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2006 Canadian emissions for air quality modelling

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Role of AQMAS

- The Air Quality Modelling Applications Section (AQMAS) supports and promotes emissions modelling activities both internal and external to Environment Canada.
- AQMAS intends to distribute model-formatted emissions inventories (SMOKE-ready) based on the latest versions of the Canadian National Pollutant Release Inventory (NPRI).
- In addition, we document and distribute ancillary files to support emissions processing for air quality model applications – gridding, temporal allocation, and chemical speciation of inventory emissions.

Talk Outline

- Overview of the 2006 Canadian base-year emissions inventory for air quality models
- Changes to fugitive-dust transport fraction calculation by land-use
- Revised VOC and PM speciation profiles and PM size disaggregation by size bins.
- Improvements to spatial allocation based on the latest socio-economic data from the 2006 Canadian census.

2006 Canadian Emissions Inventory

- The Canadian 2006 comprehensive Criteria Air Contaminants (CAC) emissions inventory is used by current AQMAS 2006 modelling platform.
- 528 SAROAD VOC species are included into the point sources. The inventory include also Mercury, Cadmium, Lead, Dioxins and Furans.

Description	CO	NH_3	NO_X	PM_{10}	$PM_{2.5}$	SO_2	VOC
Industrial	1,475,045	18,039	765,468	163,318	87,405	1,354,835	755,744
Fuel comb	721,532	1,784	76,047	112,098	110,932	46,370	155,405
Utilities	34,067	328	226,534	12,683	6,052	459,887	2,048
Miscellaneous	3,975	1,614	37	8,717	8,585	0	410,801
Incineration	4,432	75	962	523	418	1,817	1,309
On-road	4,206,390	20,227	499,771	13,935	9,882	5,034	258,646
Off-road	2,758,024	736	731,019	59,258	56,251	102,502	313,568
Open sources	26,946	504,443	6,830	1,670,911	259,489	1,309	311,104
Forest fires	2,484,823	5,325	79,159	256,470	211,210	178	340,776
Total	**11,715,233**	**552,570**	**2,385,826**	**2,297,913**	**750,224**	**1,971,931**	**2,549,402**

2006 total anthropogenic emissions for Canada (metric tons)

What's new in the 2006 Canadian emissions inventory?

- Better CAC emissions estimates
- Improved on-road mobile inventory
  - Emissions by I/M region instead of provincial total
  - Emissions by vehicle operation (EXH, EVAP)
  - Monthly emissions to account for temperature changes
- Most of industry emissions are in point-source format with detailed stack information
- Point sources have no SCC codes; however, they do have individual VOC speciation (ADOM-II, CB05, others) and temporal profiles
- Improved estimates of grid-scale fugitive dust emissions.

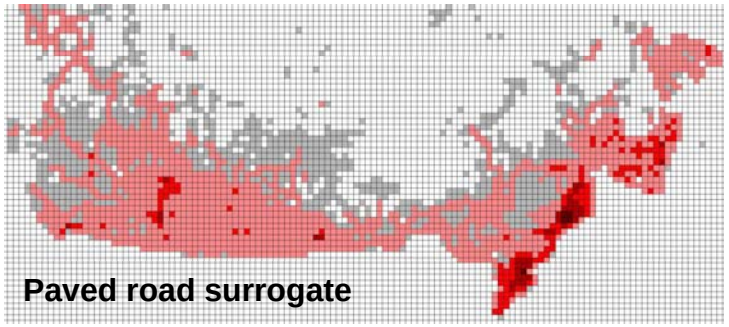
Fugitive-dust emissions transportable fraction (1)

1 – Calculate the TF fraction field

Land use type	TF
Evergreen, deciduous and mixed forest	0%
Urban	50%
Crops, mixed farming Dwarf trees, shrubs, tundra, grassland Wet land with plants	75%
Desert, Ice caps and glaciers Inland water, Ocean	100%

