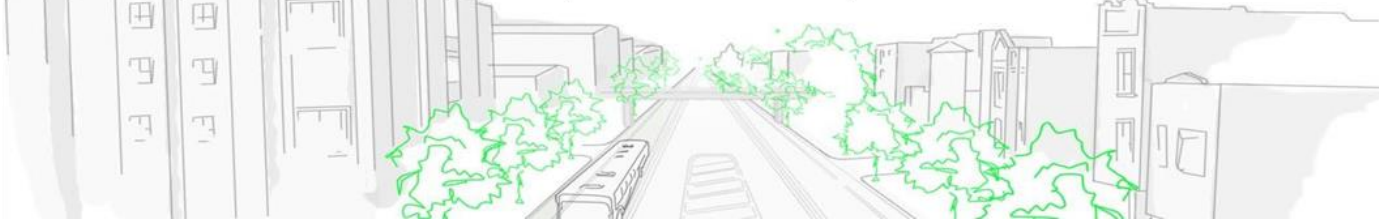


TRAQ

The Transportation & Air Quality Research Group



Quantifying the air quality and health benefits of greening freight movements

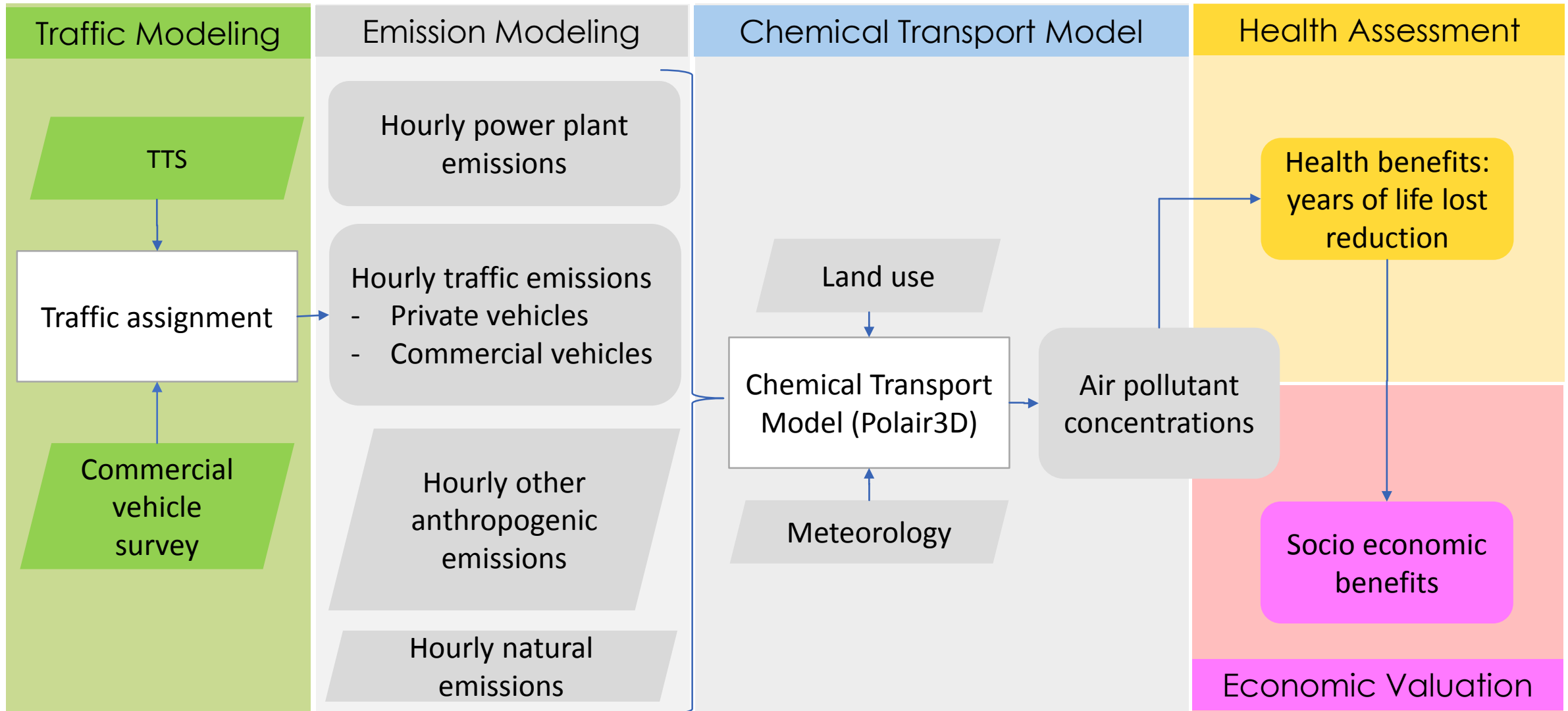
Laura Minet, Tufayel Chowdbury, An Wang, Yijun Gai, Daniel Posen,
Matthew Roorda, Marianne Hatzopoulou



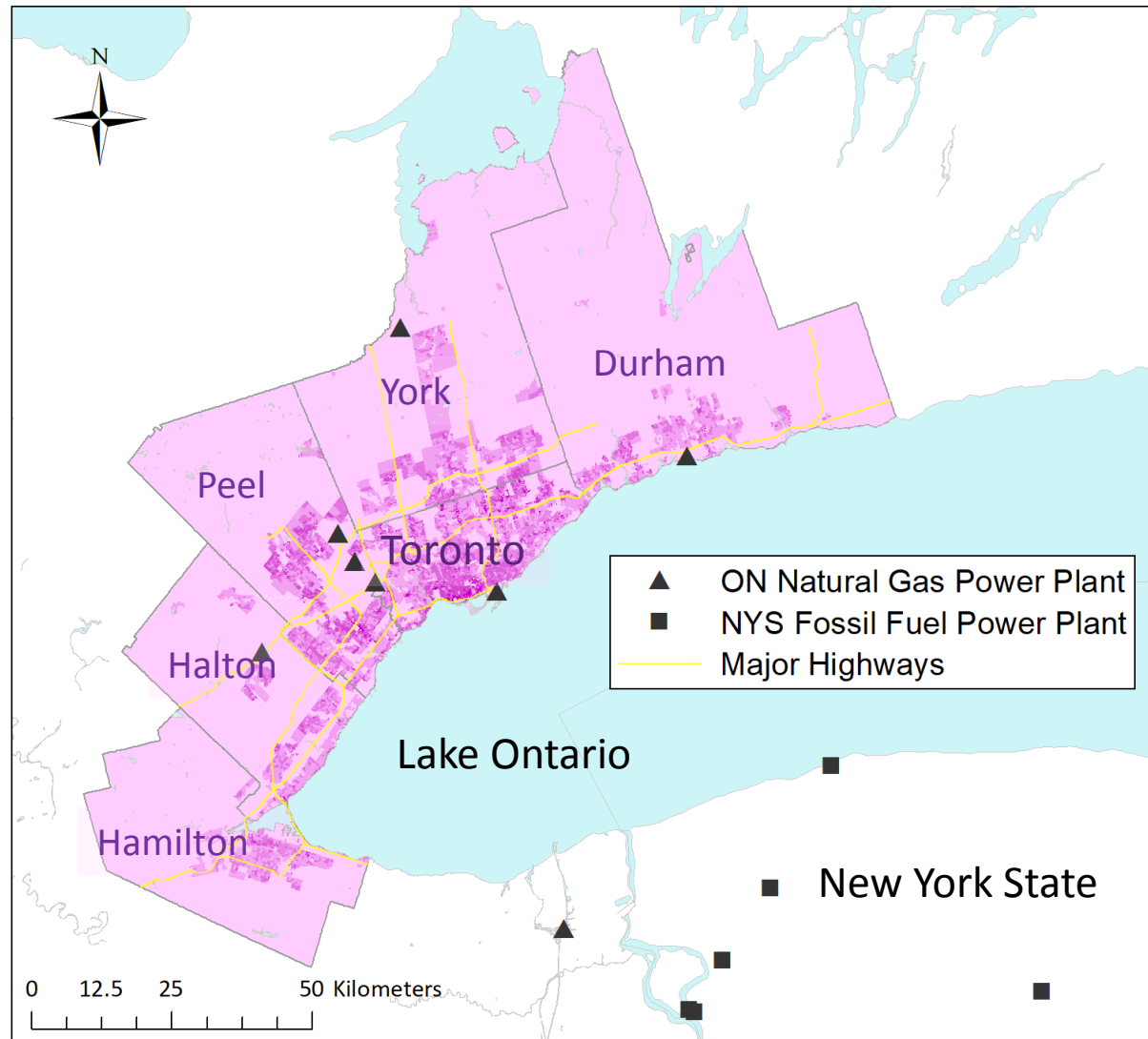
UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE & ENGINEERING
Transportation Research Institute

