

University of Toronto  
Transportation and Air Quality Research Group (TRAQ)



## Contribution of diesel trucks to climate and air quality and implications for environmental justice

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City Logistics for the Urban Economy

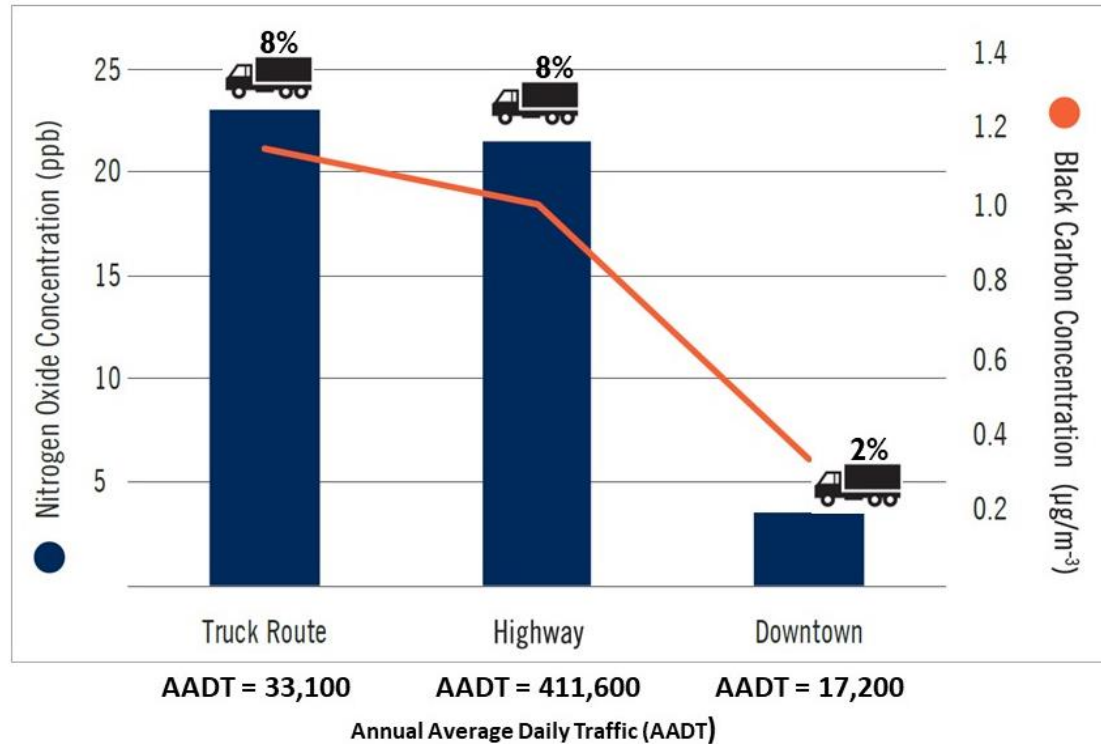


UNIVERSITY OF TORONTO  
FACULTY OF APPLIED SCIENCE & ENGINEERING  
Transportation Research Institute

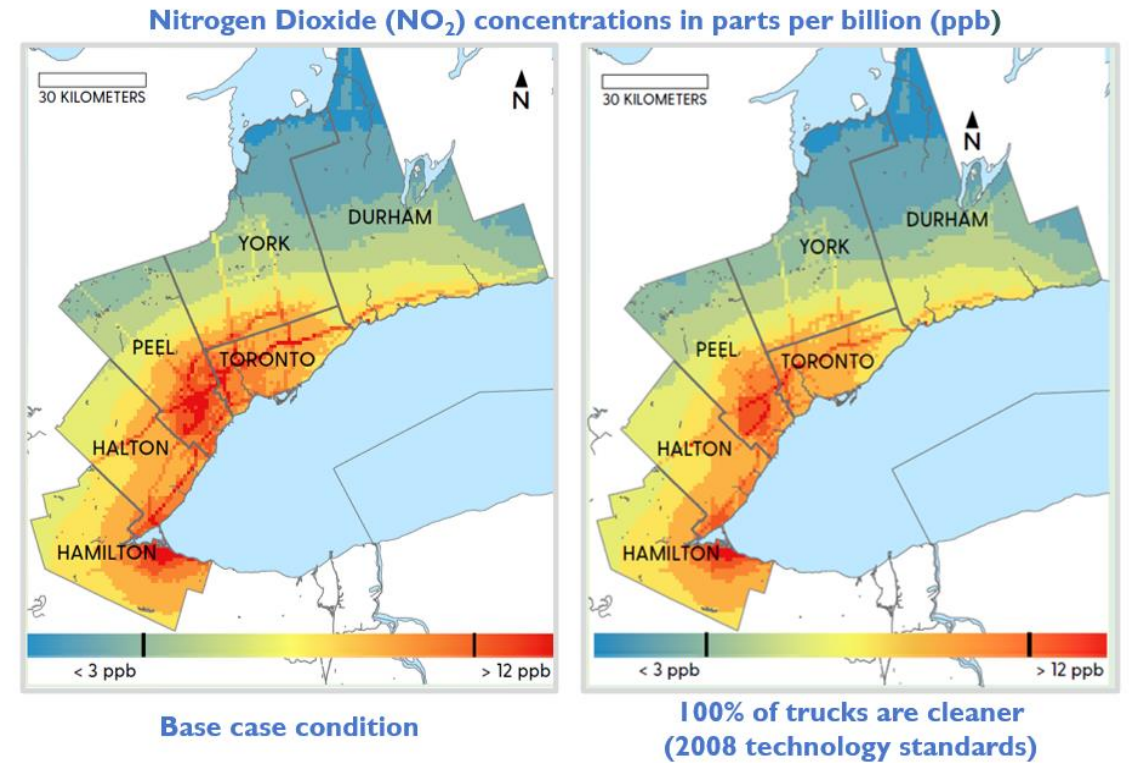
# Trucks, an important target for climate and air pollution mitigation