TF for each land-use type

2 – Generate spatial surrogates

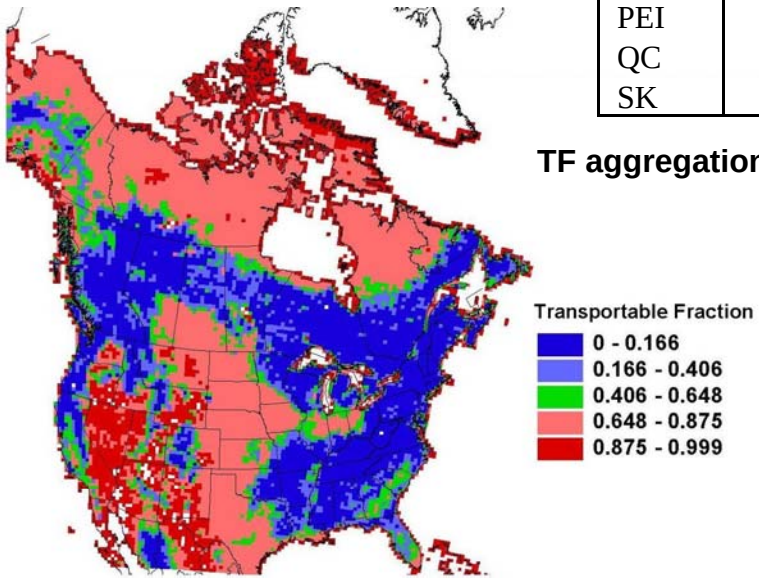


Paved road surrogate

Adjustments applied to determine the particulate matter fugitive dust emissions transportable fraction by province.

Prov	Average TF
AB	0.23
BC	0.24
MB	0.33
NB	0.21
NF	0.51
NS	0.51
ON	0.22
PEI	0.78
QC	0.33
SK	0.44

TF aggregation by province



TF at 45-km resolution with the surface field generator GenPhysX

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Fugitive-dust emissions transportable fraction (2)

3 – Apply the transportable fractions to each spatial surrogate

Prov	Urban area TF	Mining TF	Paved road TF	Unpaved road TF
AB	0.40	0.28	0.38	0.44
BC	0.27	0.08	0.19	0.12
MB	0.62	0.28	0.53	0.51
NB	0.30	0.22	0.18	0.09
NF	0.53	0.64	0.42	0.31
NS	0.27	0.26	0.33	0.24
ON	0.27	0.17	0.24	0.17
PEI	0.66	0.72	0.68	0.65
QC	0.26	0.23	0.20	0.10
SK	0.71	0.65	0.66	0.66

- A combination of surrogates and TF was generated,
- The new surrogate is calculated by intersecting each TF grid cell with the surrogate,
- The result is aggregated to the province level.

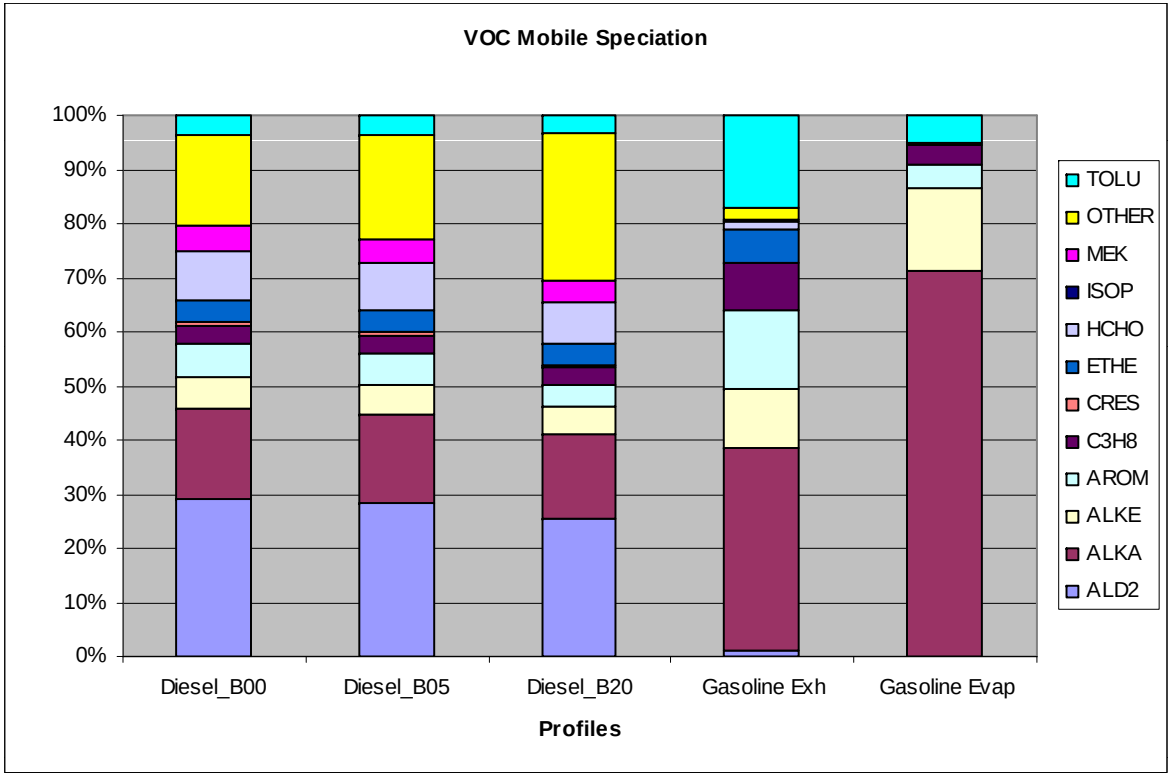
4 – Scale the emissions inventory with the new transportation fractions