UTTRI

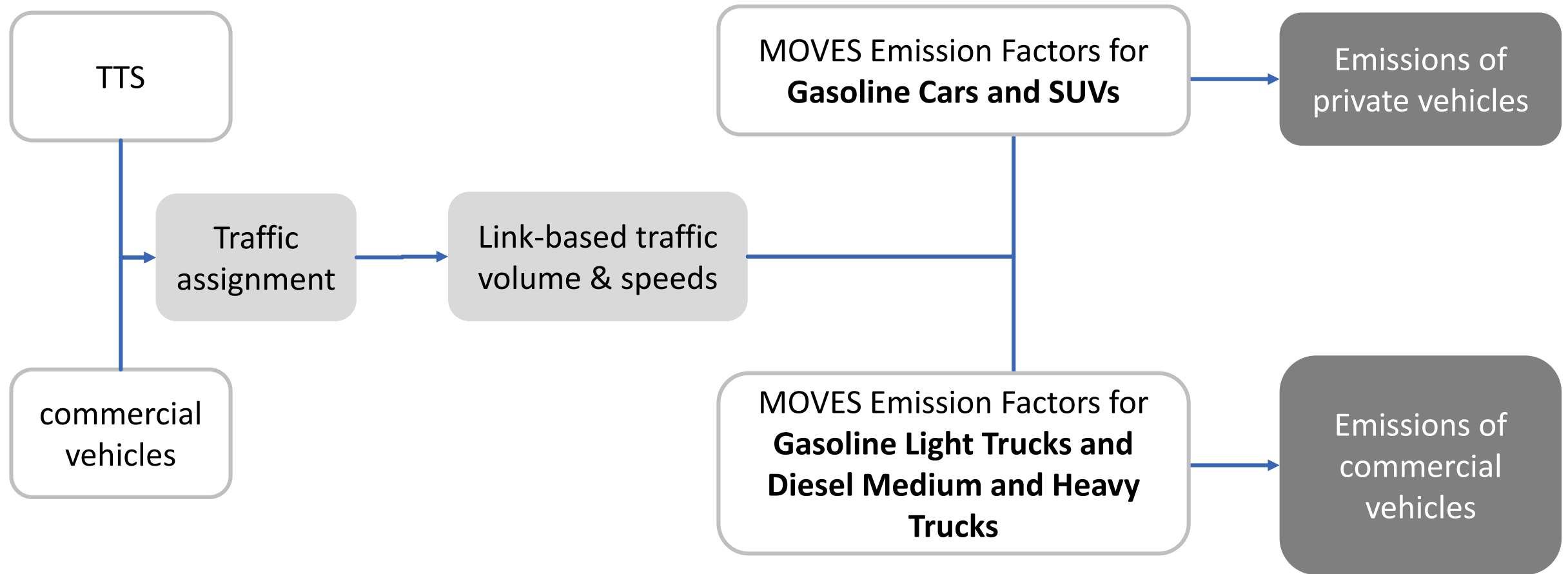
Overview of the Modeling Framework



Study Area - The Greater Toronto and Hamilton Area (GTHA)

