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Investigation of Cross-border Differences in the Spatial Distribution of Onroad Mobile Emissions Between the U.S. and Canada

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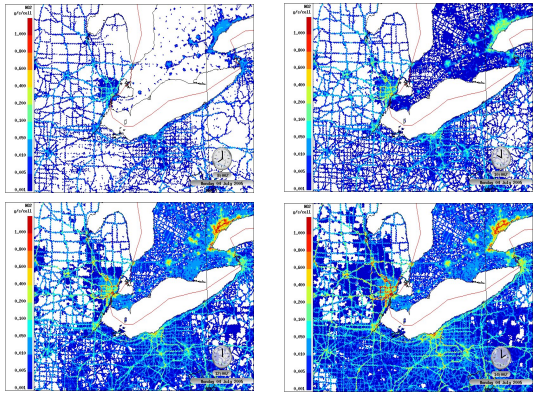
INTRODUCTION

- The Canadian air quality model AURAMS (A Unified Regional Air-quality Modelling System) was used to perform summer 2007 BAQS-Met (Border Air-Quality Study – Meteorology) simulations
- 2005 Canadian and U.S. national emissions inventories were processed to provide gridded emissions files for a high-resolution nested AURAMS grid with 2.5-km grid spacing
- Significant differences were seen in the spatial distribution of on-road mobile emissions across the U.S.-Canada border
- Per capita mobile-source emissions calculated from the U.S. and Canadian on-road mobile emissions were comparable, implying that the spatial distribution of the on-road mobile emissions was calculated differently for the two countries
- Spatial surrogates and temporal profiles used to distribute Canadian and U.S. Light Duty Gasoline Vehicle (LDGV) emissions were investigated to reveal the reasons for the differences in on-road mobile emissions across the international border

NO2 Emissions at 04, 06, 08, & 10 a.m. local time (08Z, 10Z, 12Z and 14Z UTC)

Figure 1. NO2 emissions (g/s/grid cell) at 4 local times



Cross-border Differences:

(1) Locations of the major highways in the US are obvious, but major Canadian highways can not be distinguished from smaller roads

(2) The Canadian on-road emissions appear to be overweighted to city centres (compare Detroit and Toronto) and also to smaller roads

(3) Canadian emissions are significantly smaller than the U.S. emissions a few hours before dawn, e.g., 4 am local time

Comparison of Spatial Surrogates for LDGV

> Canada, Figure 2
Only one spatial surrogate, which is the product of road length, number of lanes, and population density

> U.S., Table 1 & Figure 3
6 spatial surrogates were used to distribute LDGV emissions for 12 road classes (6 urban, 6 rural), table 1

Figure 2. Surrogate (934) for distributing Canadian LDGV emissions

CA 934 LDGV

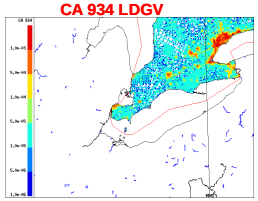
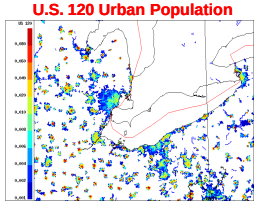


Table 1. Six surrogates for distributing U.S. LDGV emissions over 12 road classes

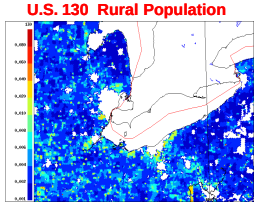
Road Class	Surrogate	Surrogate Description
Rural Interstate	210	Rural Primary Road Miles
Rural Principal Arterial	210	Rural Primary Road Miles
Rural Minor Arterial	210	Rural Primary Road Miles
Rural Major Collector	230	Rural Secondary Road Miles
Rural Minor Collector	230	Rural Secondary Road Miles
Rural Local	130	Rural Population
Urban Interstate	200	Urban Primary Road Miles
Urban Freeway	200	Urban Primary Road Miles
Urban Principal Arterial	200	Urban Primary Road Miles
Urban Minor Arterial	200	Urban Primary Road Miles
Urban Collector	220	Urban Secondary Road Miles
Urban Local	120	Urban Population

Figure 3. Surrogates for distributing U.S. LDGV emissions

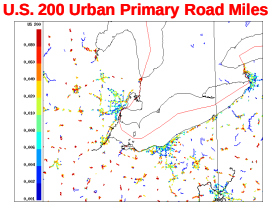
U.S. 120 Urban Population



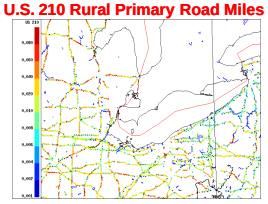
U.S. 130 Rural Population



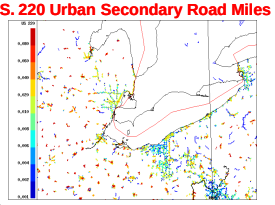
U.S. 200 Urban Primary Road Miles



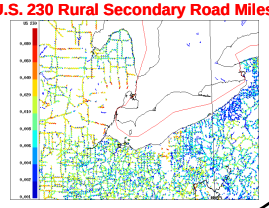
U.S. 210 Rural Primary Road Miles



U.S. 220 Urban Secondary Road Miles



U.S. 230 Rural Secondary Road Miles



Comparison of Diurnal Profiles for LDGV

> Canada
Only one diurnal profile was assigned to LDGV

> U.S.
12 diurnal profiles were assigned to LDGV for 12 road classes

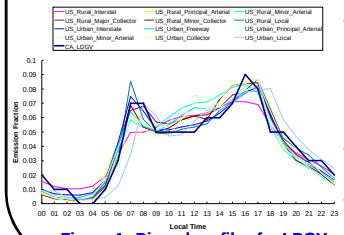


Figure 4. Diurnal profiles for LDGV

- All of the U.S. and Canadian profiles follow similar pattern: peaks at morning and evening rush hours, minimum around 3 a.m. local time
- Significant differences among different U.S. road classes
- No emissions at 3 & 4 a.m. from Canadian LDGV

CONCLUSIONS

➢ For a high-resolution (2.5-km) model grid, differences between the spatial distribution of U.S. and Canadian on-road mobile emissions after processing by SMOKE were obvious

➢ U.S. on-road mobile emissions were apportioned in the 2005 U.S. national emissions inventory to 12 subcategories by road type (e.g., rural interstate, urban collector), whereas no such apportionment was made for Canadian on-road mobile emissions in the 2005 Canadian national inventory

➢ 6 spatial surrogates at the county level were applied to disaggregate the U.S. on-road LDGV emissions spatially by road type, whereas only a single spatial surrogate at the provincial level was applied to Canadian on-road LDGV emissions

➢ For Canada, unrealistically high mobile emissions were allocated to rural areas with long roads but low population density and to city centers with high population density

➢ 12 different diurnal profiles, one for each of the 12 road classes, were used to distribute the U.S. LDGV emissions temporally, but only one profile was used for Canadian LDGV emissions; the zero emissions assumed at 3 & 4 a.m. seem unlikely for some road types

➢ New spatial surrogates similar to the U.S. ones should be used to process Canadian on-road mobile emissions, but Canadian on-road mobile emissions must first be provided separated by road type, which is not currently the case