2006 $PM_{2.5}$ fugitive dust	AB	SK	MB	NL	NS	PEI	NB	QC	BC	ON
Paved roads	52%	164%	112%	68%	30%	170%	-30%	-20%	-23%	-5%
Unpaved roads	75%	164%	106%	24%	-3%	161%	-65%	-59%	-53%	-32%
Residential construction	62%	184%	148%	111%	7%	164%	22%	4%	8%	9%
Heavy Construction	11%	161%	10%	155%	3%	189%	-11%	-8%	-66%	-31%

Percentage difference in fugitive dust emissions calculated after using the old and the new TF method

Creation of SMOKE speciation input files

Biodiesel VOC speciation profiles for vehicle exhaust were constructed using measurements made by an Environment Canada laboratory

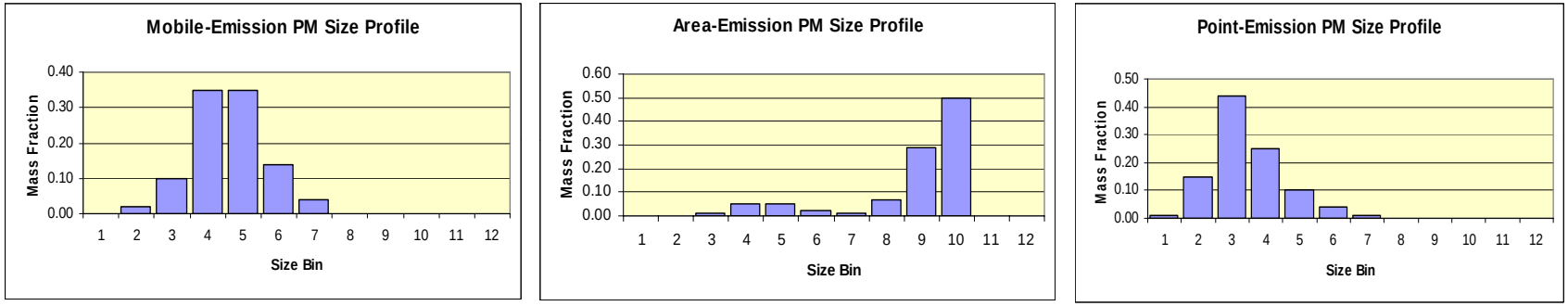


Gasoline, regular diesel, and bio-diesel speciation profiles

Particulate matter speciation and size disaggregation

PM emissions were speciated into chemical components by SCC and size disaggregated into 12 different size bins by primary source category

- The PM species are sulfate, nitrate, soil dust, black carbon, and organic carbon
- three size profile by emission category:



Particulate matter size distribution for mobile, area, and point sources

Updated Canadian spatial surrogates (1)

- A new set of Canadian spatial surrogates based on the 2006 census data from Statistics Canada is now available:
  - 108 NAICS classes
  - an updated Canadian National Road Network (2009).