Excessive exposure to traffic-related pollutants can occur near roads with significant proportions of trucks

### Observation



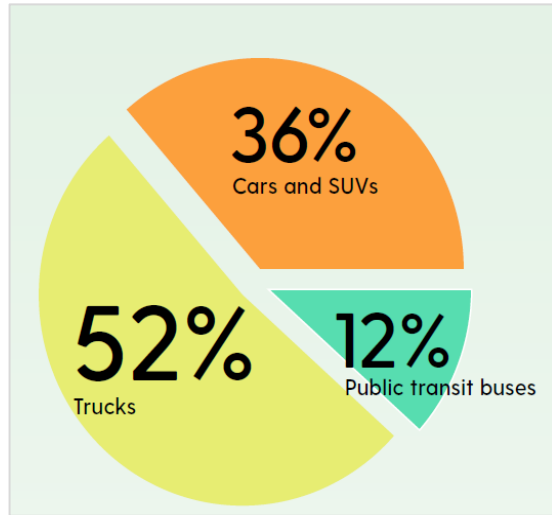
### Simulation



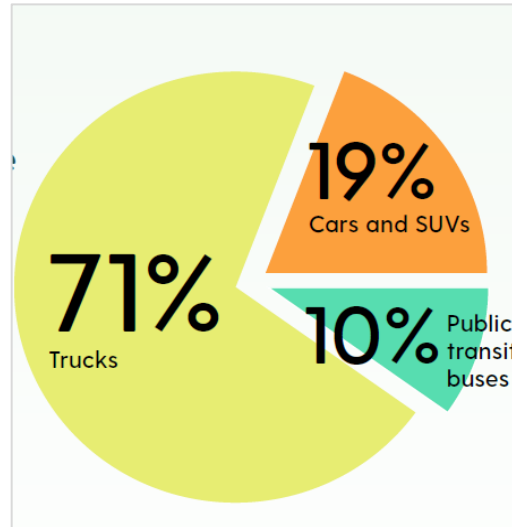
# Large trucks contribute disproportionately to air pollutant emissions

Based on the 2016 traffic-related emission inventory in the Greater Toronto and Hamilton Area (GTHA)

Traffic-related air pollution indicators

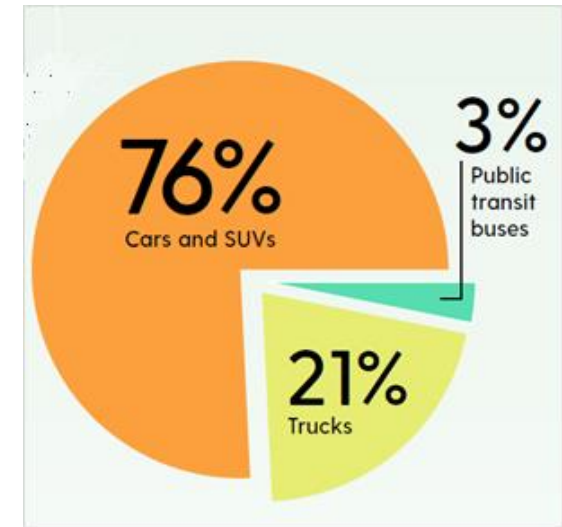


Nitrogen Oxides ( $\text{NO}_x$ )  
 $\text{NO}_x = \text{NO} + \text{NO}_2$



Black Carbon (BC)  
BC = Soot

Greenhouse gas (GHGs)



Carbon Dioxide ( $\text{CO}_2$ )  
Longer lifetime in the atmosphere

# Research Objectives

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1. Evaluate air quality benefits associated with mitigation plans targeting truck technology and truck movements
2. Identify disparities in exposure to truck-related air pollutants

