**INTRODUCTION**

Exposure to traffic-related air pollutants (TRAP) can cause and exacerbate many adverse health impacts, especially considering the susceptibility and vulnerability of many individuals living near major roads. Traffic is responsible for a major share of emissions in cities, and the contribution of TRAP to PM Appear to be increasing relative to other sources in large US Midwestern cities like Detroit and Chicago. Thus, is remains important to continue to develop air pollution modeling and exposure tools that can be used in health studies to improve exposure estimates and reduce exposure error measures, which can alter study outcomes with implications for the development of policies and regulations.

This poster summarizes recent work exploring and combining two approaches for predicting near-roadway pollutant concentrations. The first is dispersion modeling, specifically the Research Line-source (RLINE) model, a recently developed model designed for near-roadway applications, which includes novel features including improved estimates of downwind and upwind dispersion, and effects of depressed roadways and road-edge geometry. Several of these features have not been evaluated in the peer-reviewed literature, and few studies have evaluated the overall performance of RLINE. The second uses statistical data fusion models that combine observations of pollutant concentrations obtained at monitoring sites with dispersion model predictions.

**OPERATIONAL EVALUATION OF RLINE**

Performance metrics for NOx and CO are summarized in Table 1; scatterplots are shown as Figure 2.

- For NOx, daily RLINE predictions (20 - 38 ppb) were similar to observations (23 - 48 ppb), however, for CO, predictions (180 - 320 ppb) generally fell below observations (479 to 673 ppb).
- Model performance decrease with distance from the road, e.g., for NOx, R2 fell from 0.58 to 0.74 at the near-road site (10 m from I-96), 0.57 to 0.58 at the 100 m Eliza Howell (urban) site (100 m from I-96), and 0.32 at the E 7 Mile (sites) site (350 m from MI-87).
- Performance was better during “downwind” conditions as compared to winds parallel to roads.

Evaluation results depended on the site. For example, the near-road site (using the IngChem monitor) had the highest R2 (Figure 2), the lowest % reducible VG, the highest model-mean to background ratio, but the highest F8. The E 7 Mile (site) was predicted to under predict daily averaged suburban, urban and industrial sites, as over-predicted; and reducible errors at all sites exceeded systematic errors, suggesting improvements in model inputs or parameterizations could improve model performance.

Evaluation results depended on the monitoring instrument, in part being a function of detection limits. This applied to CO where measurements often fell below detection limits. It also applied to NOx measurements, e.g., those at the E 7 Mile (site) (mean=48 ppb) exceeded the CHEM performance metrics (37 ppb predictions), while predictions during these periods were similar (38 and 37 ppb).

**DISPERSION MODELING**

We compared modeled and measured concentrations of NOx, CO, and PM10 in Detroit, MI from the period from 2011 to 2014. Figure 1 shows the study domain.

On-road mobile sources were modeled using an updated, spatially- and temporally-resolved link-based emission inventory (9700 links), emission factors from MOVES2014a for the local vehicle mix, link speed estimates, and ambient temperature. Vehicle volume estimates were weighted by vehicle emission factors, several vehicle emission factors, and weighted using data from the Michigan DOT traffic count database. Updated temporal allocation factors were used to add contributions back to 14 permanent traffic recording stations in Detroit.

**SENSITIVITY ANALYSIS**

Statistical performance metrics included the root mean square error (RMSE), percent of predictions within a factor of 2 (FA2), fractional and mean bias (FB and MB), geometric mean bias (MG), normalized mean squared error (NMME), and geometric variance (VG). Performance was evaluation by pollutant, site, and year. Effects were seen across the year. Here we show results by wind direction.

Sensitivity analysis. In this poster we show sensitivity to four meteorological datasets: Detroit City airport (KDTx), Detroit Metro airport (KDTKX), on-site/DTKx, and on-site/DTKx. [Onsite required additional inputs from the airport data.] We evaluated each input in a manner improved in a meaningful way, e.g., threshold of 0.05).

**DATA FUSION MODELS**

Here we investigate if improved estimates of TRAP concentrations can be obtained using statistical data fusion models that combine monitoring observations and RLINE output. We explore whether RLINE outputs can improve estimates of TRAP concentrations in near-road urban environments, whether RLINE output can relate to other adverse health outcomes, and whether the combined use of updated emission inventory, and whether estimates improve if pollutants are jointly vs. independently.

Monitoring data were collected using a Mobile Air Pollution Lab (MAPL) along nine transects that crossed major roadway intersections. Data was collected from the transect area up to 500 distance from the road, which was sampled at 3.5 m for NOx, PM10, and other measurements. For each pollutant, the ‘best-fit’ concentration was defined as the lower limit of the 95% confidence interval of the lowest pollutant concentration in that area during the monitoring period, and the ‘near-road increase’ (MR) was defined as the difference between the observed and background pollutant concentrations.

Dispersion modeling using RLINE predicted NOx and PM10 concentrations attributable to traffic, where RLINE was run using 195 regularly spaced point locations within a 1 km region centered around the major road, during the same period that the monitoring data were recorded.

Several statistical models were considered. Single pollutant models were used a regression model: $Y = a + b_1 X_1 + e$, where $Y$ is the log NOx concentration for a pollutant at site $x$ at time period $t$, $X_1$ is large spatial trend for site, and $e$ is a normally distributed error term. Using the $b_1$ from this model, we estimated the percent improvement in the log NOx pollutant concentration; $e$ is small spatial variation in the log NOx pollutant concentration; $e$ is independent error process; $X_2$ is log NOx pollutant concentration for time period $t$ provided by the RLINE at the closest receptor to location $x$ and $e$ is a normally distributed error term.

All models were fit within a Bayesian framework using MCMC algorithms, and validation was performed by comparing predictions with observed values at the hold-out sites. Some results are shown in Tables 3 and 4.

**SENSITIVITY ANALYSIS**

The meteorological dataset affected RLINE performance. Performance metrics, compared in Table 2 for NOx differed by site and metric:

- For $R_2$, the use of onsite data often improved results: onsite/KDET was best at the near-road and urban sites, and on-site/DTKD and onsite/KDTKx were often better when using all data.

Considering just airport data, KDET was typically better than KDTW, confirming other analyses.

- VG also showed benefits from using airport data, and on-site/KDET had close to these VG for all sites and methods.

Trends with the other metrics varied by site and instrument.

**REFERENCES**


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