan 1, 2016 to Dec 31, 2023
- Inclusion: Adult (>18), Salt Lake County residents, elective general anesthesia at UU (excl. ASA 5/6, OB, ECT, and bronchoscopy)
- PM2.5 exposure: Nearest Hawthorne EPA monitor; maximum 7-day pre-op PM2.5 used (acute exposure)
- Also analyzed by EPA daily PM2.5 limit ($35 \mu\text{g}/\text{m}^3$) as binary
- Primary outcome: Binary composite of in-hospital complications (pneumonia, SSI, UTI, sepsis, stroke, MI, thromboembolism), identified via diagnosis codes
- Covariates: Age, sex, season, year, Elixhauser comorbidity index
- Analysis: Multivariable Bayesian hierarchical regression with Hamiltonian Monte Carlo, reporting odds ratios and 95% credible intervals
- Comparison performed to CT-Based exposure PM2.5 exposure model
- Tools: R (v4.4.1), brms (7), and related packages

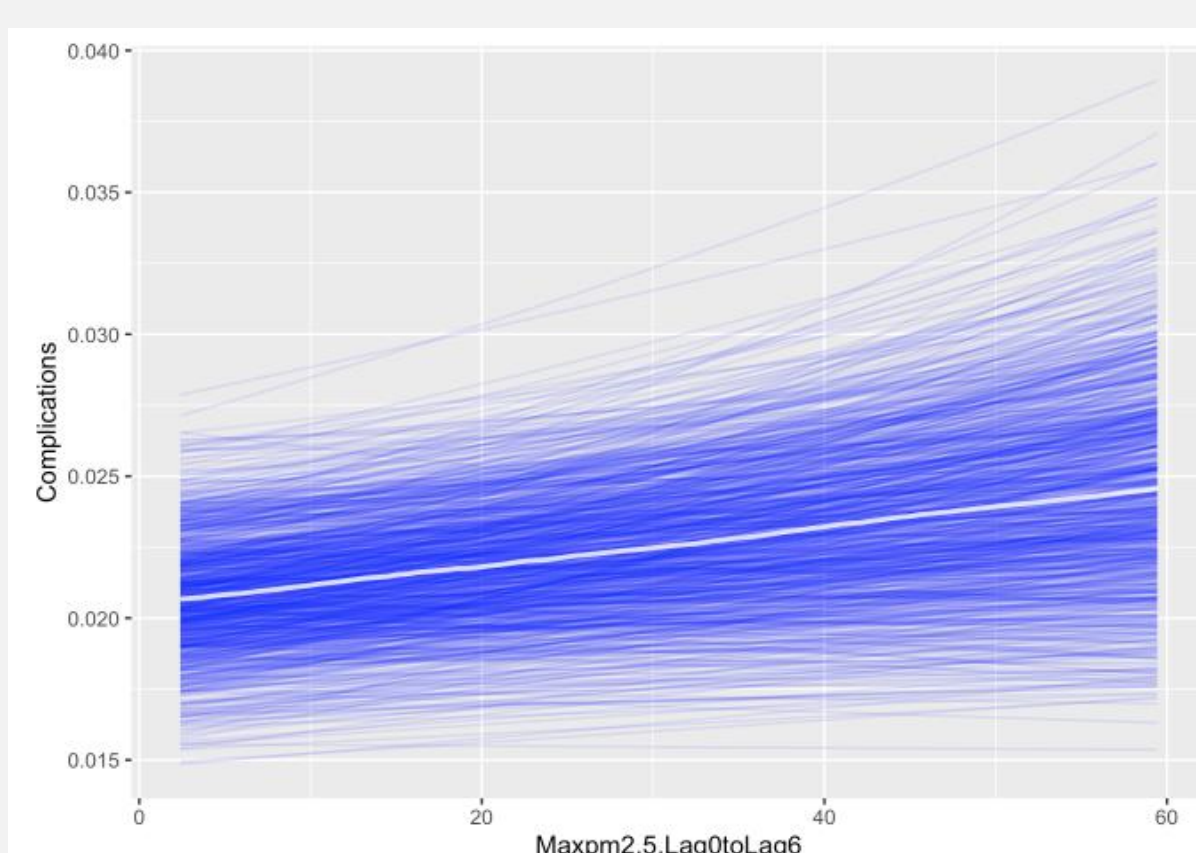


Figure 1: Complication Rate (0.015 = 1.5%) vs. Census-tract level PM2.5 estimate daily mean (in $\mu\text{g}/\text{m}^3$).

