DEVELOPMENT OF TRANSPORTATION AIR EMISSIONS IN CANADIAN CITIES

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INTRODUCTION

Urban transportation emissions can impact significantly on local and regional air quality. A common approach to account for roadway emissions for modelling purposes is to apply road network spatial allocations with regional transportation total emissions. Emission processing models, such as U.S. EPA's SMOKE, can be used to obtain gridded, hourly, speciated emissions. Transportation emissions for Edmonton, Alberta were required as an input to the regional air quality model CMAQ. Comparison of two available data sources was done to select the most accurate emissions to characterize transportation inputs in the region.

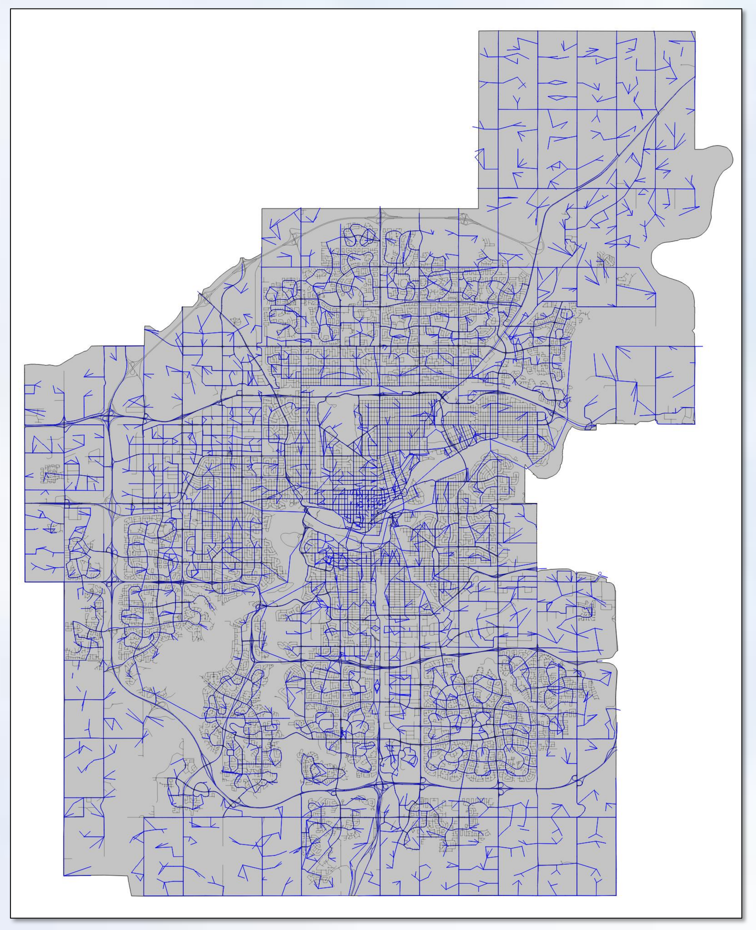

Figure 1 – Canvec 2010 road network (black) overlaid with the CALMOB6 link-based road network (blue)

TRANSPORTATION EMISSION SOURCES

Two data sources were available for transportation emissions in the region; standard distribution of Environment Canada province-wide emission totals using a spatial surrogate, and city specific emissions calculated by the City of Edmonton.

The U.S. EPA's Spatial Surrogate Tool can be used to generate inputs for emission models such as SMOKE. For transportation emissions, a regional total is distributed using a road network shapefile, with road types, lengths, and densities determining the portion of the regional emissions that will be distributed to each gird cell. The CanVec 2010 road network, available from Natural Resources Canada, was used to distribute emissions in Edmonton and throughout the entire province using SMOKE's spatial surrogate tool.

The City of Edmonton uses a fuel economy and emissions model based on the U.S. EPA's MOBILE6 to calculate emissions within the city boundary. The model uses the output of urban travel forecasting models based on city specific traffic counts to provide emissions tailored exclusively for the area.

The CALMOB6 road network and the CanVec 2010 road network are both shown in **Figure 1** for comparison.

MODEL COMPARISON

A comparison of emissions within the city limits was done to select the transportation emission model to be used. The CALMOB6 model generally provides lower total emissions for the City of Edmonton when compared to the spatial surrogate (CanVec + SMOKE). **Figure 2** provides emissions during a typical January weekday.

While the CALMOB6 emission totals are lower, they are very well distributed throughout the city, with emission hot spots along major truck routes, highways, and through the downtown core. The spatial surrogate on the other hand shows some of the larger emission hot spots in residential areas throughout the city. This can be attributed to higher road density in these areas skewing the distribution of the province-wide emissions.

