AIR QUALITY IMPACT OF OFF PEAK DELIVERY OF GOODS IN THE REGIONAL MUNICIPALITY OF PEEL

Redefining possible.

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GOAL OF THE STUDY

Previous Assessment:

- Design a reliable high resolution Air Quality photochemical model tool that can be used for urban planning (Base Case)
- Use the tool to assess the impact of population growth on health in the Region on Peel (Scenario)

Current Assessment:

- Air quality impact of an Off-peak delivery (OPD) emission scenario, where delivery of goods occurs during evening and overnight hours.

Background


New Tecumseth
124
89
Shelburne
East Gwillimbury
Newmarket
400
Aurora
404
48
Mono
Orangeville
Grand Valley
Caledon
Vaughan
Markham
Erin
407
400
401
Brampton
427
410
Toronto
Halton Hills
6
7
401
Mississauga
Guelph
407
Milton
6
Oakville
401
6
403
Cambridge
8
Burlington

Background

- Base Case

- **Current emissions (2010) were modeled**
- **Model results showed good agreement with monitoring data from NAPS for key pollutants**
- **Model results are sensitive to changes in emission intensity, chemistry, location and timing**
- **Model is well suited to inform high-level planning decisions**

Background

- Base Case
- **Population Growth Scenarios**

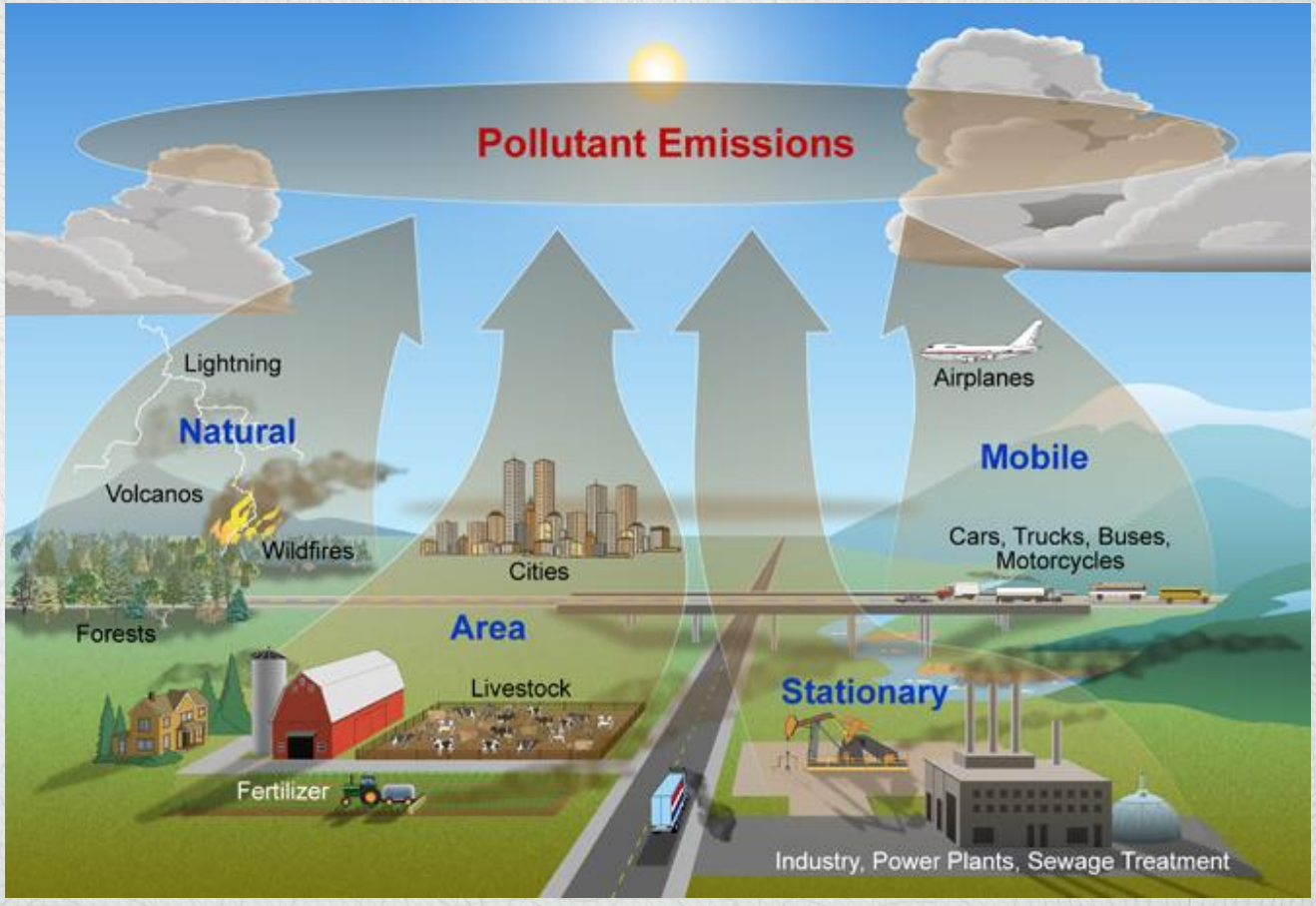
- **Several population growth scenarios were assessed**
- **Model results generated great interest in planning agencies**
- **Many opportunities were identified to extract valuable data to help inform planning and decision making**

Background

- Base Case
- Population Growth Scenarios
- **Updated Base Case (2015)**
- **OPD Scenario**

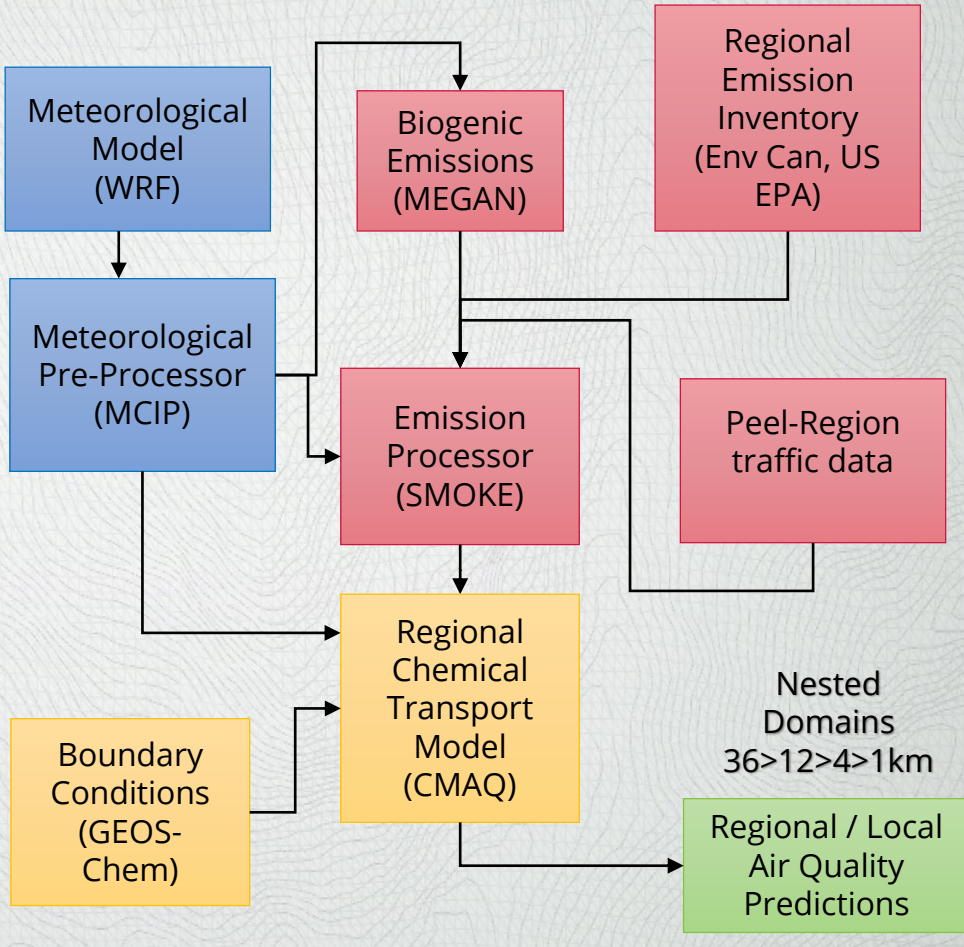
- **New base case (2015) was modelled**
- **Additional scenarios were developed in conjunction with the Region of Peel Steering Committee**
- **Off-Peak Delivery (OPD) Scenario was identified as the next step**
- **OPD: delivery of goods only occur during evening and overnight hours (7pm-7am)**
  - Pilot OPD was Launched and showed overall 11% reduction in emissions
  - Impact to air quality to be assessed prior to full scale implementation