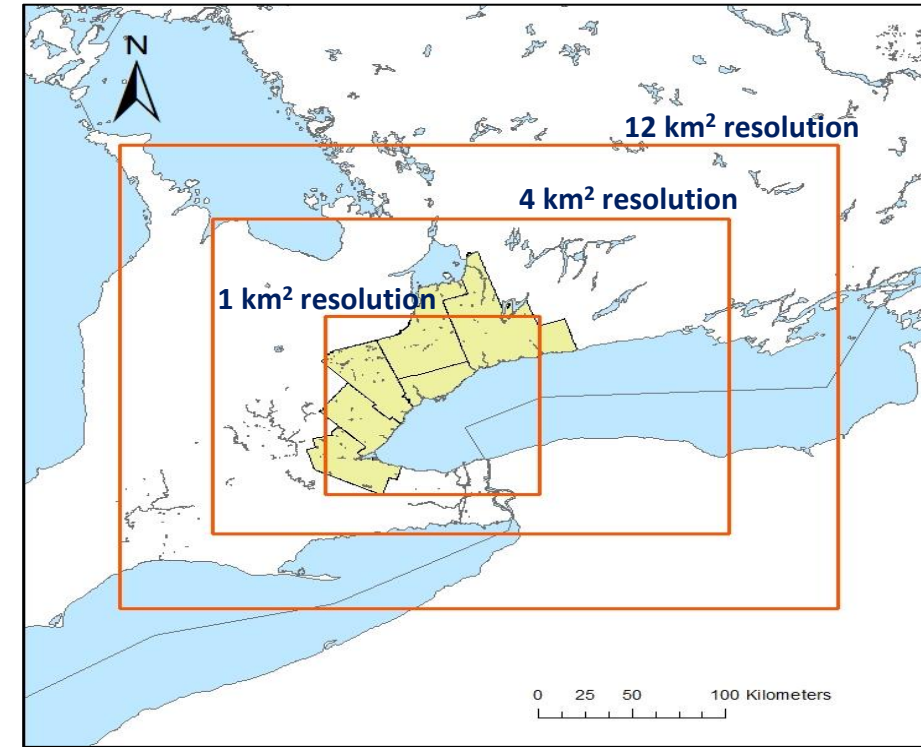
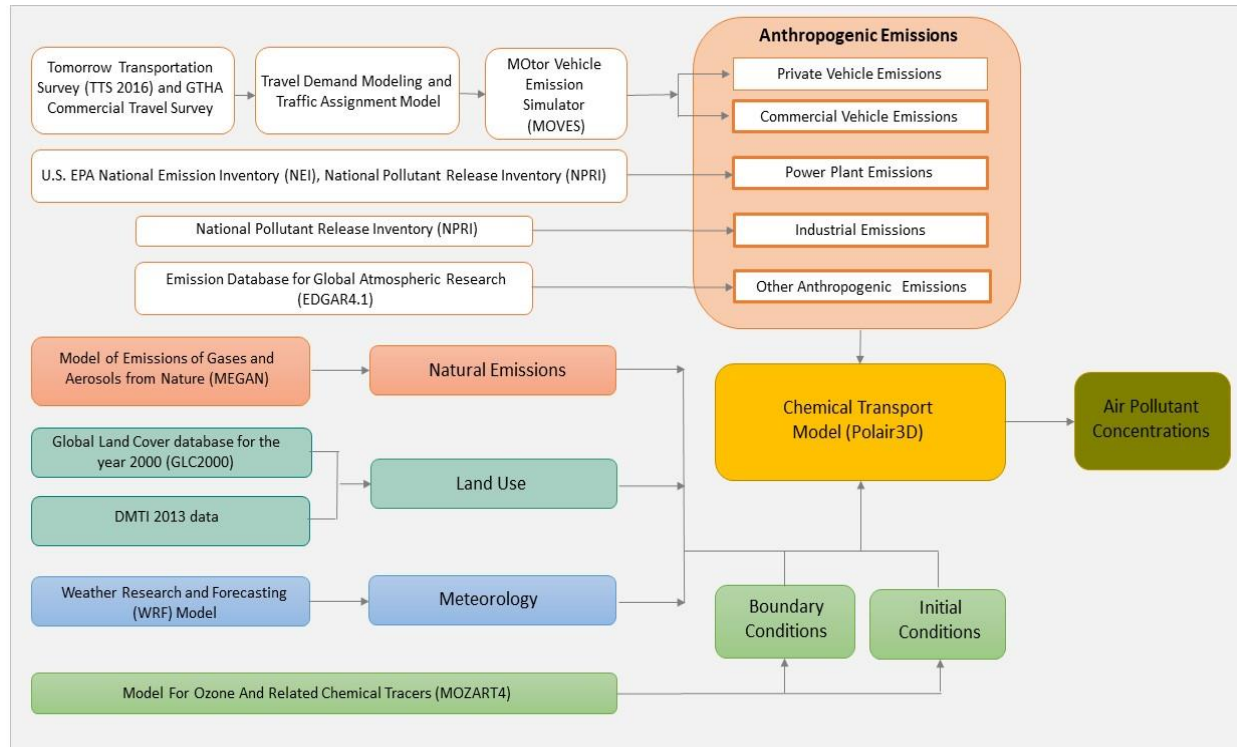
# 1. Air Quality Modelling