By incorporating actual traffic data CALMOB6 is able to characterize transportation emissions in the city with better spatial accuracy than the SMOKE spatial surrogate.

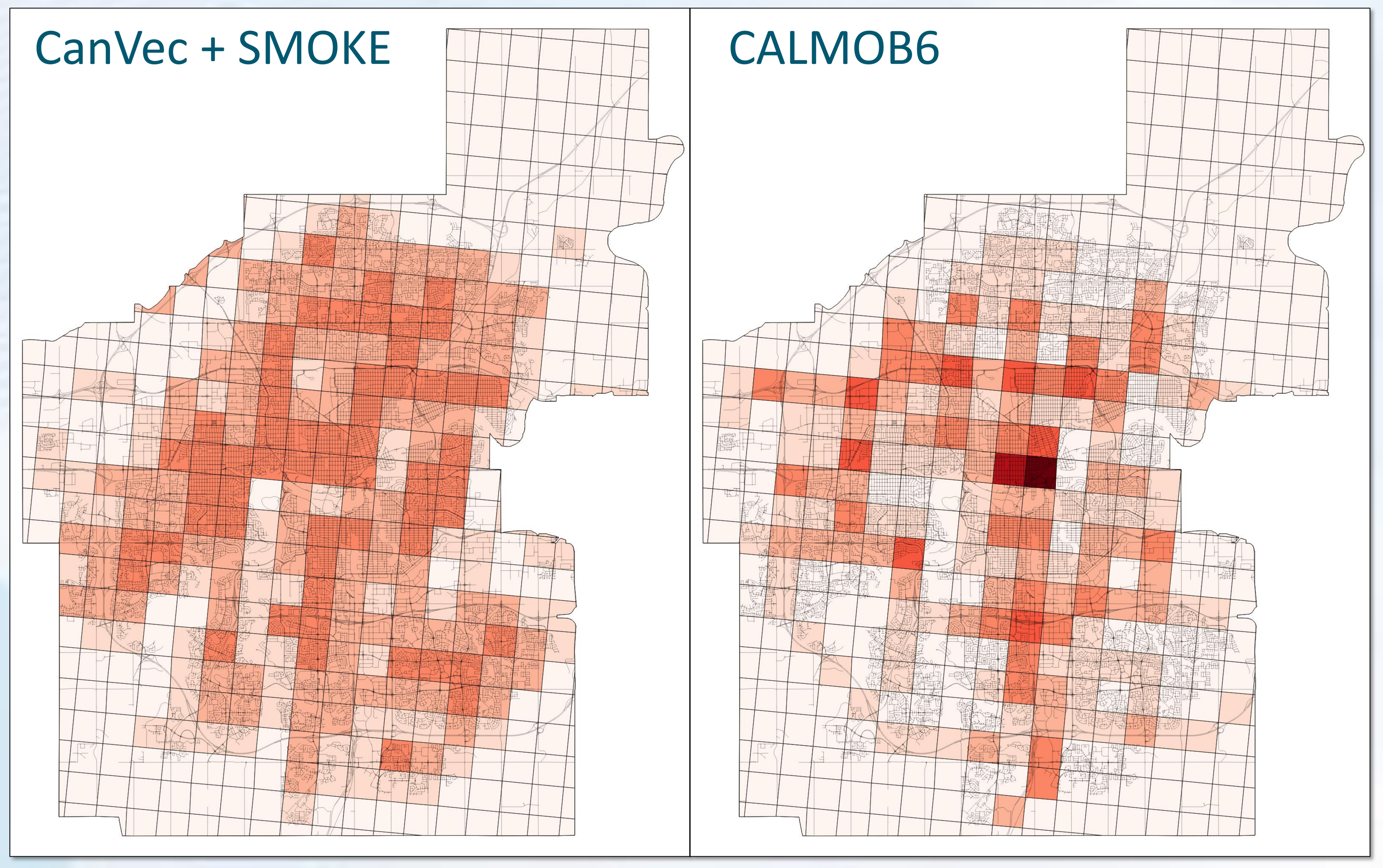

Figure 2 – NO_x emission distribution from CanVec + SMOKE and CALMOB6

INTEGRATING EMISSION SOURCES

While CALMOB6 emissions were selected for the City of Edmonton, the Spatial Surrogate was used for the remainder of the province/study area. Integrating these two transportation emission sources presented a unique challenge. Poor transitions between sources could result in boundary effects with unexpected impacts along the city edges.