Model Details

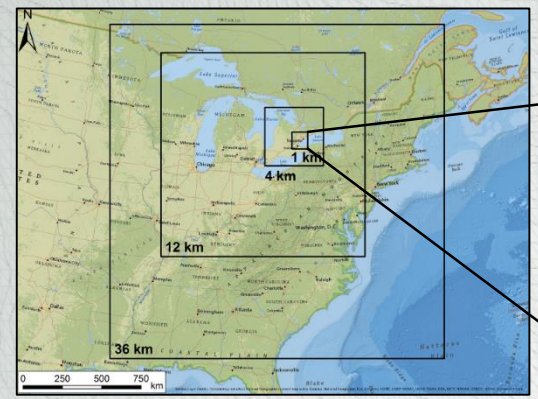


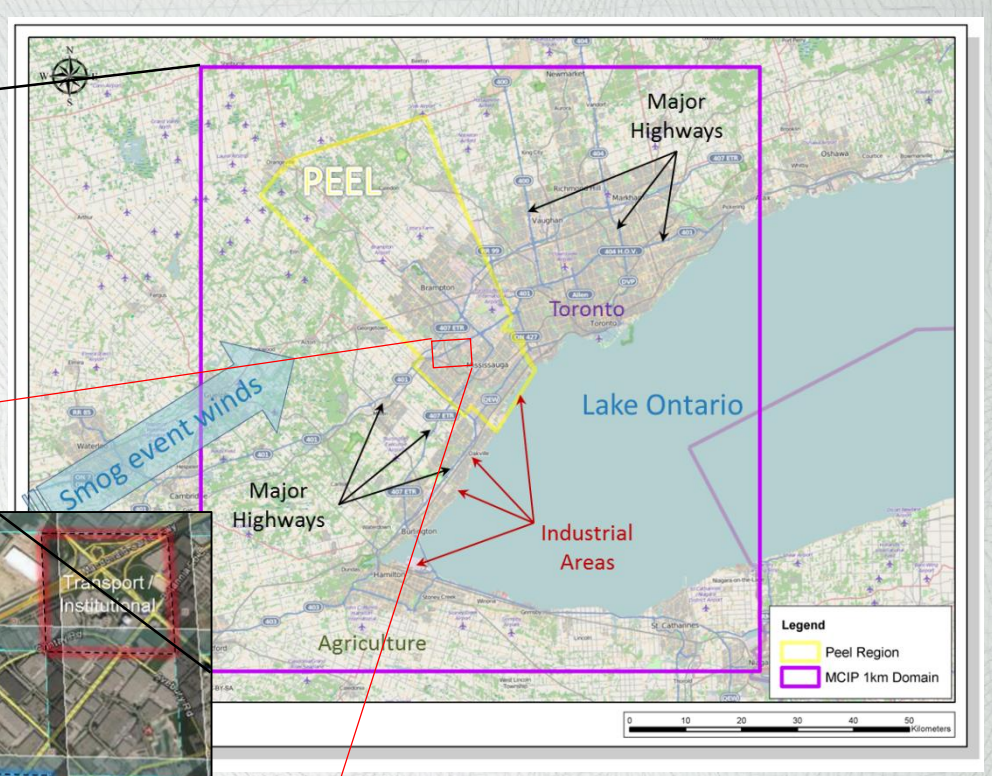
Model Details – Photo Chemical Modeling

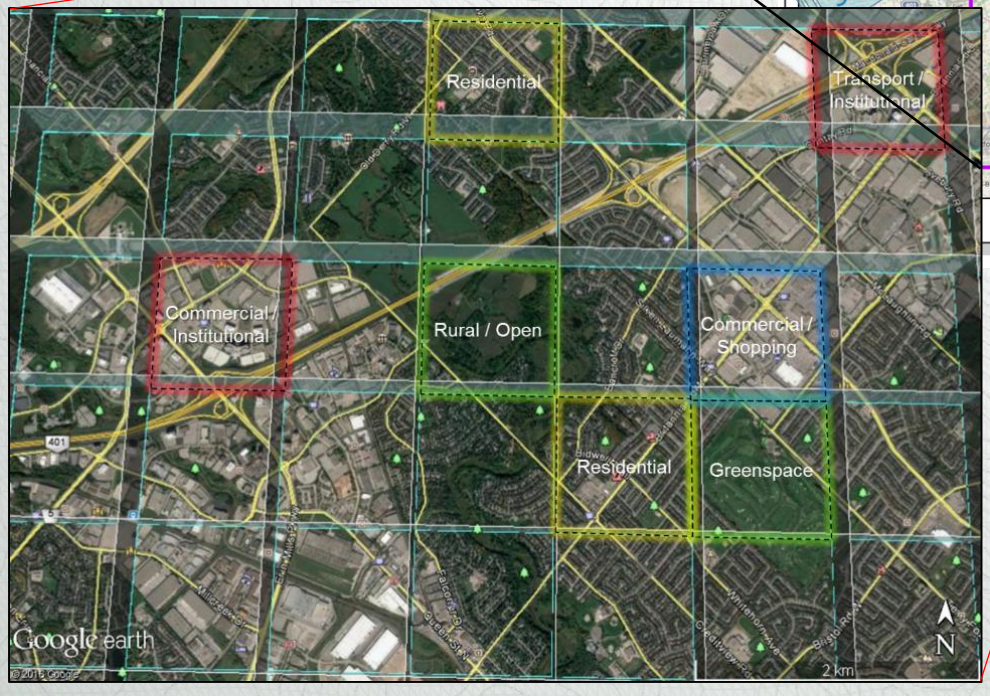
1. Meteorological model used to simulate winds, clouds and temperature over the study area.
2. Air emission inventories (Canada, US) are processed to account for spatial and temporal variations in emissions using GIS and emission processing tools.
3. Air quality models simulate the transport, dispersion, chemical reactions and deposition of complex compounds