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# A Chemical Transport Model (CTM) to assess air quality in the GTHA

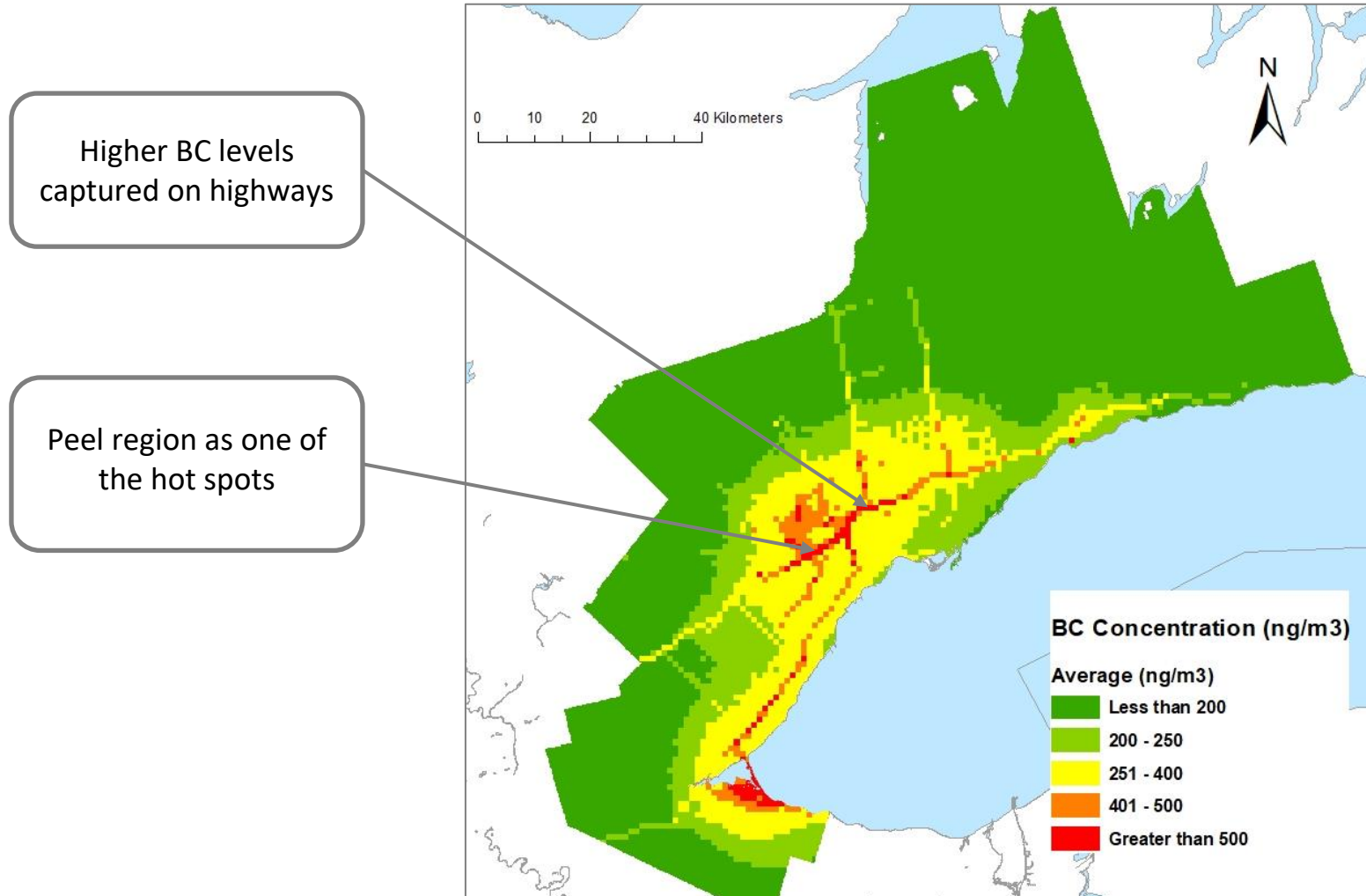


## Scenario analysis:

- Scenario illustrating the impacts of newer truck technology
- Scenario for off-peak deliveries