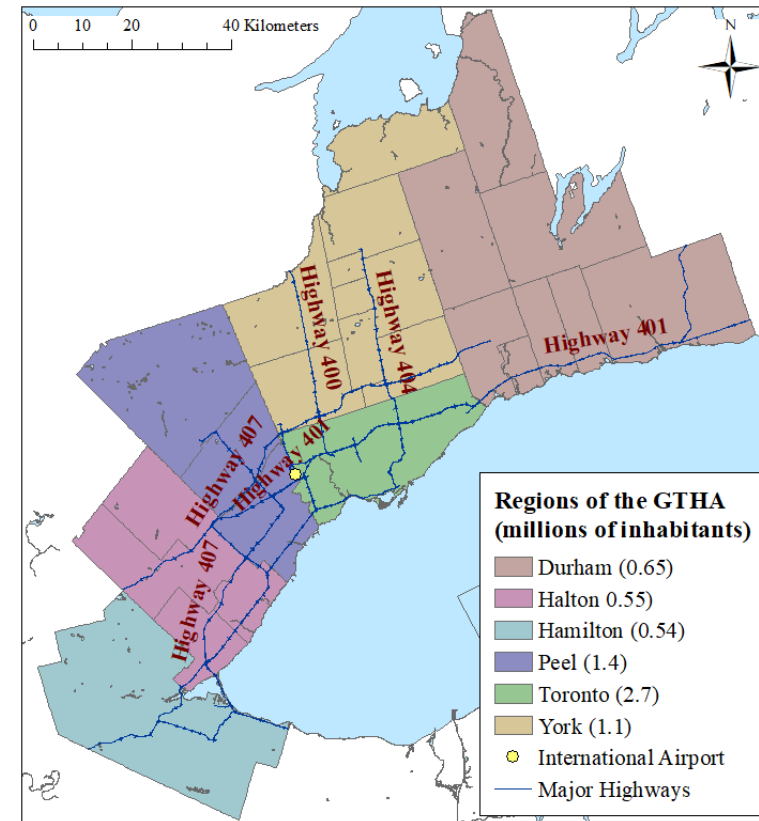


Traffic Emission Modeling

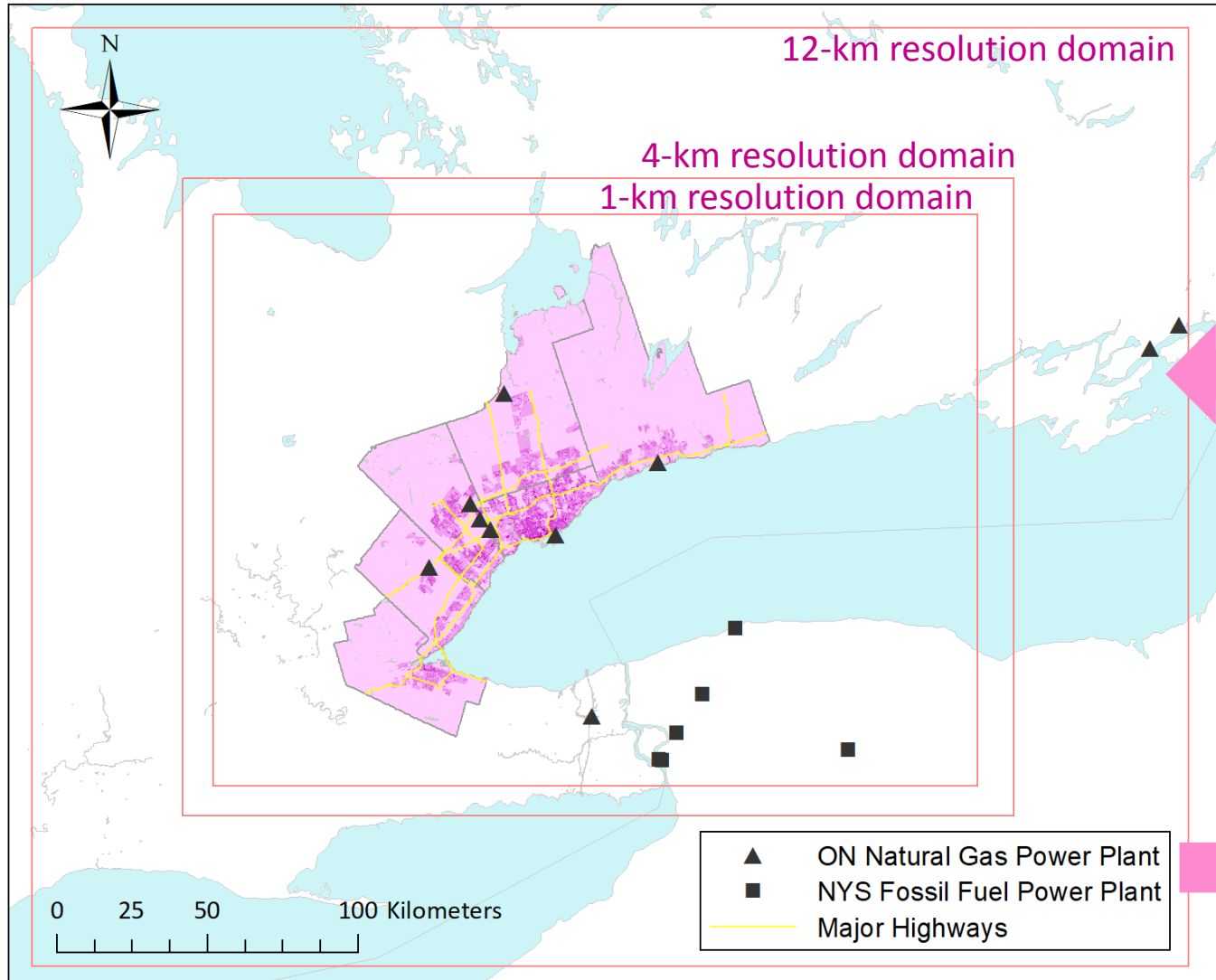


Two Case Studies

- 1) Assessing the impact of all diesel commercial vehicles on air quality and health
- 2) Assessing the impact of lowering freeway-sourced diesel emissions by reducing diesel emissions on highway 401



The chemical transport model in Polair3D



Polair3D: The chemical transport model of Polyphemus with a **high spatial** (1×1 km²) and **temporal** (1 hour) resolution

Input: Hourly emissions of seven criteria air contaminants (CACs) - PM₁₀, PM_{2.5}, NH₃, NO_x, CO, VOC, and SO₂.

- Point source emissions from power plants and industries
- Link-based traffic emissions
- Other anthropogenic emissions, biogenic emissions

Output: Hourly concentrations of PM_{2.5}, NO₂, O₃, BC for each 1 by 1 km cell

3) Health Outcomes Assessment

Approach: Comparative risk assessment (CRA)

Procedure:

1. Identified concentration response functions (CRFs), which define the relationship between exposure and increased risk of disease

Concentration Response Functions (CRFs)

Source	Pollutant	Cause	RR (10 μ g/m ³)
Crouse et al. 2012	PM _{2.5}	All Causes	1.100 (1.050 - 1.150)
Crouse et al. 2015	NO ₂	All Causes	1.053 (1.032 - 1.075)
Jerrett et al. 2009	O ₃	Respiratory Disease	1.020 (1.007 - 1.033)
Janssen et al. 2011	BC	All Causes	1.791 (1.480 - 2.255)
			Max

3) Health Outcomes Assessment

Approach: Comparative risk assessment (CRA)

Procedure:

1. Identified concentration response functions (CRFs), which define the relationship between exposure and increased risk of disease
2. Estimate the Years of Life Lost (YLL)

4) Economic Valuation of Health Impacts

The economic benefits are evaluated based on:

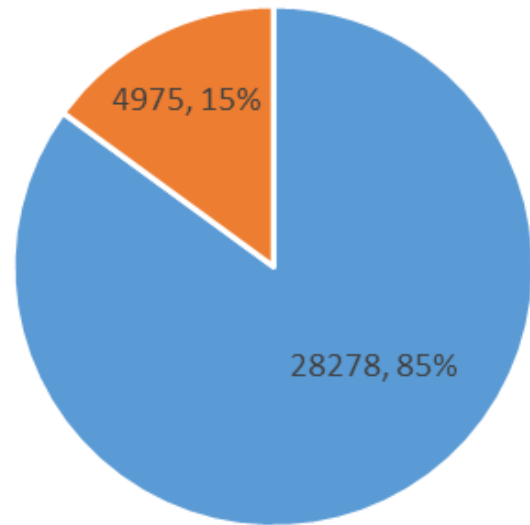
Unit: 2016CAD\$

- **Health impacts due to changes in air pollution exposure:** use the Value of Statistical Life Year (VSLY)
 - The Value of a Statistical Life (VSL) is interpreted as a measure of the benefit individuals receive from enhancements to their health and safety
 - The VSLY accounts for life expectancy
 - **VSLY** used: \$324,000



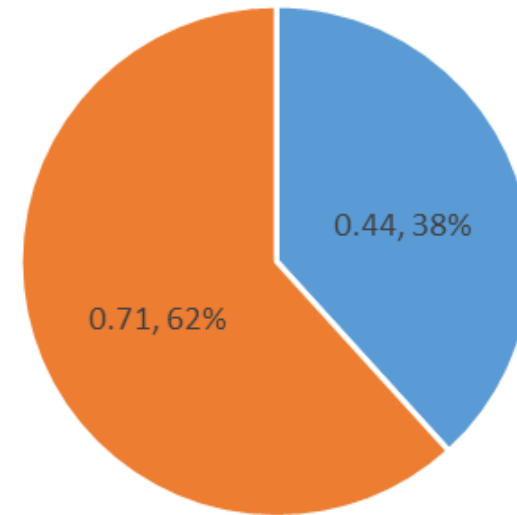
Results

GHG emissions from transport in the GTHA
(metric tons per day)



■ All modes ■ Diesel trucks

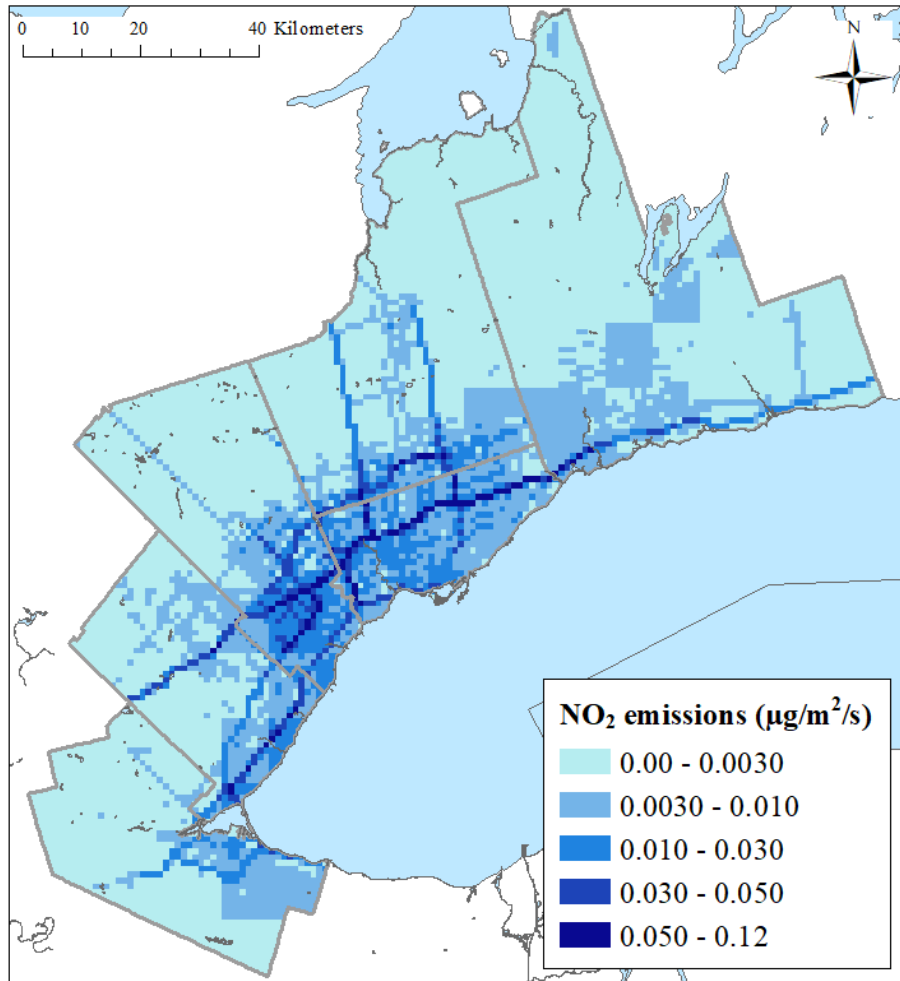
PM2.5 emissions from transport in the GTHA
(metric tons per day)