Model Details – Nested Domains







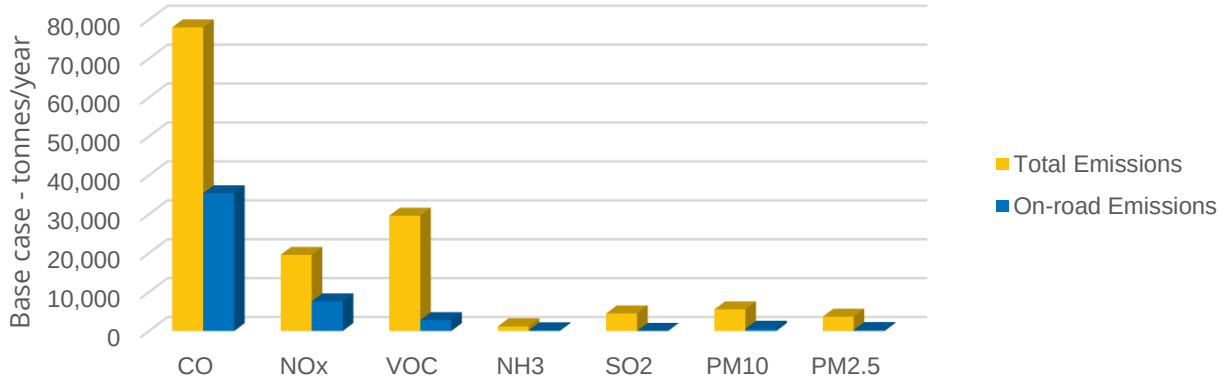
Model Details – The OPD Scenario

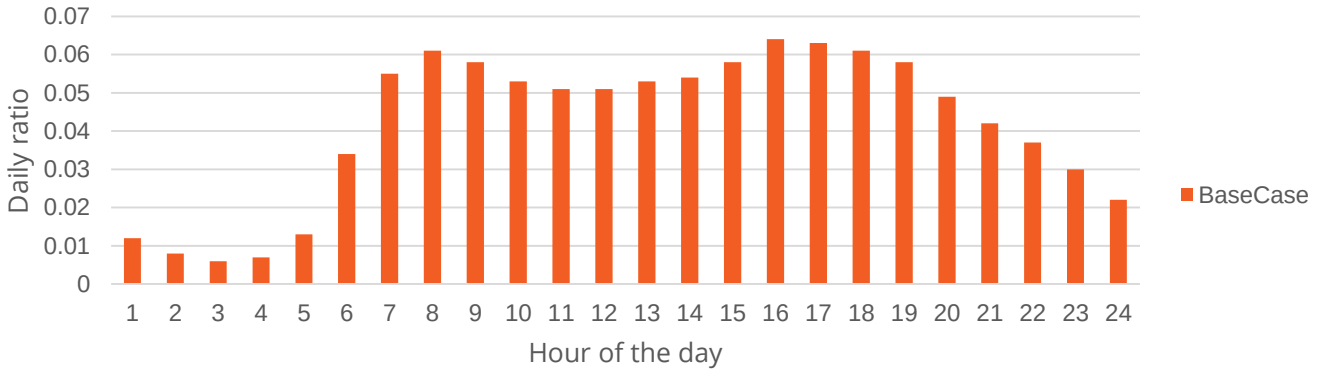
- The OPD scenario

- **Delivery trucks only (no cars)**
- **The retail sector only**
- **Retail delivery → 43% of light trucks**
  → 17% of medium/heavy trucks
- **Same road network**
- **OPD applied to the Region of Peel only, both for urban and rural areas**
- **OPD hours: 7 pm - 7 am**
- **100% participation rate**
- **Overall emission reduction = 11%**
- **OPD applied for weekdays and weekends**
- **The months of August and March were selected for modelling**

Model Details - Emissions

- **Base Case**
- **Diurnal Variations in base case**



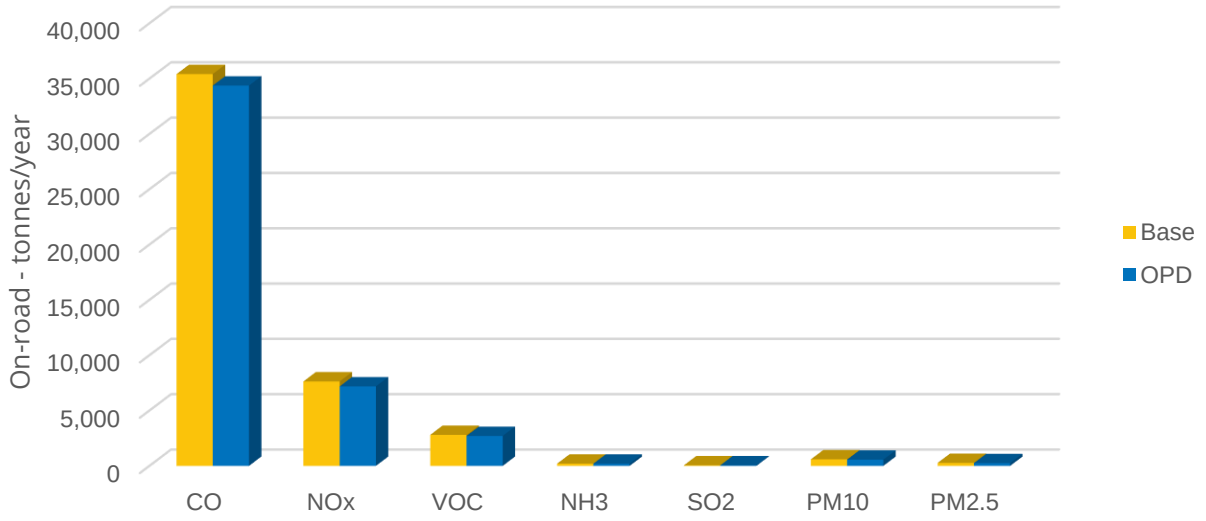


Diurnal variations in emissions of trucks on urban highways

Model Details - Emissions

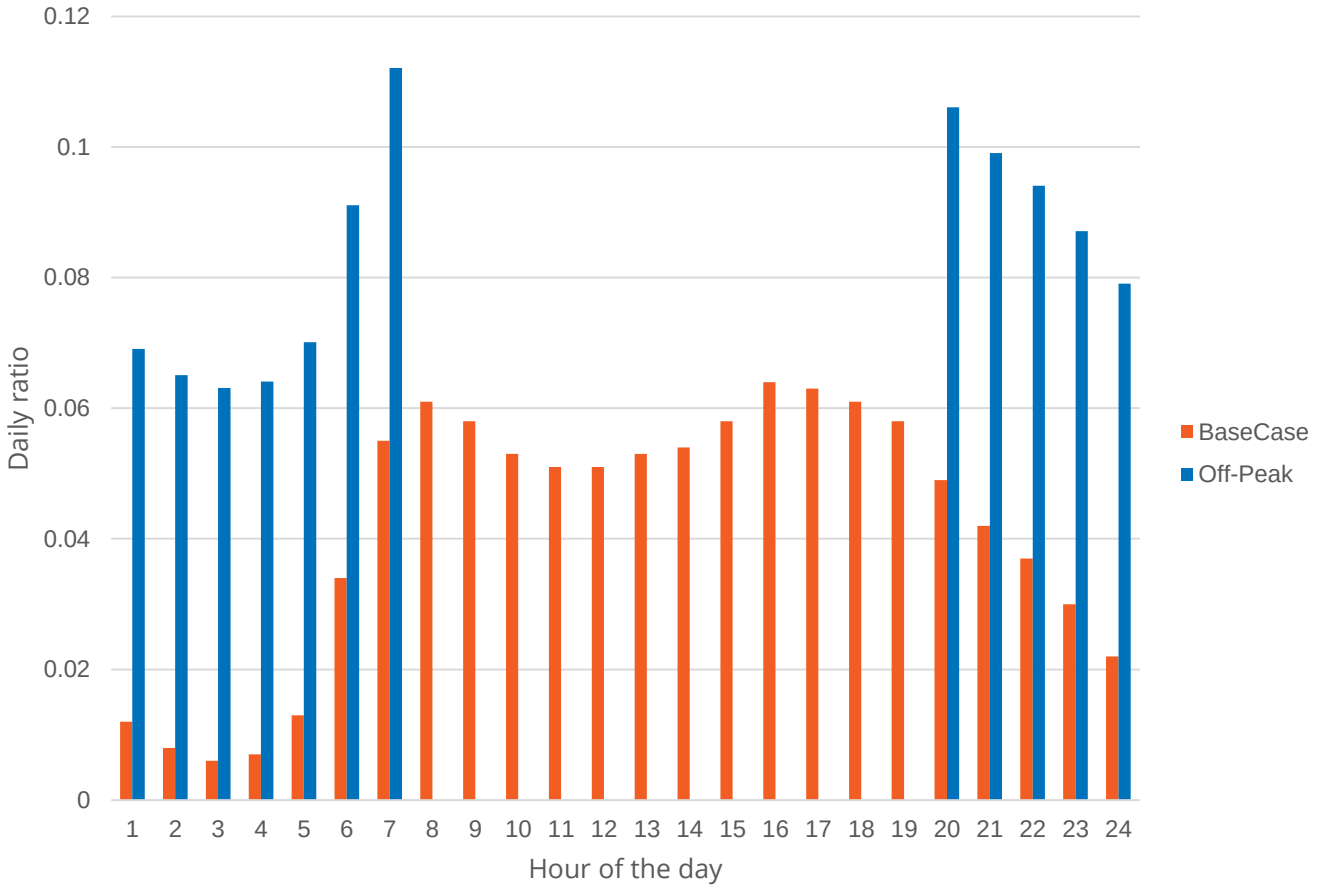
- Base Case
- Diurnal Variations in base case
- **OPD Annual Emissions Comparison**