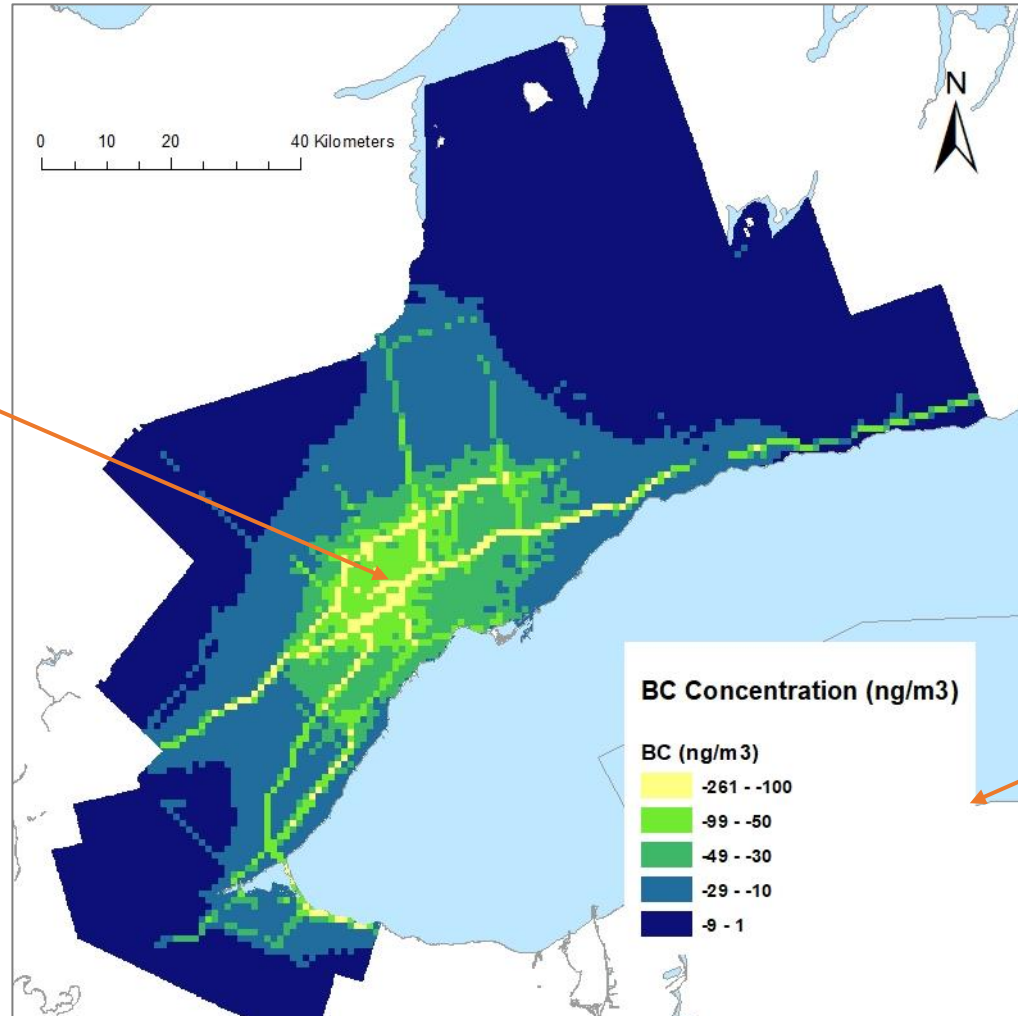


# A. Base case scenario of Black Carbon concentrations



## B. Impact of renewing all diesel trucks to 2008 technology or newer (difference compared to base case)

Largest