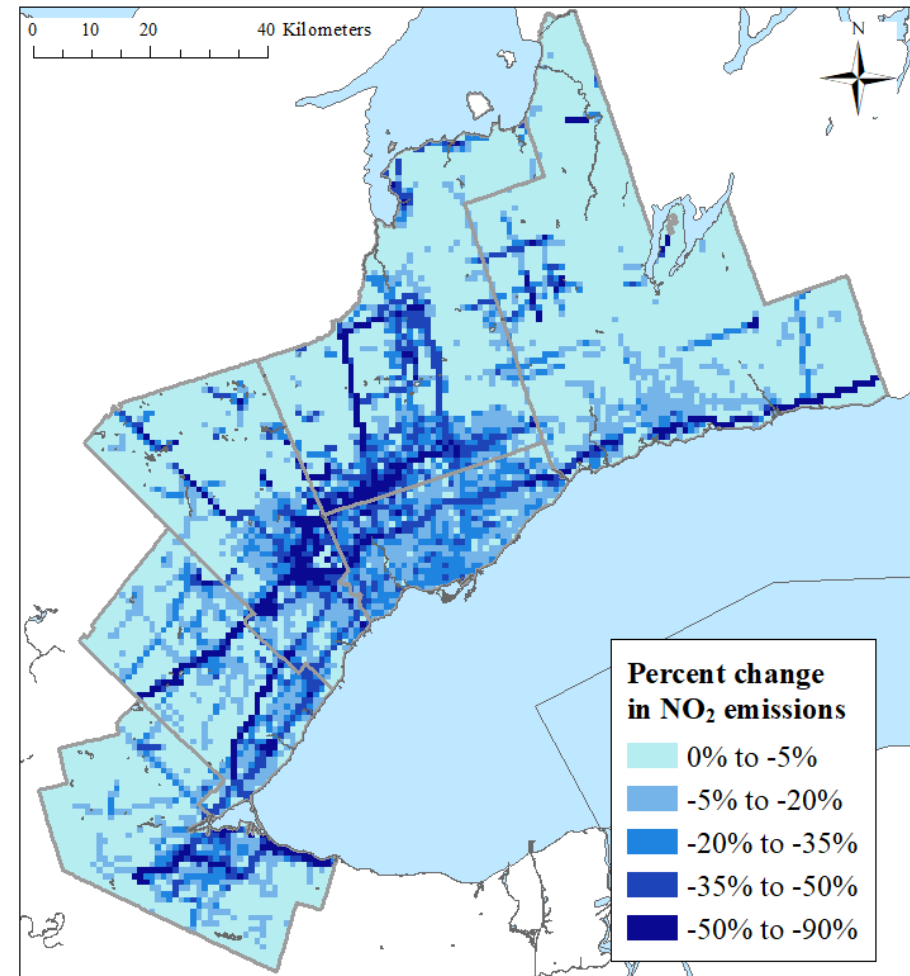
■ All modes ■ Diesel trucks

Surface Emissions

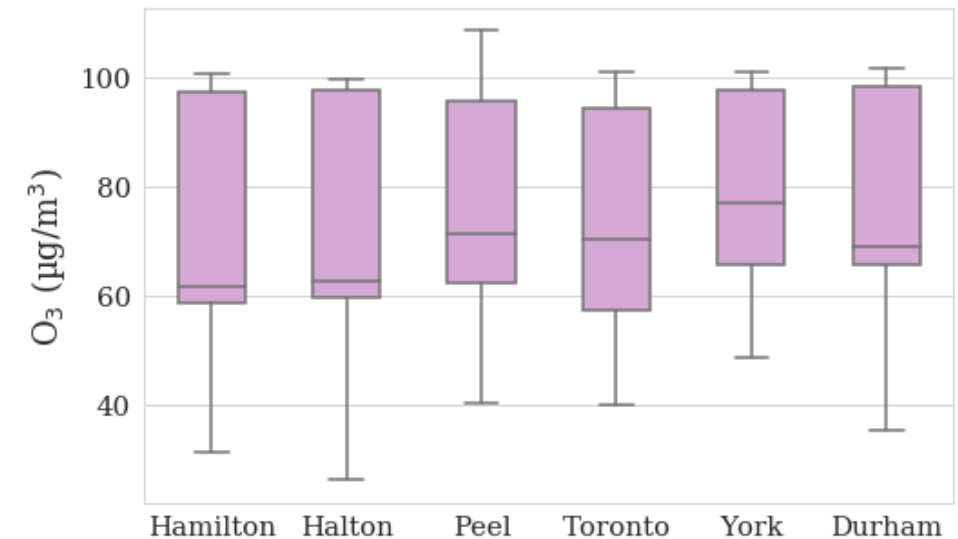
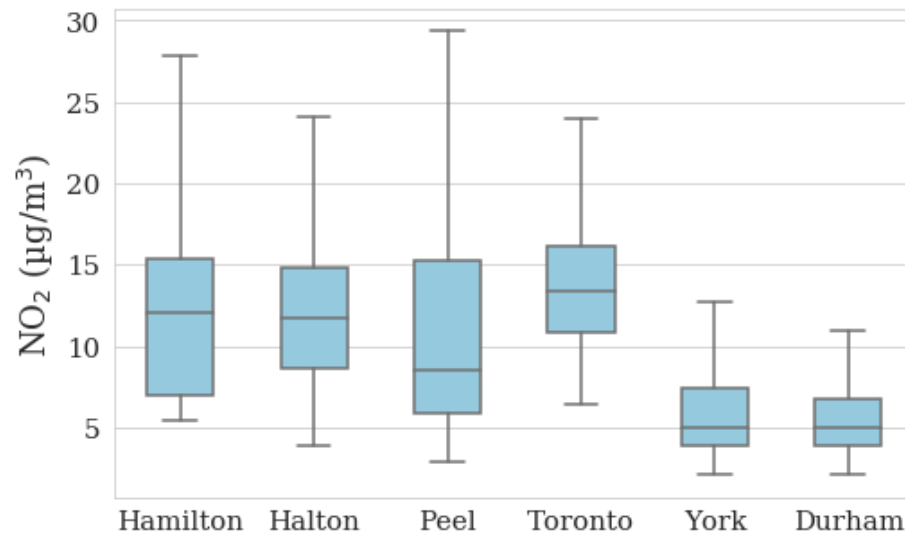
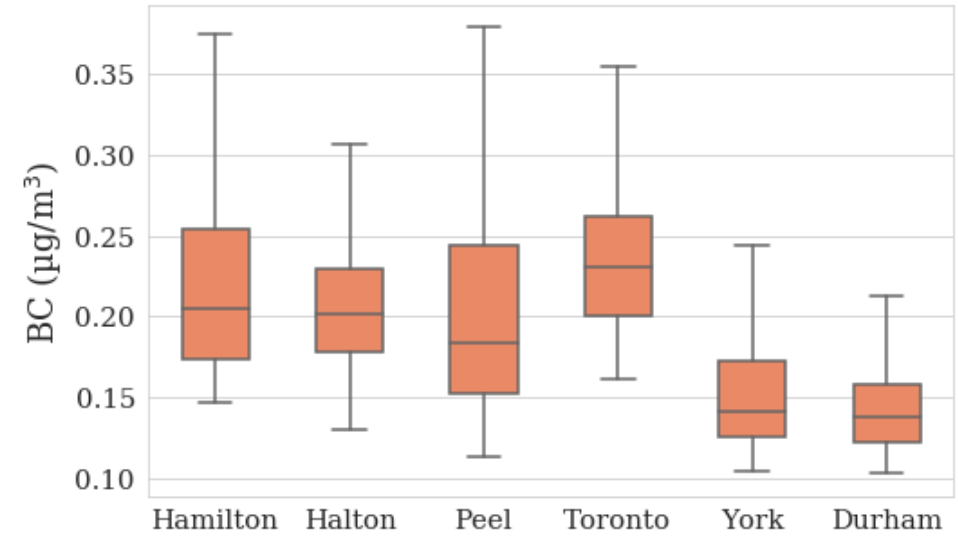
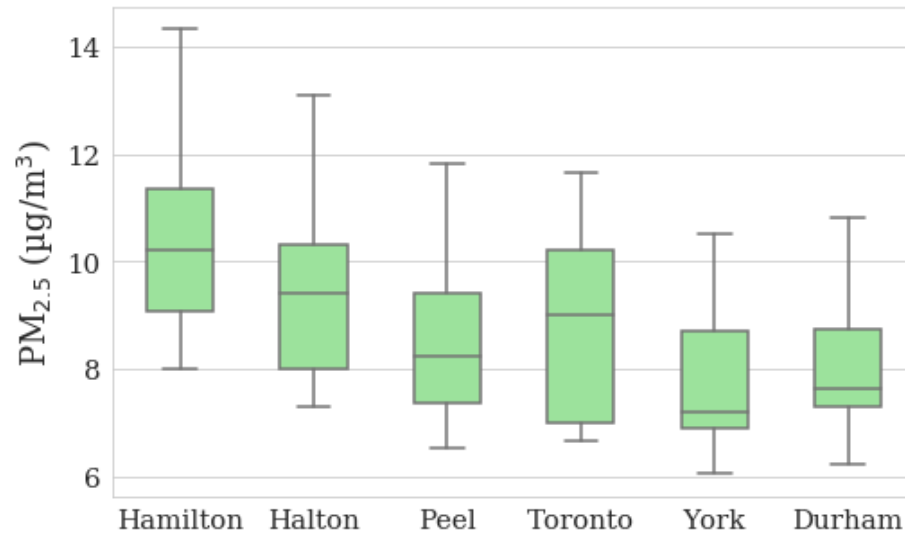
(a) Base case surface emissions