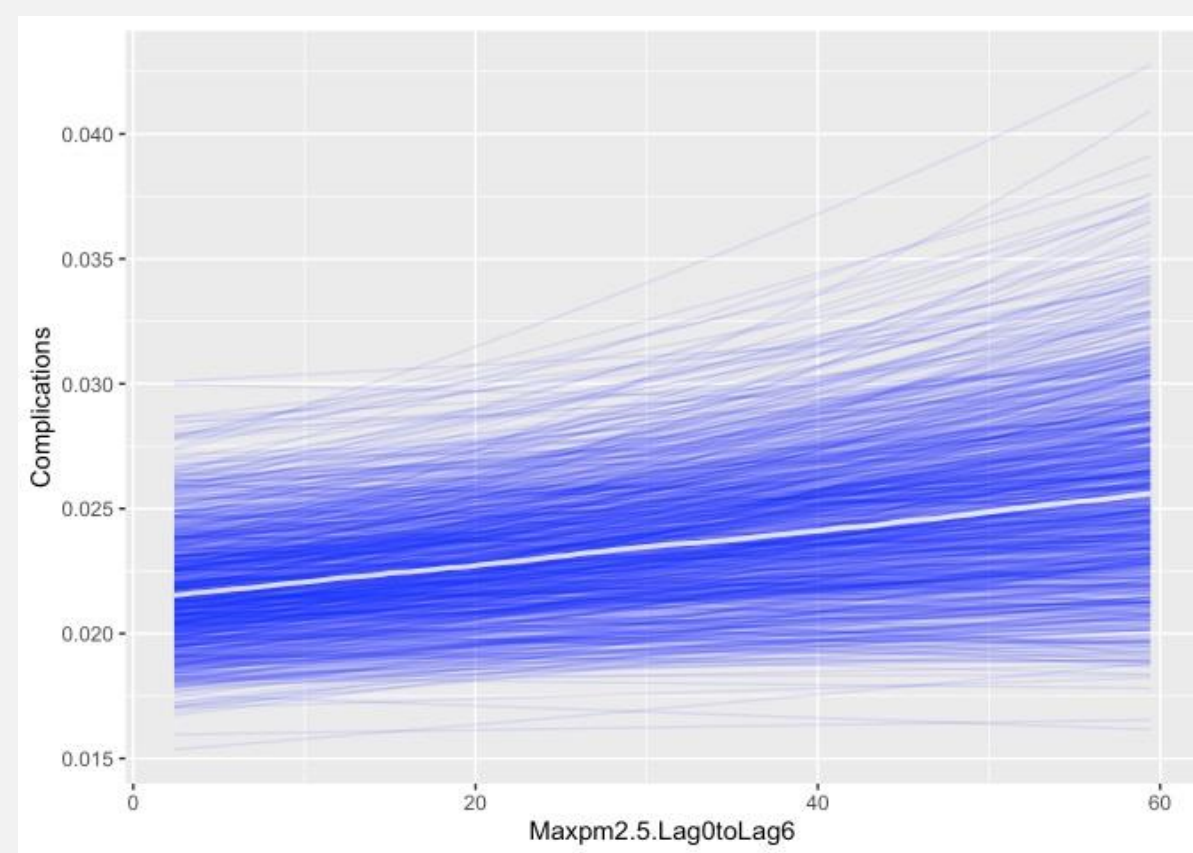


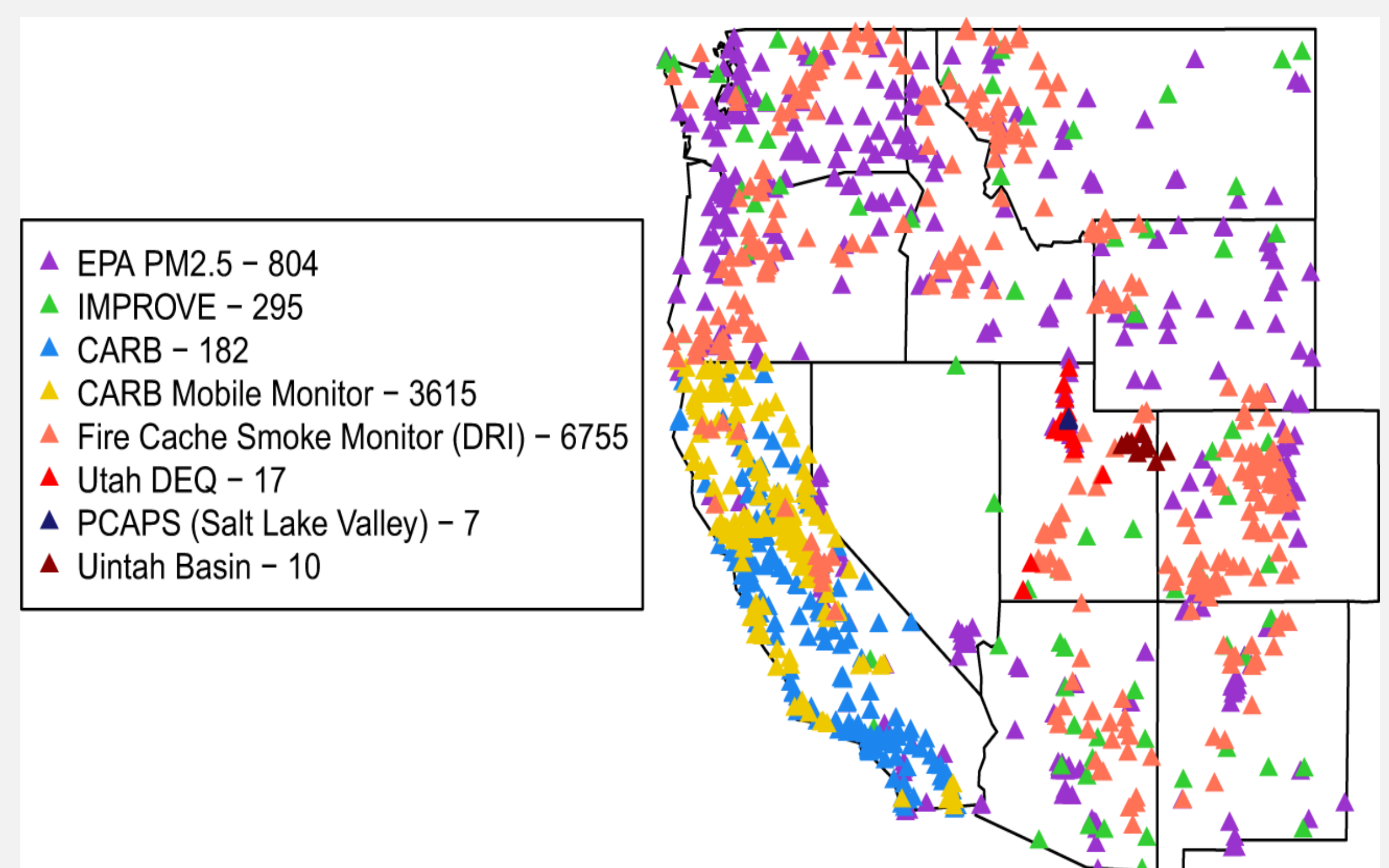
Figure 2: Complication Rate (0.015 = 1.5%) vs. EPA Single Site Hawthorne Monitor PM2.5 estimate daily mean (in $\mu\text{g}/\text{m}^3$).

Results: Scale & SDOH Surprises

- 90,051 adult patients from Salt Lake County
- Binary model ($\text{PM}_{2.5} > 35 \mu\text{g}/\text{m}^3$): OR 1.2 (95% CI 1.012-1.433), Bayesian $R^2=0.275$
- Continuous model: effect=0.003 (95% CI -0.0009 to 0.007), crossing identity, weaker association
- Census tract-based nested models had slight predictive gains but minimal practical impact
- Complication rates declined over 2016-2023; Elixhauser was a key predictor; age/season had minimal effects
- Results demonstrated poorer fit with inclusion of Counties outside of EPA monitor site

Intro: Does Precise Exposure Scale Matter?

- Over 6 million annual deaths are attributed to PM2.5 worldwide(1).
- We previously linked PM2.5 to increased postoperative complications(2), using geocoded Census Tract (CT)-level PM2.5(3) and SDOH data(4).
- Scaling this across MPOG (5) is hampered by regulatory and data challenges inherent to address-level geocoding.
- Without geocoding, we lose access to critical SDOH and CT-level PM2.5 data.
- To address this, we propose using the nearest EPA regulatory monitor at each MPOG site, removing the need for geocoding.
- Prior studies validate this approach(6), but not in perioperative cohorts.
- We compared CT-based vs. single-site EPA-based PM2.5 data in our UU MPOG cohort.
- We hypothesized that EPA monitor-based results would be comparable to the geocoded method.



From Reid et al. (3) Single Site Monitoring Stations, by Source of Monitor. There are hundreds of EPA monitors throughout the Western USA, however their distribution in rural areas is lacking, and often one to several per County.

Conclusion: Feasible, With Caveats

- High PM2.5 ($> 35 \mu\text{g}/\text{m}^3$) within 7 days pre-surgery \uparrow complication risk by 20% (OR 1.2, 95% CI 1.012-1.433)
- EPA monitor data is feasible for scalable analysis, but county-level (or city-level for nationwide studies) is recommended to minimize misclassification bias
- Wider geographies (large counties, high geographic variation) require caution
- Excluding SDOH data did not significantly affect results
- Future research should explore mechanisms linking environmental/social factors to surgical risk

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