TEMPORAL PROFILES

While it was shown that the CALMOB6 data provides a better spatial distribution than CanVec + SMOKE Spatial Surrogate, the temporal distribution is very coarse, focusing on typical rush hour periods and daily totals. To eliminate edge effects when blending emission profiles a better temporal distribution needed to be developed for use with the CALMOB6 emission totals.

Temporal profiles for emissions within the City of Edmonton were developed for heavy and light duty vehicles. The CALMOB6 model uses 21 vehicles classes which were divided into these 2 categories based on vehicle type and relative spatial distribution of each class.

Traffic counts provided by the city were used to generate a representative profile for light-duty vehicles during both weekday and weekend periods. Plots of the resulting light duty vehicle diurnal profiles are included in **Figure 3** for both weekdays and weekends.

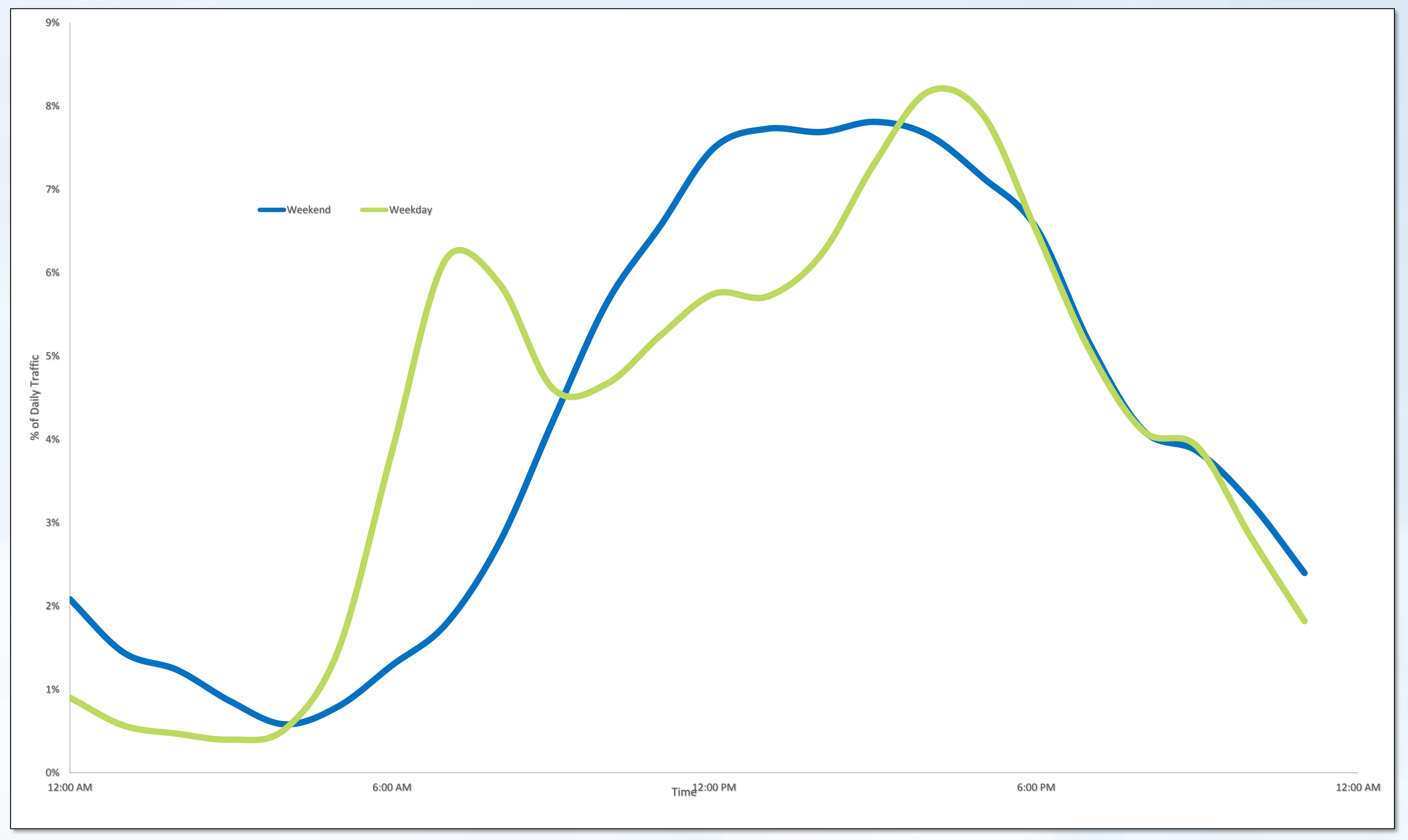

Figure 3 – LDV diurnal traffic profiles developed from city-wide traffic counts

WEEKLY PATTERNS

Weekly traffic patterns for light-duty vehicles were extracted from representative traffic counts provided by the city. Heavy duty traffic variations were not available as a weekly pattern from any of the data sources available so the U.S. EPA standard heavy duty weekly traffic distribution was applied.