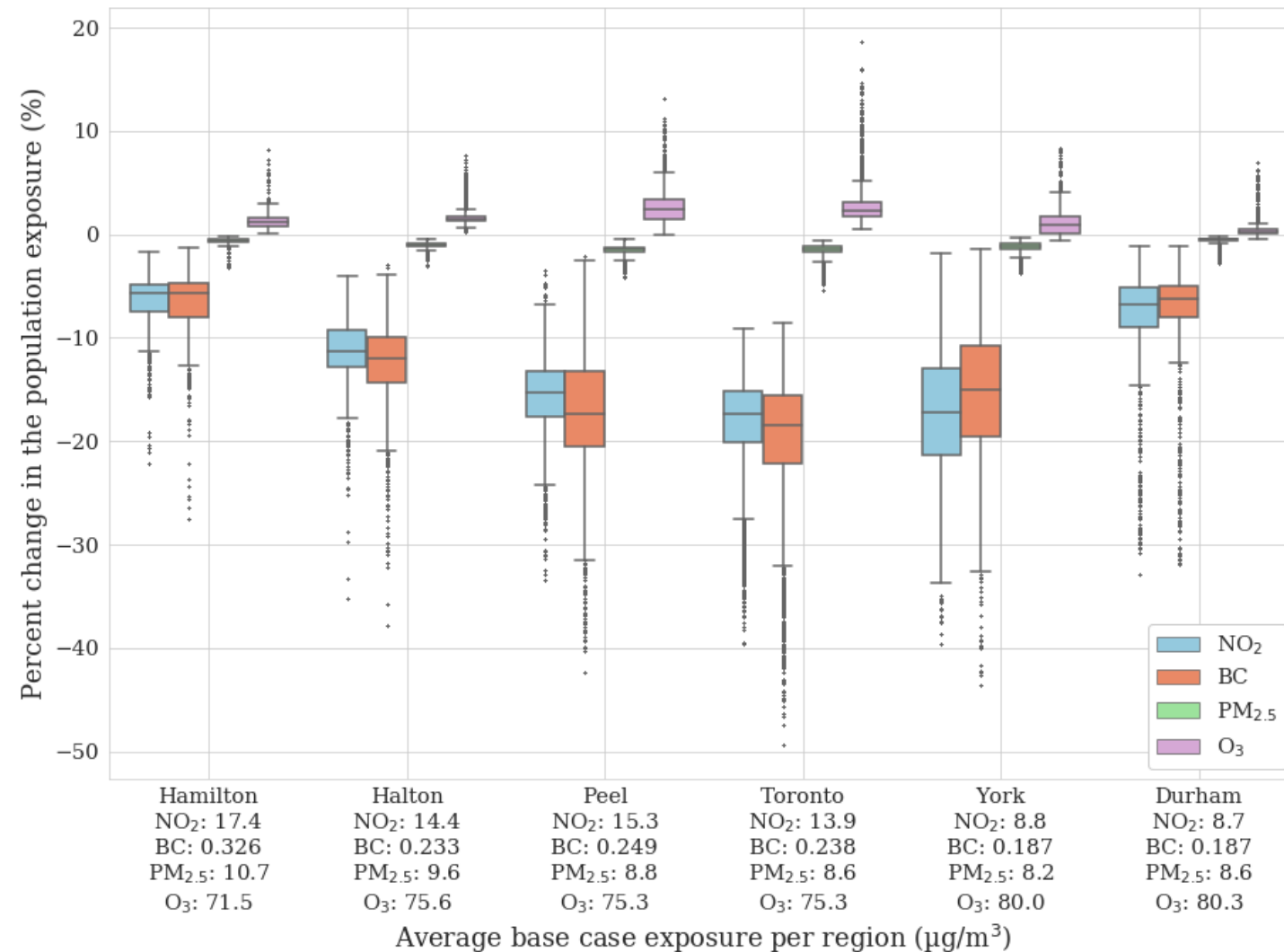
(b) Percent change without diesel emissions