Scenario	CO	NOx	VOC	NH3	SO2	PM10	PM2.5
OnRoad mobile emissions in Peel							
Base Case	35,417	7,635	2,802	205	53	593	270
Off-Peak Delivery	34,375	7,186	2,708	199	51	562	251
Emission reduction	-3%	-6%	-3%	-3%	-4%	-5%	-7%
Total emissions in Peel							
Base Case	78,033	19,577	29,630	1,192	4,516	5,577	3,685
Off-Peak Delivery	76,991	19,128	29,536	1,186	4,514	5,546	3,666
Emission reduction	-1%	-2%	0%	0%	0%	-1%	-1%



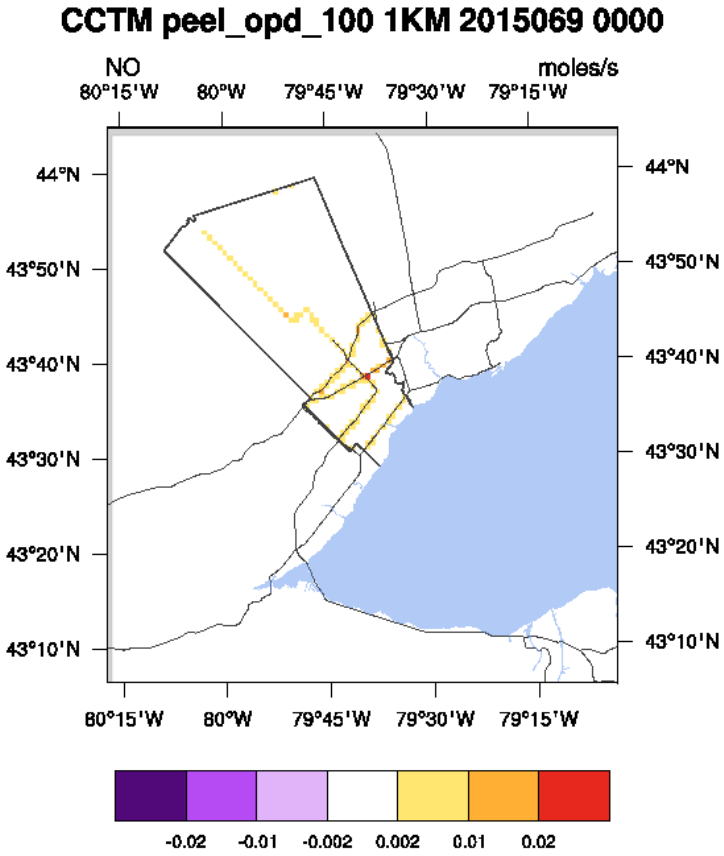
Model Details - Emissions

- Base Case
- Diurnal Variations in base case
- OPD Annual Emissions Comparison
- **OPD Diurnal Emissions Comparison**

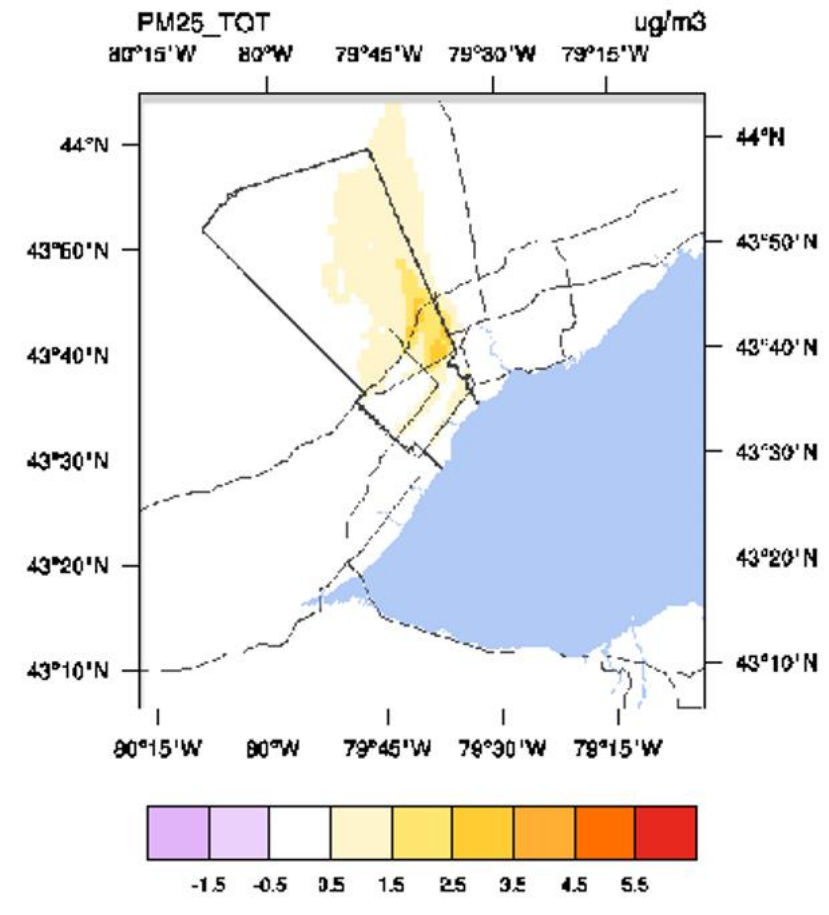


Model Details - Emissions

- Base Case
- Diurnal Variations in base case
- OPD Annual Emissions Comparison
- OPD Diurnal Emissions Comparison
- **OPD Spatial Distribution**