reductions are observed on highways

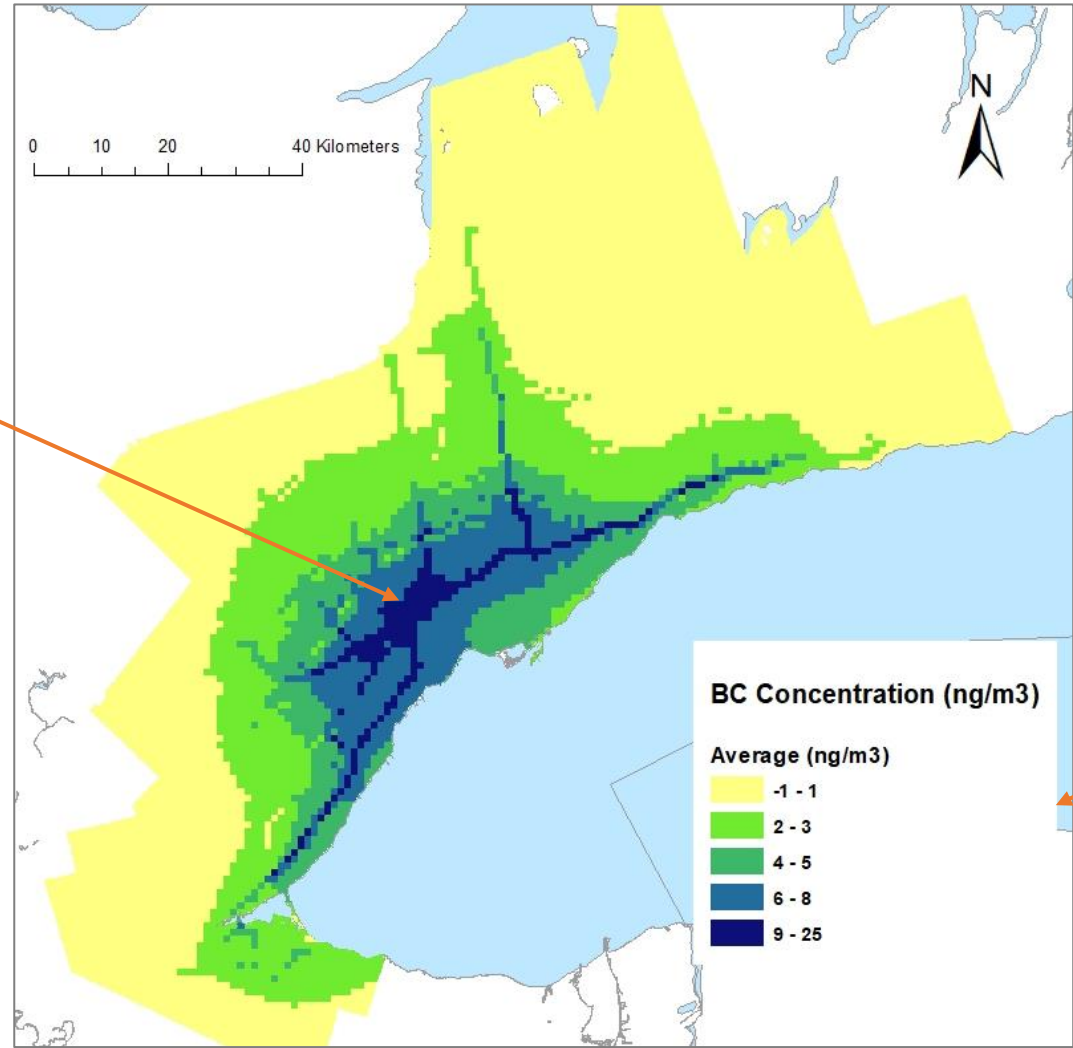


Overall reduction across all regions



## C. Impact of OPD scenario (difference compared to base case)

Largest increase in air pollution is observed on highways