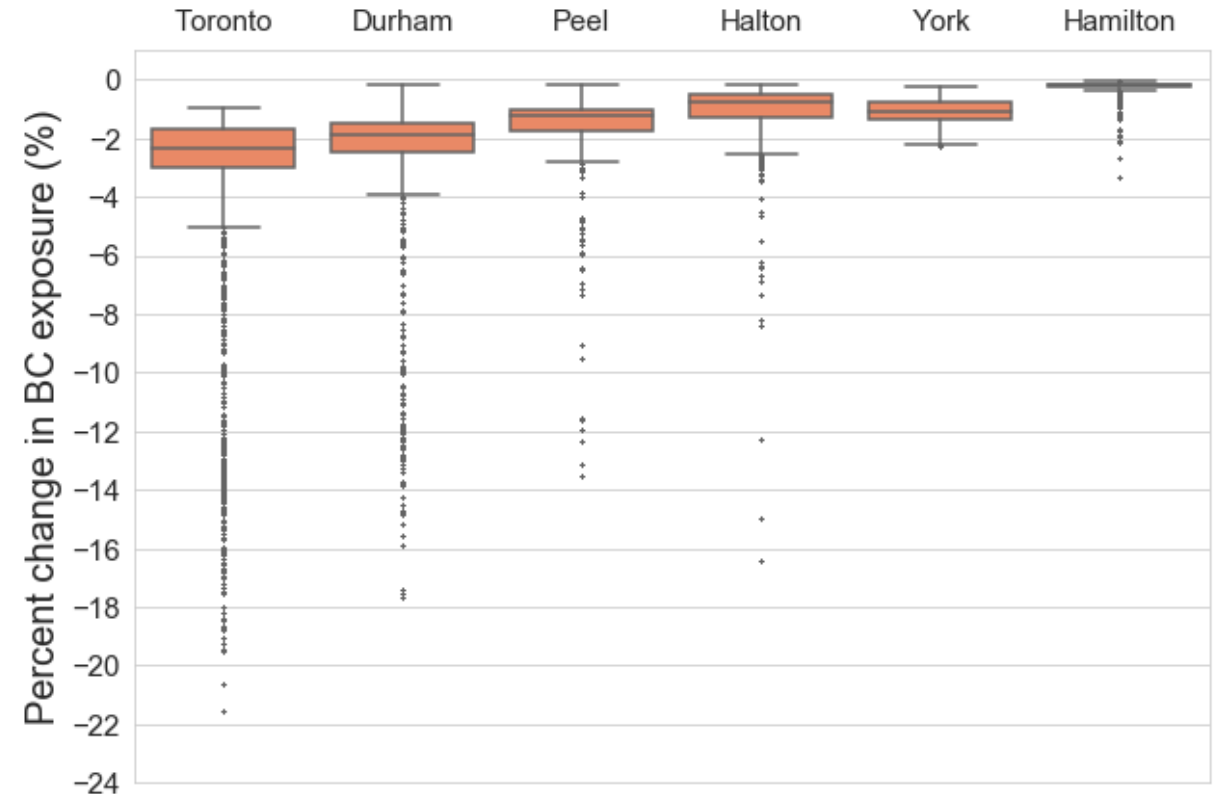
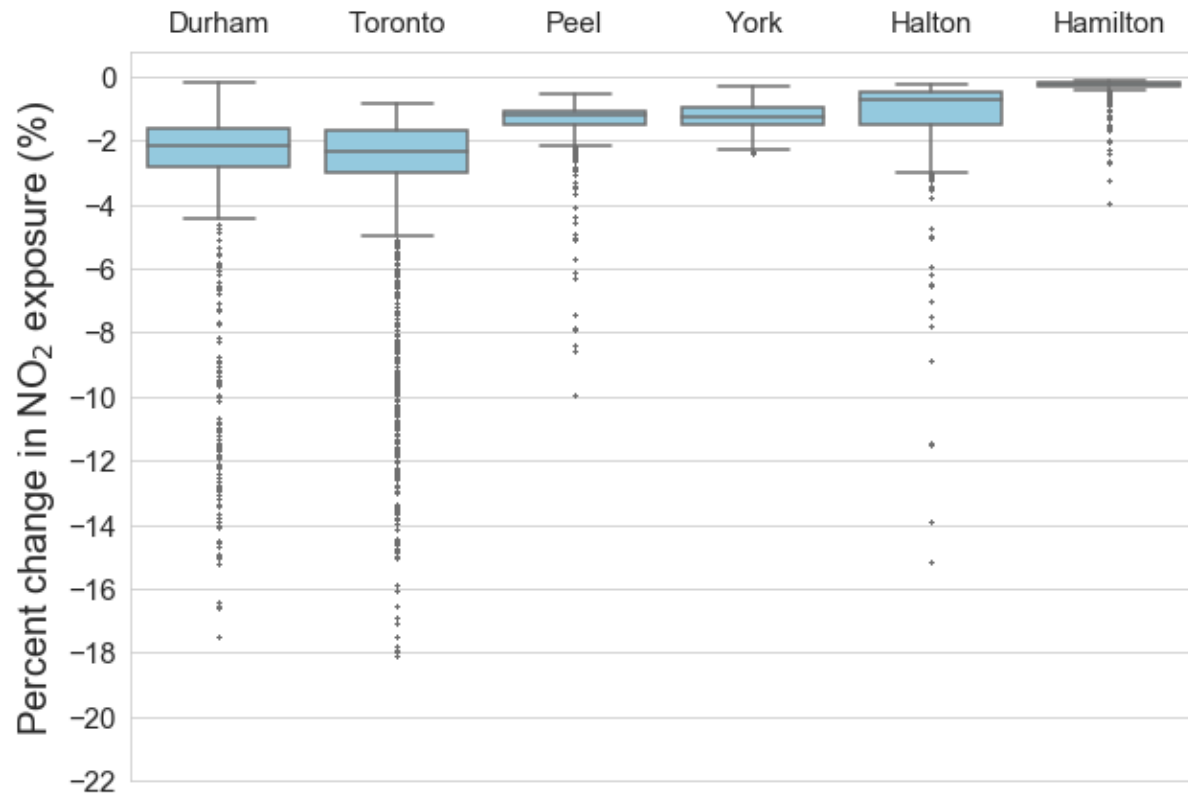
Base Case: Levels of $\text{PM}_{2.5}$, NO_2 , O_3 and BC



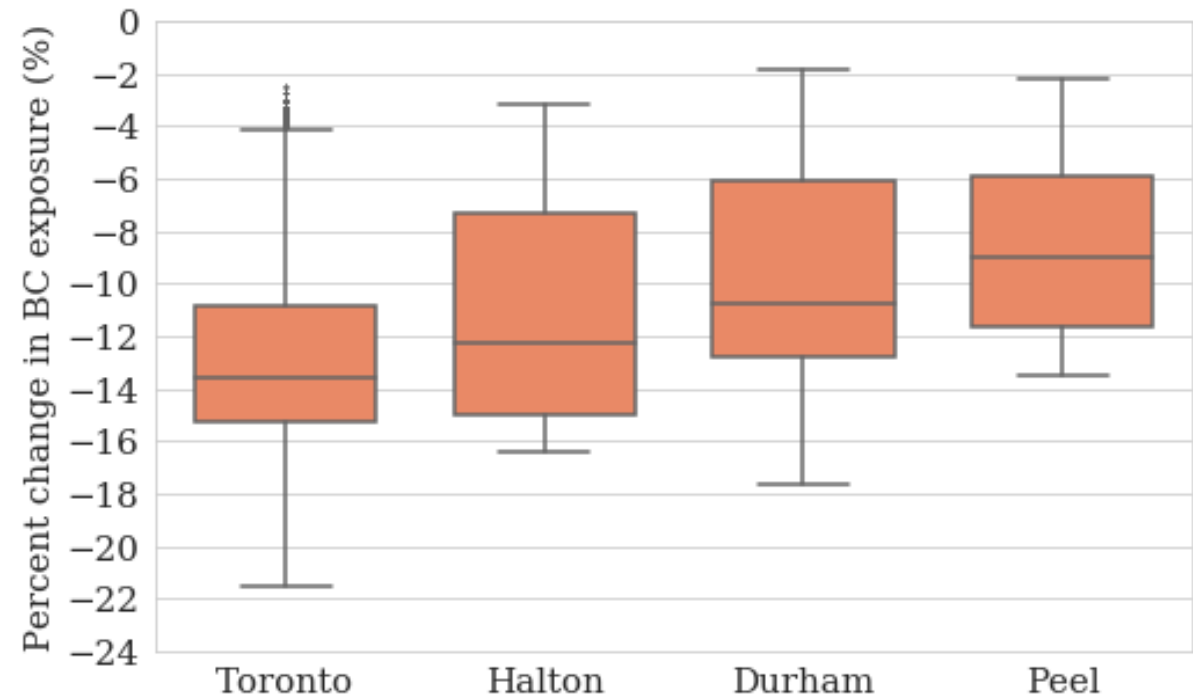
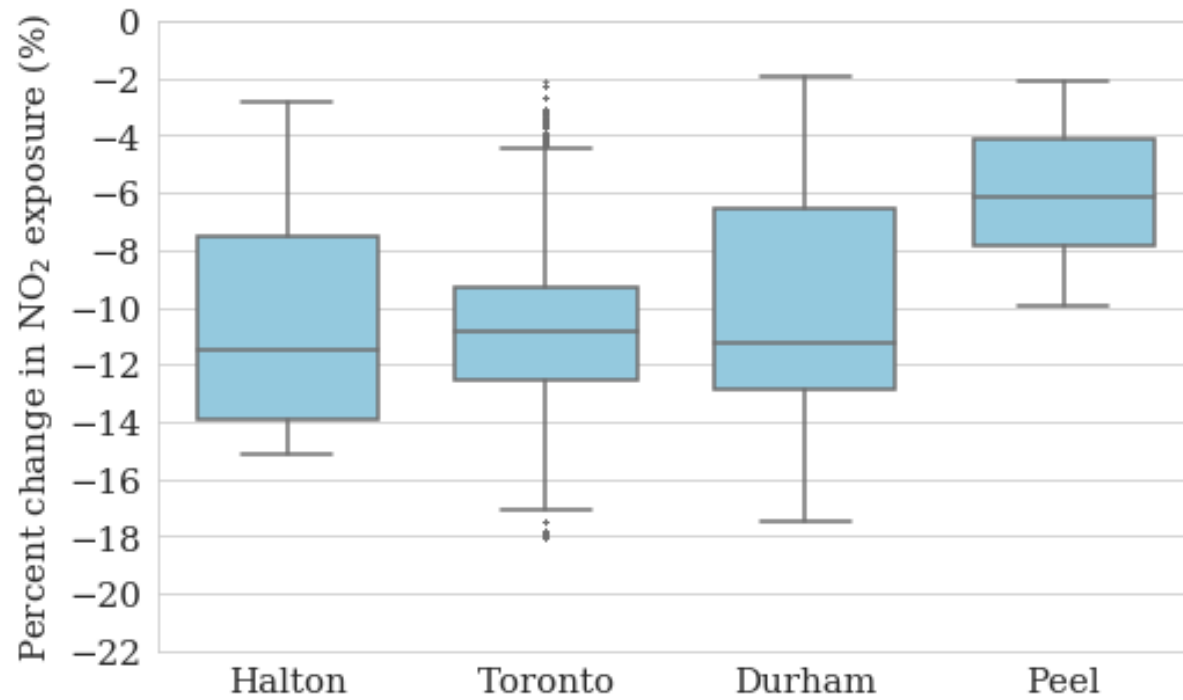
Percent change in the population exposure to NO₂, PM_{2.5}, BC and O₃ in the case **without diesel emissions**