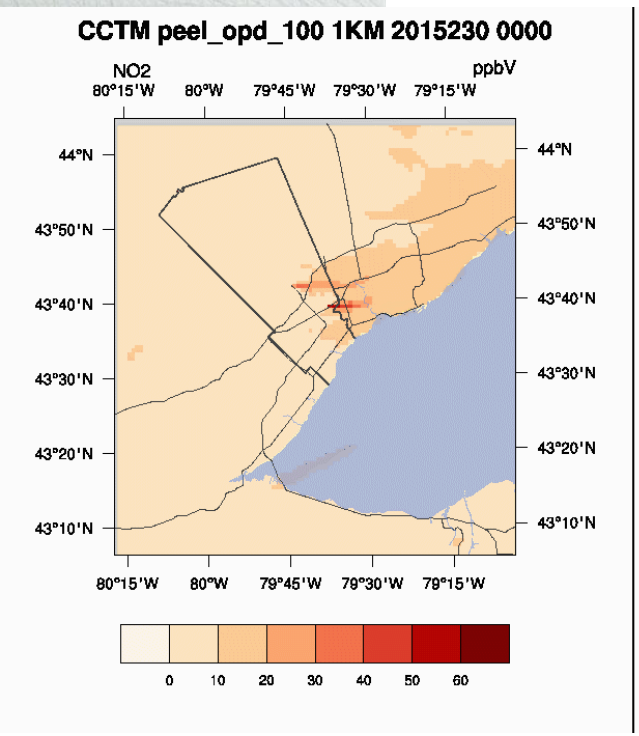


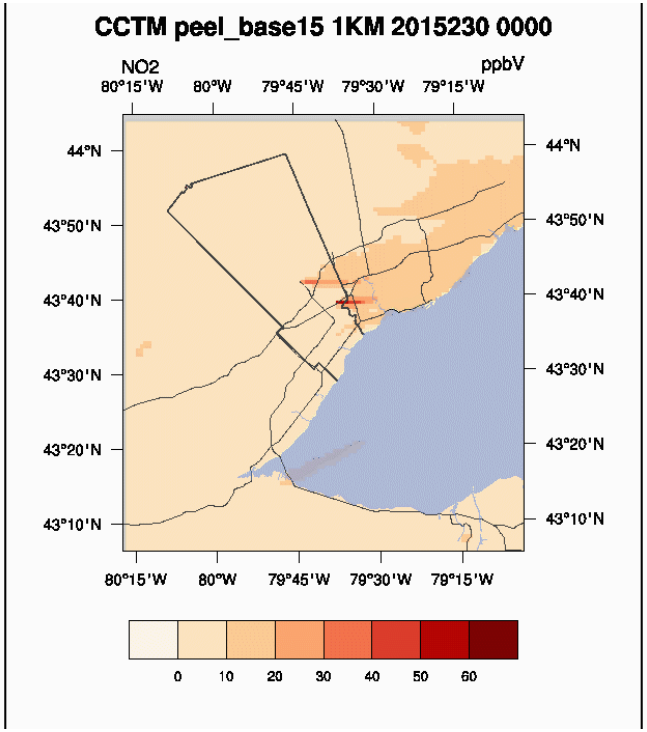
Model Results

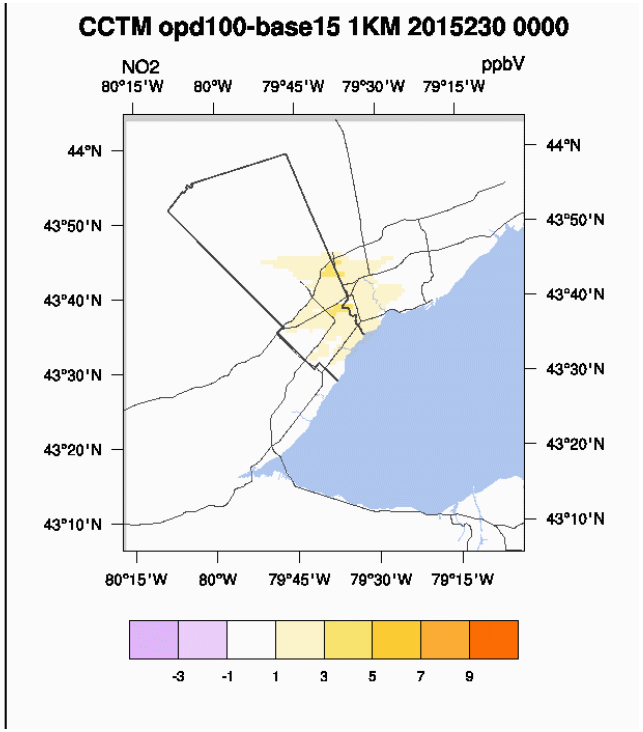


Model Results

- NO_2

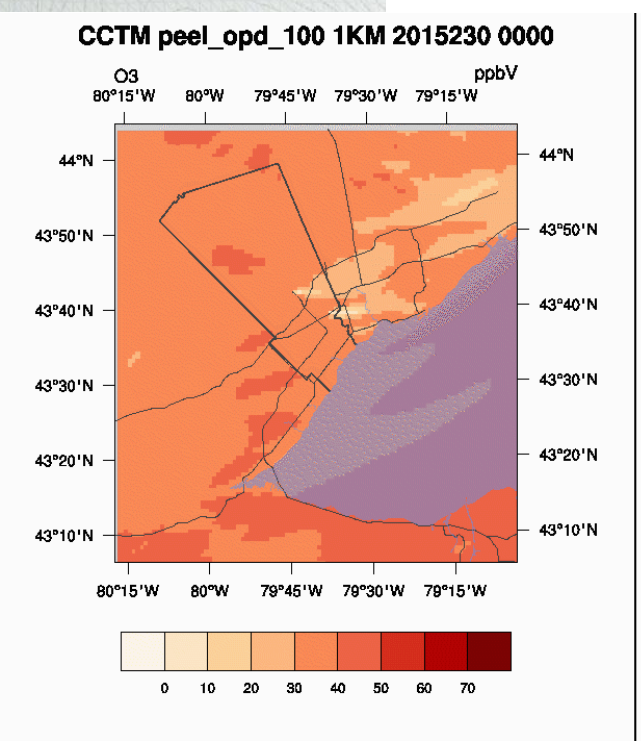


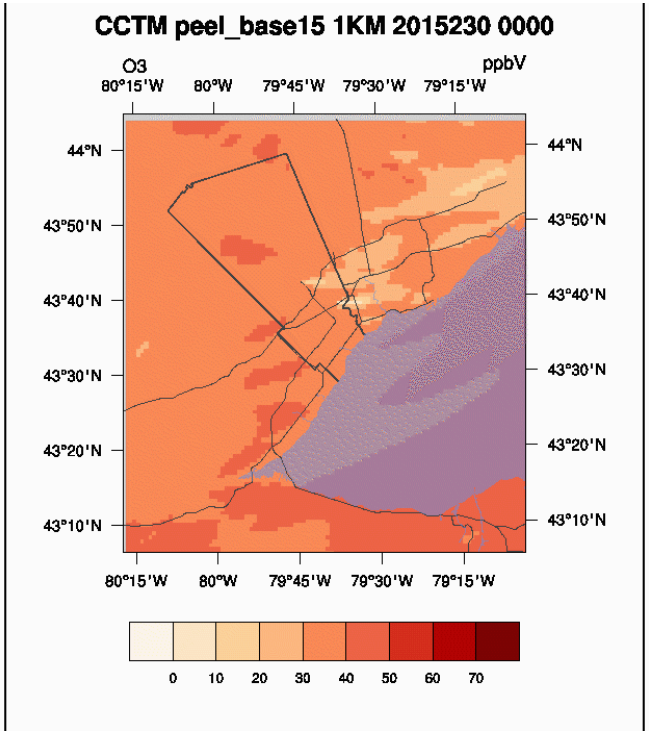


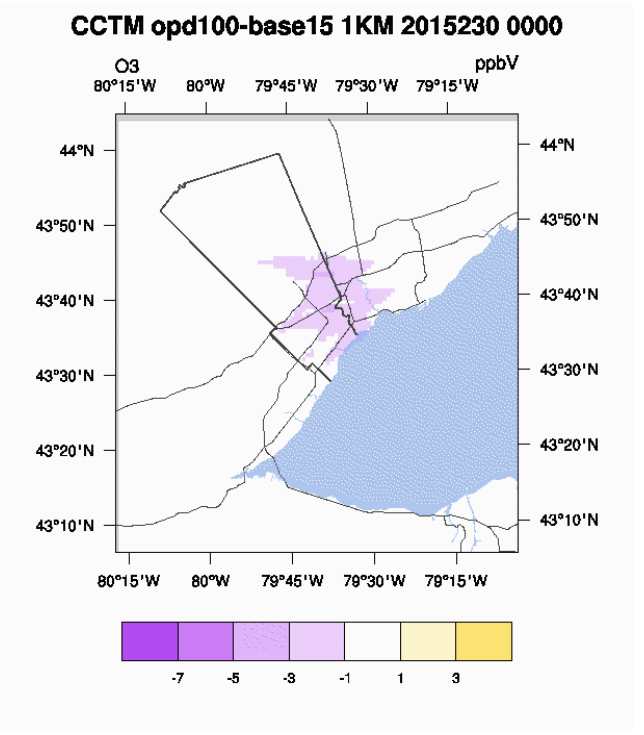


Model Results

- NO_2
- **O_3**

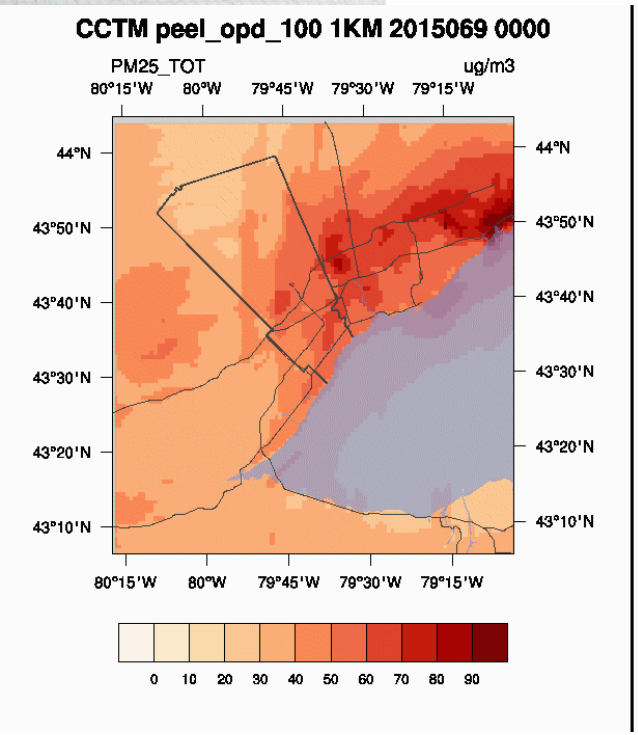


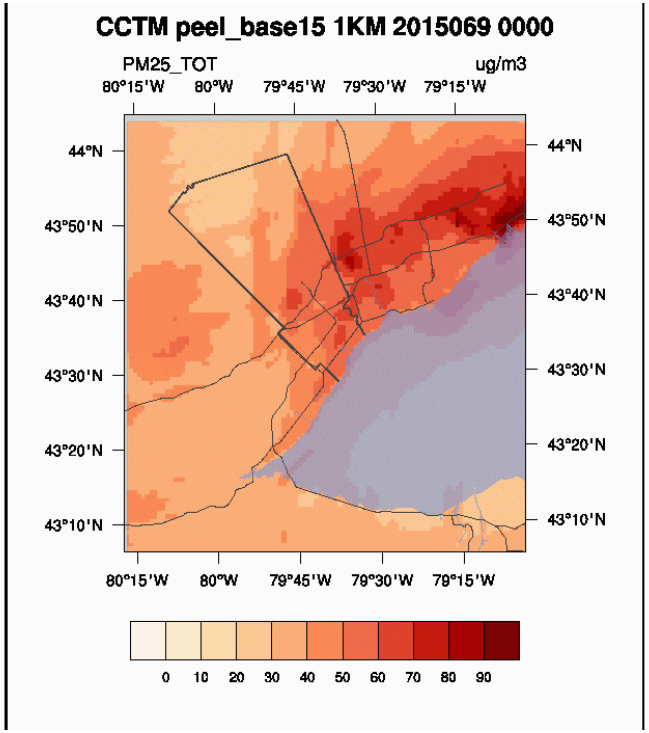


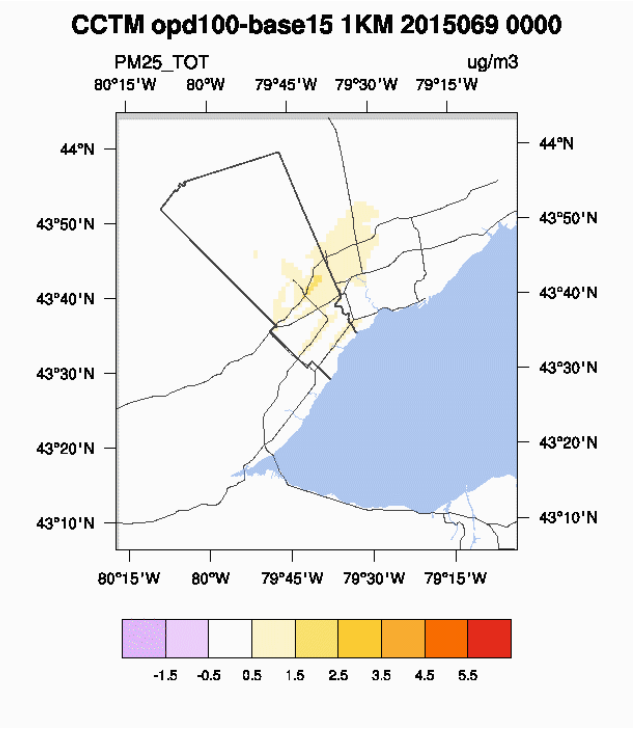


Model Results

- NO_2