GENERATING SPATIAL SURROGATES

Once temporal profiles were developed new spatial surrogates needed to be produced to integrate the emissions with SMOKE. This was done for each of the vehicle classes to properly distribute emissions by standard classification code (SCC).

Each grid cell was assigned a percentage of the total emissions from each pollutant by vehicle class. While there are slight variations from pollutant to pollutant in terms of emission distribution, it was found that the overall profile for heavy and light duty vehicles remained fairly consistent. As shown in **Figure 4**, the distribution of heavy duty emissions is approximately equal across pollutants.

To generate the final surrogates the emission distribution for NO_x, $PM_{2.5}$, and SO_2 were averaged together. These surrogates effectively communicate the patterns produced by the CALMOB6 emissions, with heavy-duty contributions coming largely from the highways and the downtown core, while light duty emissions are well distributed, especially in residential areas.

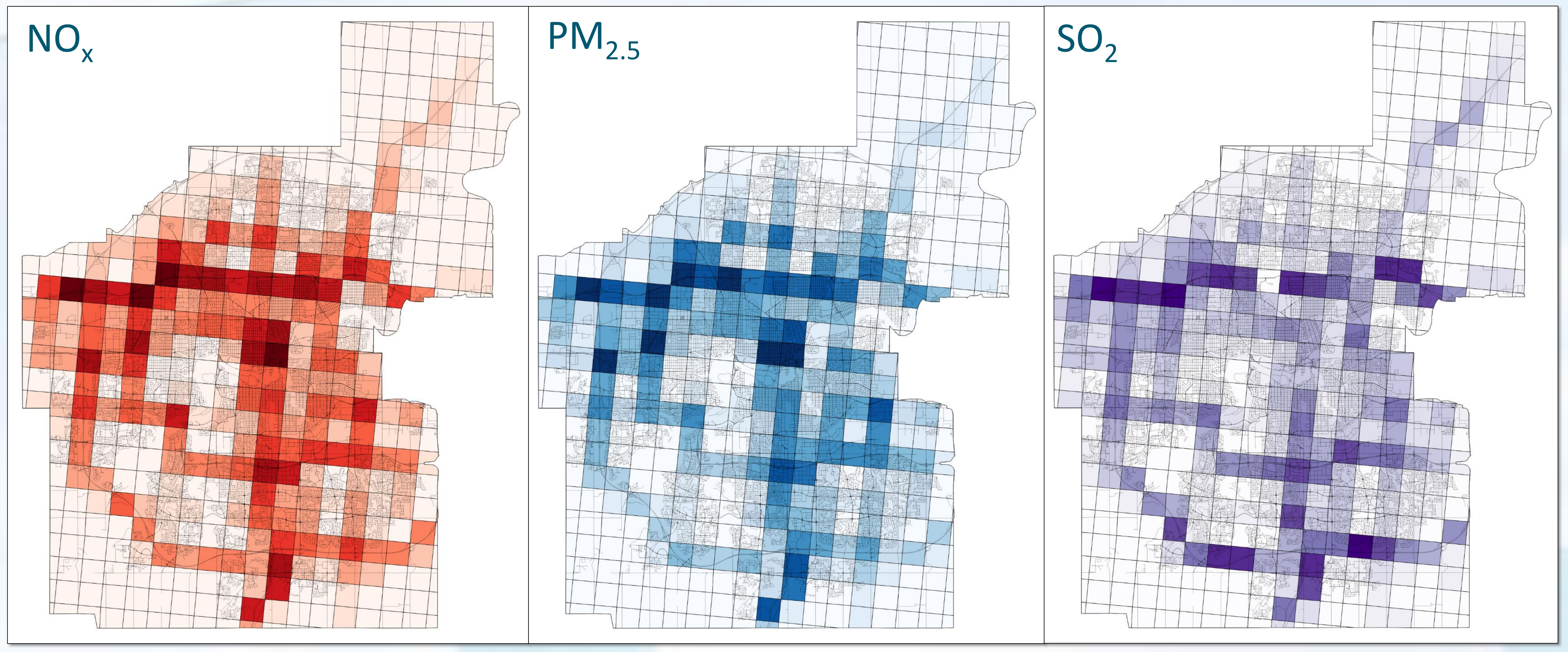

Figure 4 – HDV emissions distributions for NO_x, $PM_{2.5}$, and SO_2

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