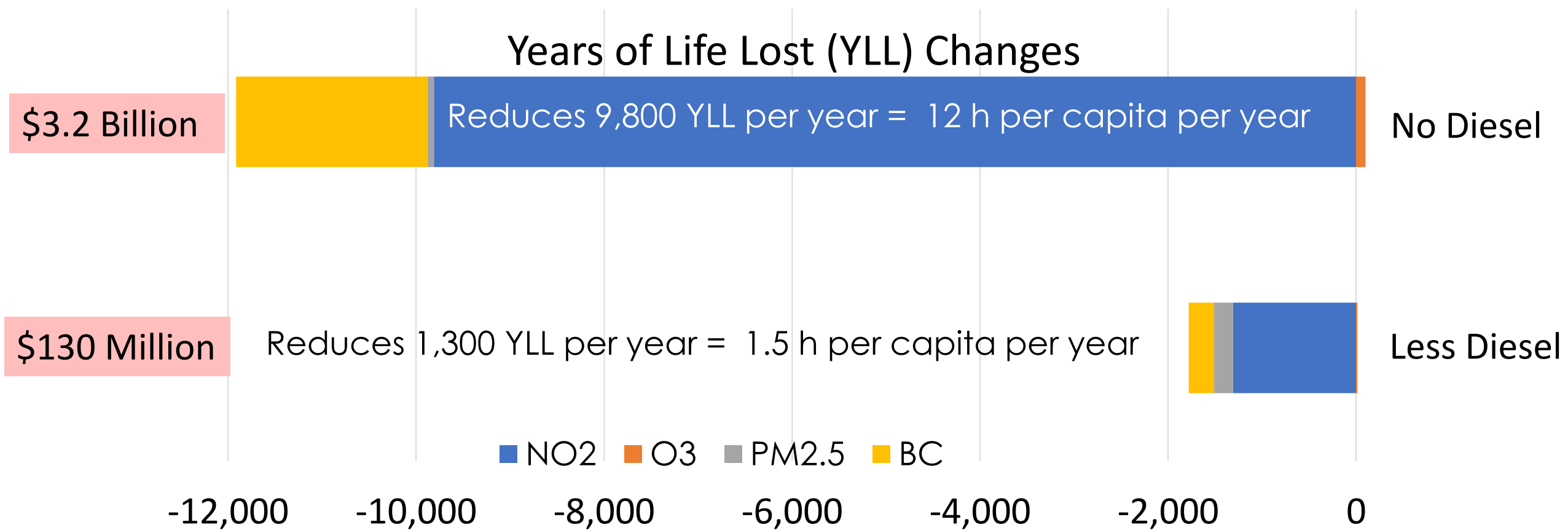
Percent change in the population exposure to NO₂ and BC in the case with less diesel emissions on Highway 401