- O_3
- **$PM_{2.5}$**



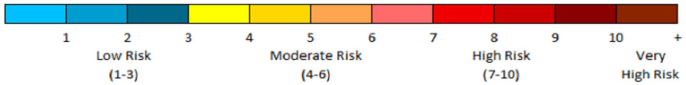


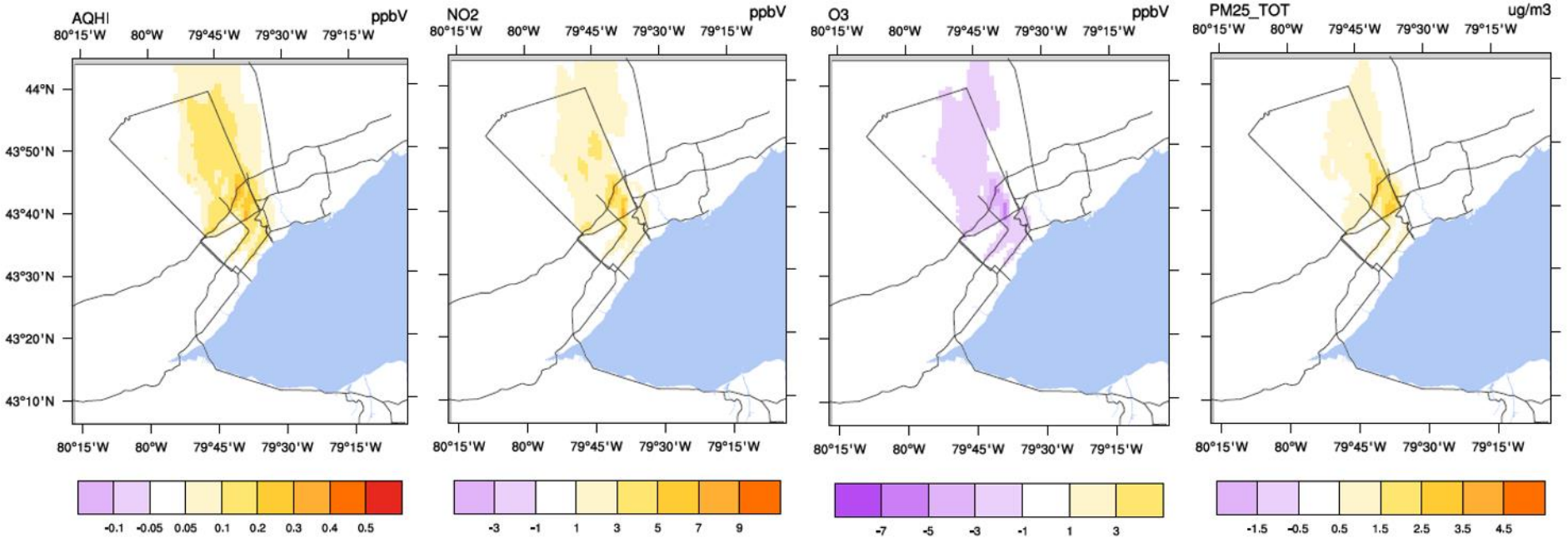


Model Results

- NO_2
- O_3
- $PM_{2.5}$
- **AQHI**

$$\frac{10}{10.4} \times \left(100 \times \left(e^{(0.000871 \times NO_2)} - 1\right)\right) + \left(e^{(0.000537 \times O_3)} - 1\right) + \left(e^{(0.00048 \times PM_{2.5})} - 1\right)$$





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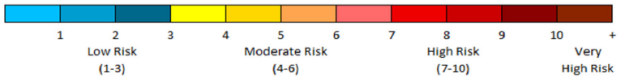

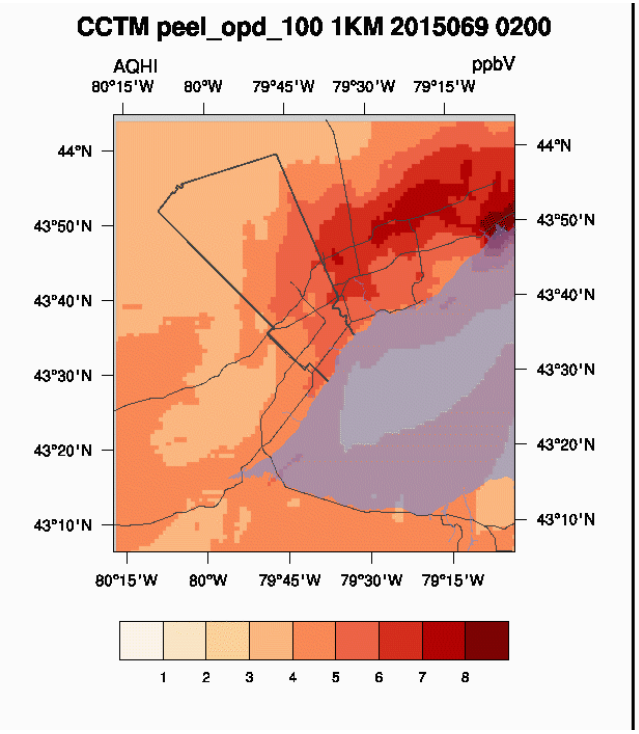