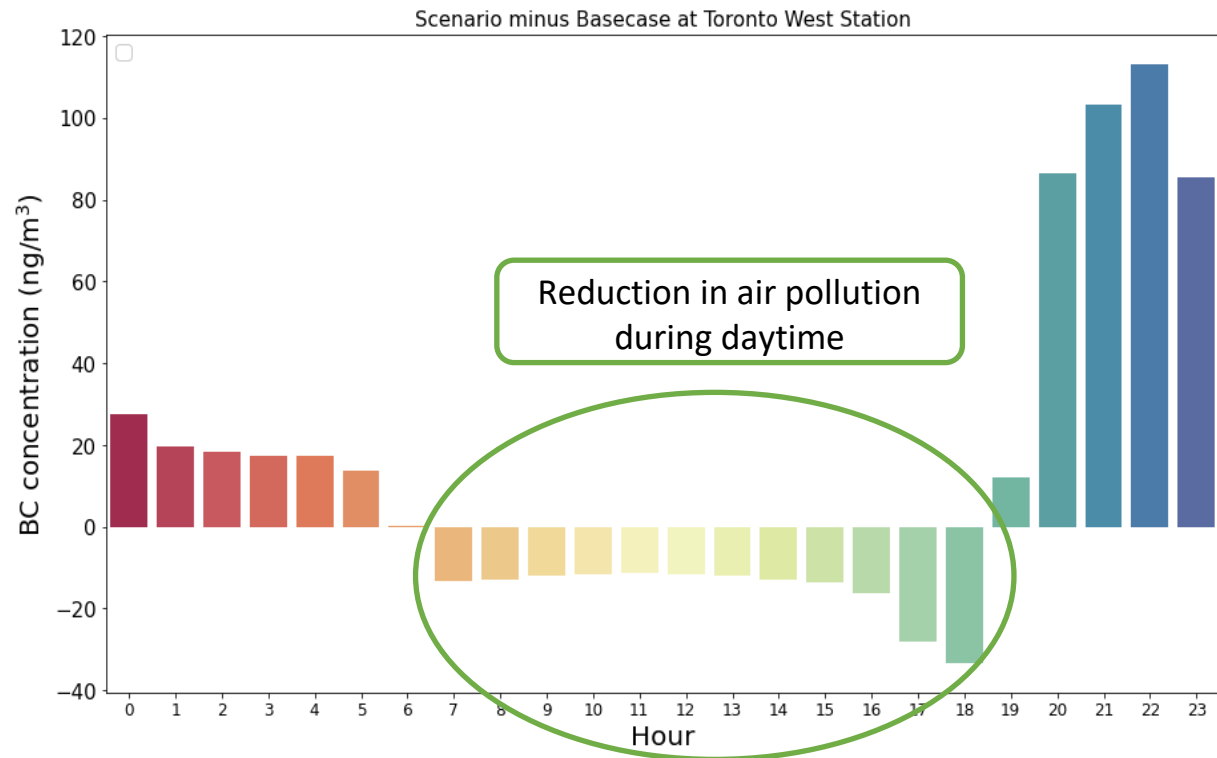
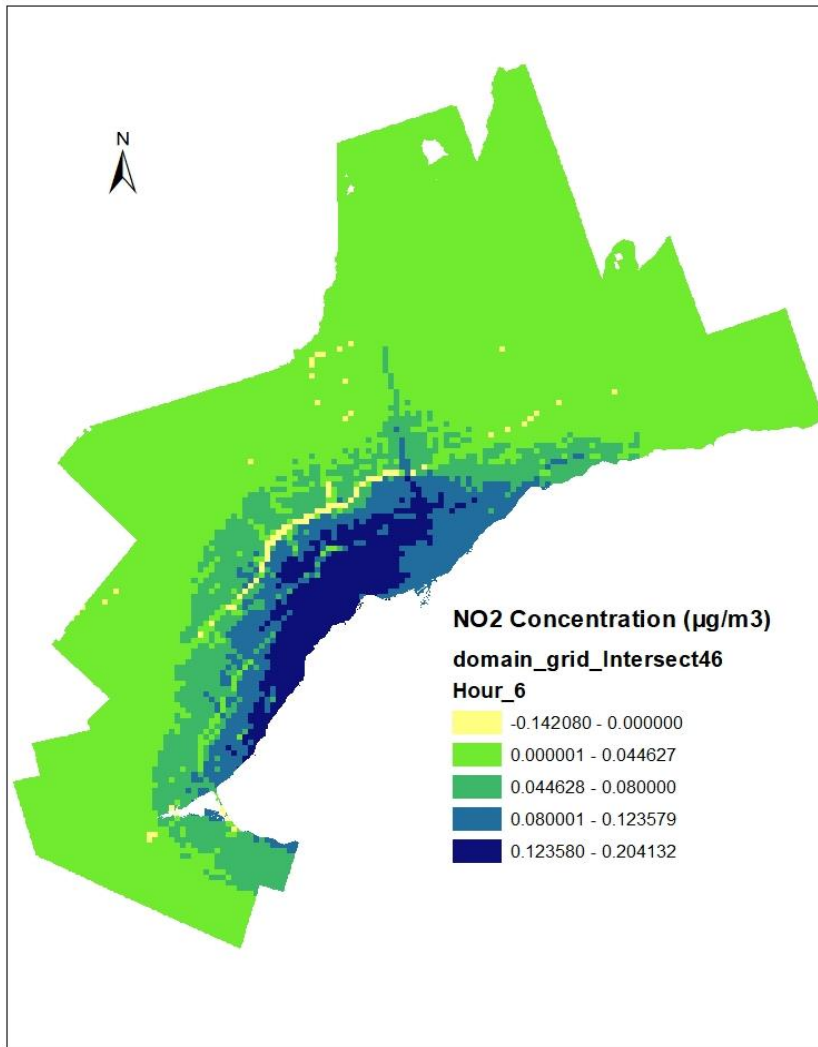
Generally air pollution improvement happens in outer area and air quality degradation occurs on major highways