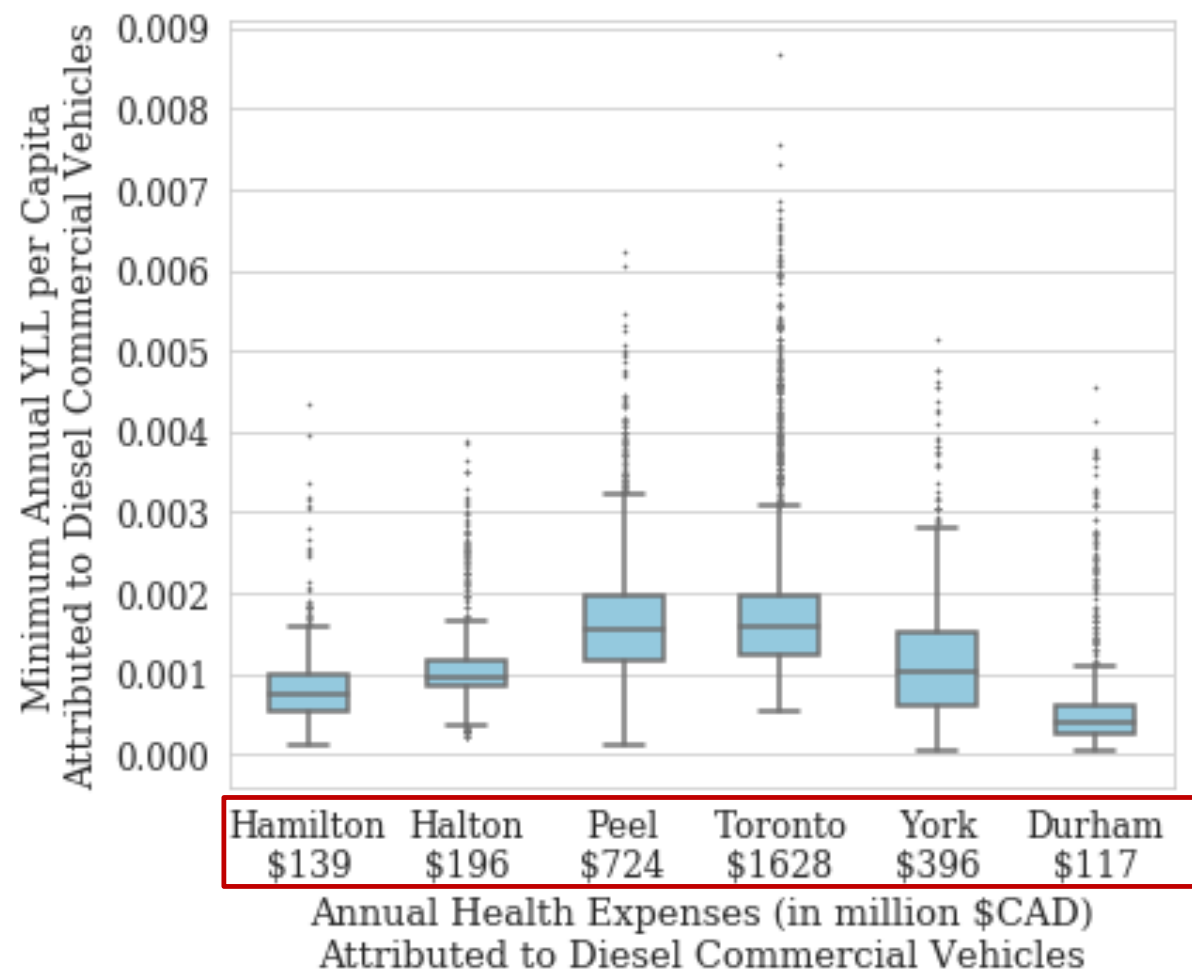
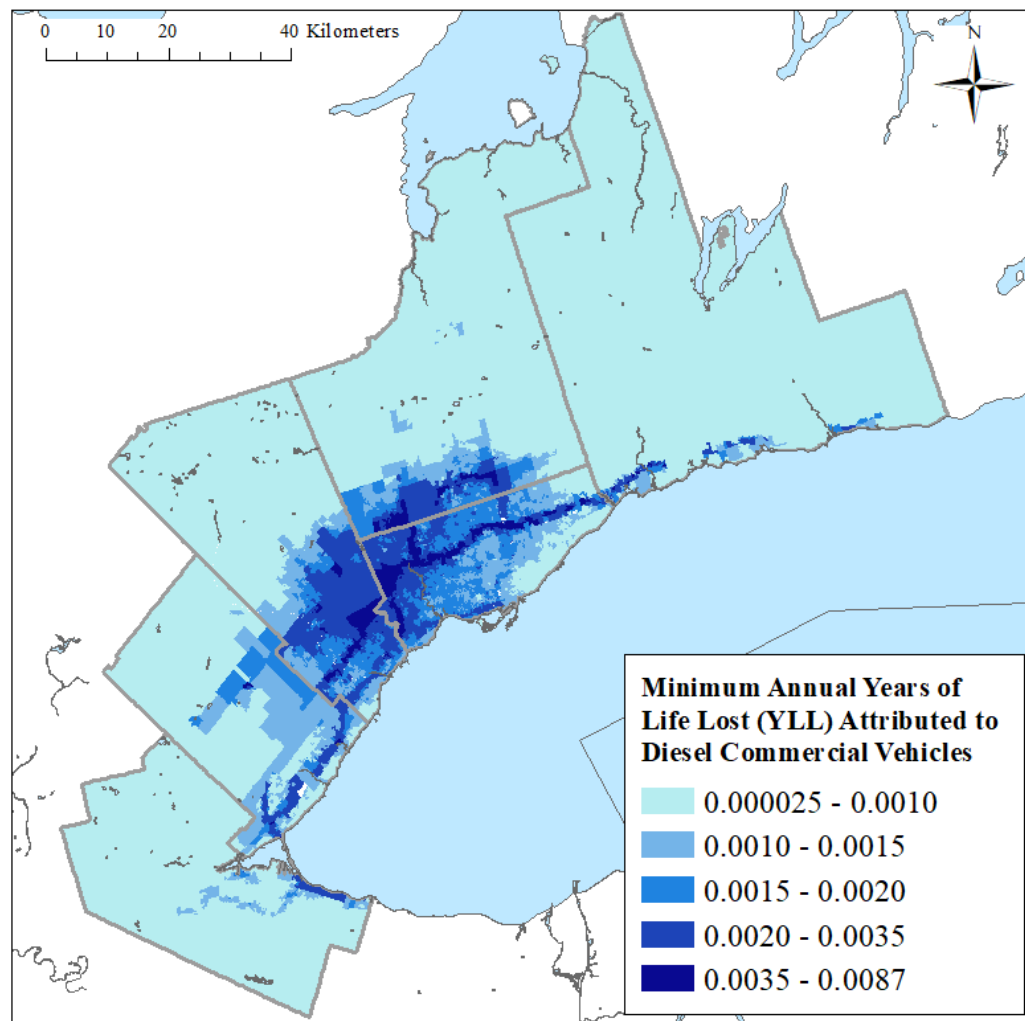
Percent change in the population exposure to NO_2 and BC in the case with less diesel emissions on Highway 401 for population living within 500m of Highway 401



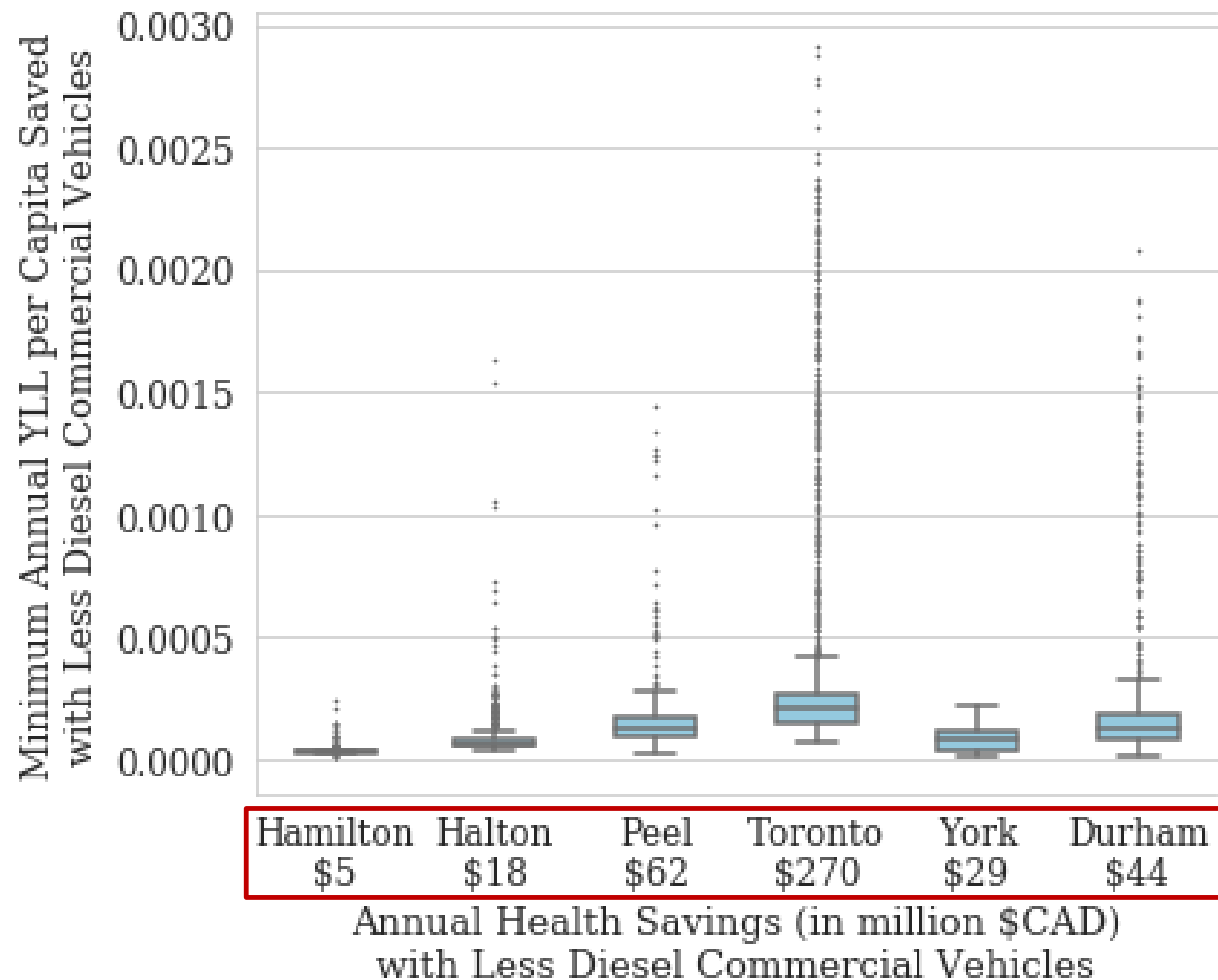
Assessment of the Health Outcomes and Economic Valuation



Assessment of the Health Outcomes



Assessment of the Health Outcomes, under the lower freeway-sourced emissions case



Health savings are higher for regions with higher populations

But this analysis also shows that even small reductions in free-way sourced emissions can achieve large benefits