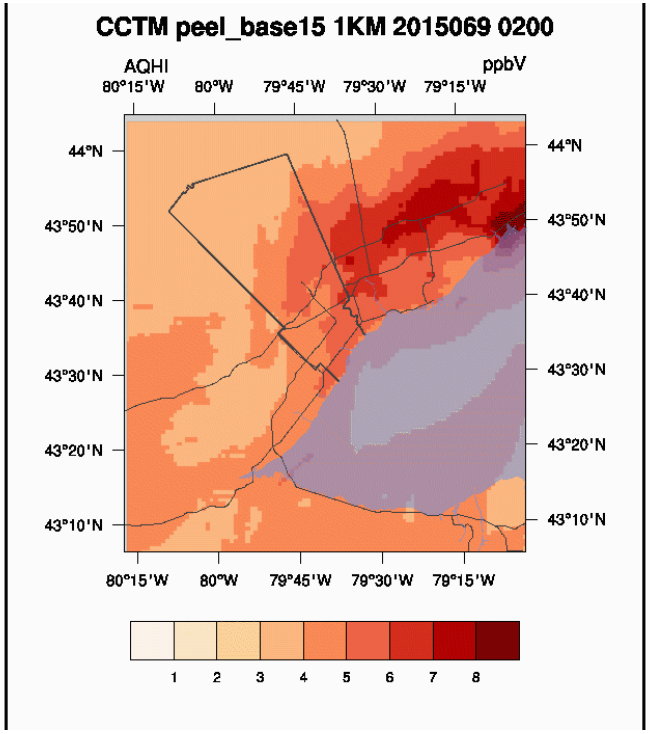

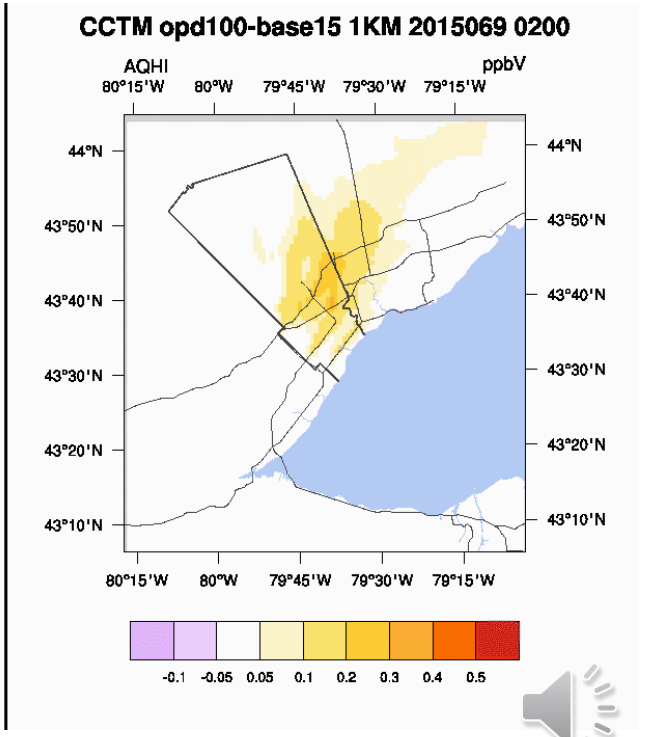

Model Results

- NO_2
- O_3
- $PM_{2.5}$
- **AQHI**

Frequency of AQHI at high risk for the Base Case and the OPD scenario

(count of all grid cells at all hours with AQHI>7)

Month	Base Case				OPD			
	1km domain		Peel Region		1km domain		Peel Region	
	Count	%	Count	%	Count	%	Count	%
March	5550	0.069	398	0.039	5849	0.073	511	0.050
August	788	0.010	293	0.029	963	0.012	439	0.043