POPULATION	SPORTSTOR	BUILDEALER	SECURITIES	TOTTOUR
TOTDWELL	GENERSTOR	FDBVDEALER	INSURANCE	REPAIRMAIN
URDWELL	MISCSTOR	HEALTHSTOR	MUTALFUNDS	PERSERV
RDWELL	NONSTOR	GASSTOR	TOTBANK	RELIGUSERV
ALL_INDUST	TOTSTOR	AIRTRANS	REALESTATE	PRIVATHOUS
FOODMANU	ELECTMANU	RAILTRANS	RENTALSERV	TOTOSERV
BEVTABMANU	TRANSPMANU	WATERTRANS	LESSORS	FGOVADMIN
TEXTILMILL	FURNITMANU	TRCKTRANS	TOTREAL	PGOVADMIN
TEXTILPROD	MISCMANU	PASSTRANS	PROFECTEC	LMGOVADMIN
CLOTHMANU	TOTMANU	PIPETRANS	MANAGEMENT	ABADMIN
LEATHRMANU	FRMPRWSL	TOURTRANS	ADMINSERV	INTERADMIN
WOODMANU	PETPRWSL	SUPRTTRANS	WASTEMGMT	TOTGOV
PAPERMANU	FBTPRWSL	POSTAL	EDUSERV	COMFUEL
PRINTSUPRT	PERPRWSL	COURIER	AMBUSERV	TOTDISRET
PETCOLMANU	CARPRWSL	STORAGE	HOSPITALS	TOTINSTGOV
CHEMMANU	BUILDPRWSL	TOTTRWH	NURSEFAC	PRIMARY
PLASTCMANU	MACHPRWSL	PUBLISHSER	SOCIALASS	MANASSEM
MINERLMANU	MISCPRWSL	MOVIEINDUS	TOTSERV	DISRET
METALMANU	WSLAGNT	BROADCAST	ARTINDUST	COMSER
FABMETMANU	TOTWSL	DATASERV	HERITAGE	COMCOOK
MACHMANU	CARDEALER	TOTINFO	RECINDUST	
COMPUMANU	FURNITSTOR	BANKS	ACCOMSERV	
CLOTHSTOR	ELECTSTOR	CREDITSERV	RESTBARS	

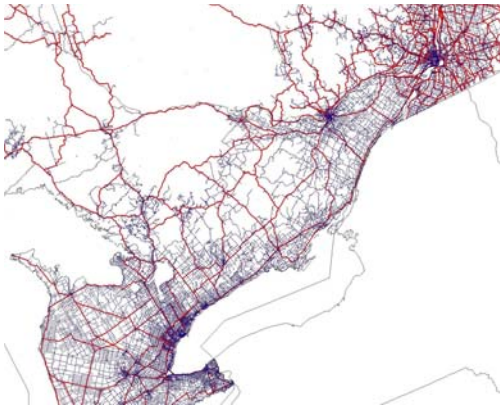
Surrogate attributes from 2006 census data

Updated Canadian spatial surrogates (2)

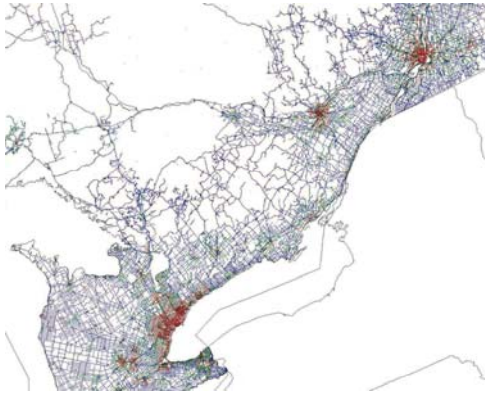
- On-road vehicles surrogates were developed as weighted population and roadway miles across all road classes.
- The average weight for all vehicle types are based on the amount of VMT the vehicles travel on each of the road types.

	Highway, freeways	Primary road (arterials)	Secondary road (collectors)	Residential Street
VMT	30%	42%	16%	13%

Average roadway type ratios for the Canadian road classes



Road classes in eastern Canada



Combination of road miles and population

Conclusion

We have developed a new 2006 Canadian emissions inventory for air quality model applications, including:

- Updated emissions inventory data relative to 2002 inventory
- More detailed on-road emissions inventory and revised VOC chemical speciation for on-road vehicles
- Revised transport fraction calculation by land-use
- PM emissions speciation and size allocation by source type
- New set of Canadian spatial surrogates based on 2006 census data from Statistics Canada and new cross-reference file

These improvements in the generation of Canadian emissions modelling files allow greater flexibility in the design of air quality modelling scenarios.