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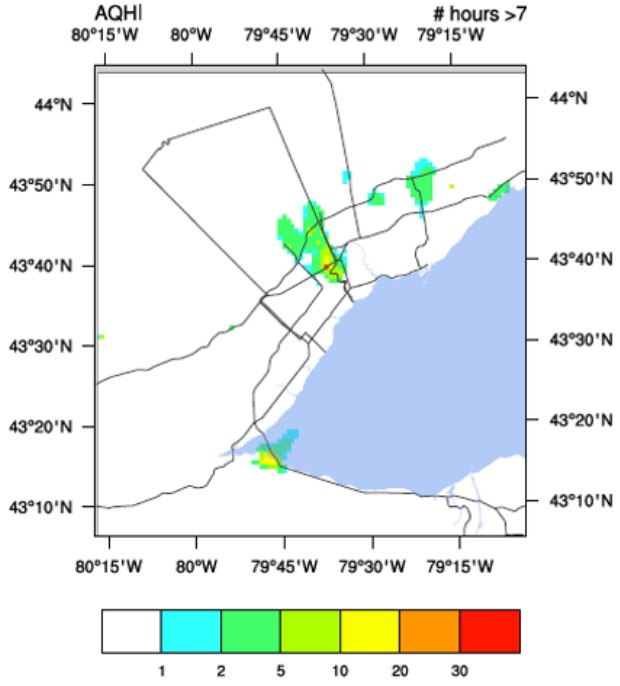

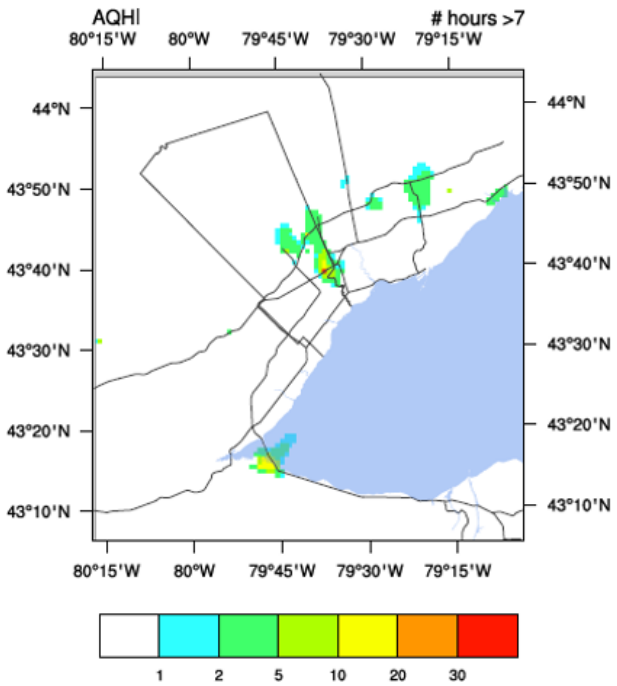

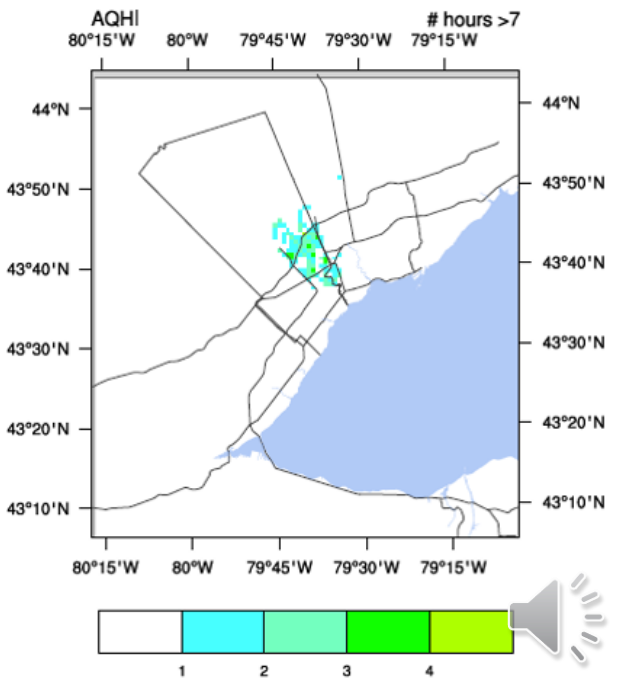

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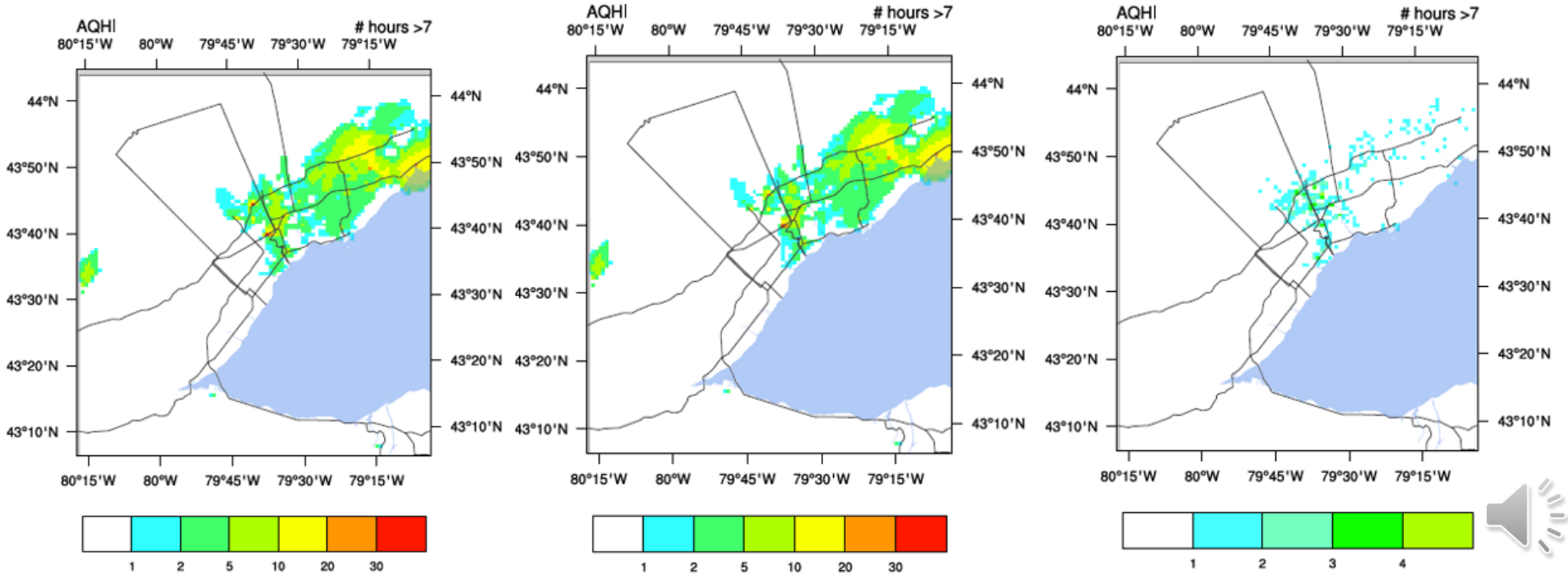

Summary and Conclusions

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Image credit: Peel's region Goods Movement Strategic Plan 2017-2021
https://www.peelregion.ca/pw/transportation/goodsmovement/pdf/goods-movement-strategic-plan-2017-2021.pdf

Summary and Conclusions

- Air quality effects of an off-peak delivery scenario were examined in comparison with a 'normal traffic' base-case
- WRF-SMOKE-CMAQ photochemical modeling was used to model atmospheric photochemical reaction, dispersion and transport of pollutants
- Overall 3% - 7% reduction in on-road emissions in the Region of Peel
- Overall minimal change in concentration of key pollutants
- Up to 0.5 reduction in AQHI
- Slight increase in the number of high-risk air quality hours/locations

THANK YOU

Redefining possible.