# New truck technology vs. OPD

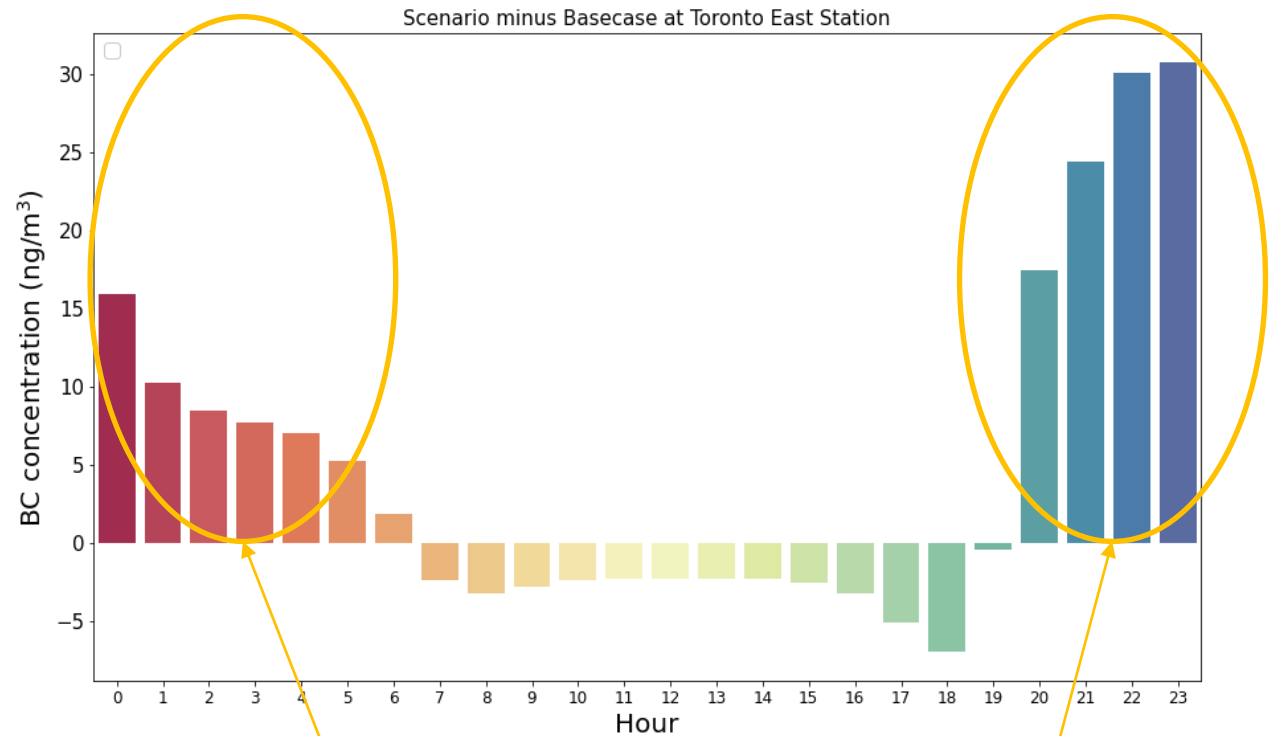
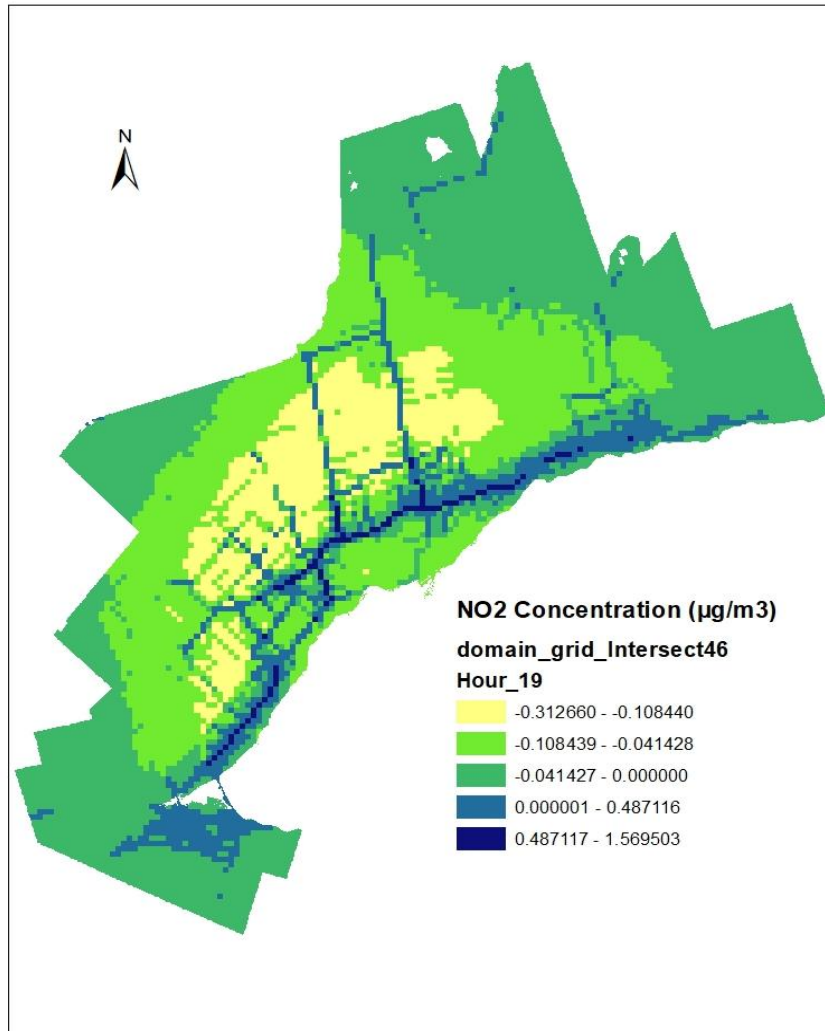
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- Newer trucks result in improved air quality everywhere
- Off-peak delivery leads to minimal impacts on air quality
  - OPD scenario reduces truck emissions during the daytime, but some of these emissions are replaced by those of passenger vehicles (induced travel) → overall effect is improvement in day-time air quality
  - OPD scenario increases night-time emissions of trucks, released in a more stable atmosphere → overall effect is an increase in air pollution

# Diurnal Pattern of Air Pollutant Concentrations (daytime)



# Diurnal Pattern of Air Pollutant Concentrations (nighttime)



Increase in air pollution during nighttime

# 2. Environmental Justice Analysis

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# Ontario Marginalization Indices

## Dependency

- Proportion of the population who are aged 65 and older
- Dependency ratio (total population 0-14 and 65+ / total population 15 to 64 )
- Proportion of the population not participating in labour force (aged 15+)

## Residential Instability

- Proportion of the population living alone
- Proportion of the population who are not youth (age 5-15)
- Average number of persons per dwelling
- Proportion of dwellings that are apartment buildings
- Proportion of the population who are single/divorced/widowed
- Proportion of dwellings that are not owned
- Proportion of the population who moved during the past 5 years

## Material Deprivation

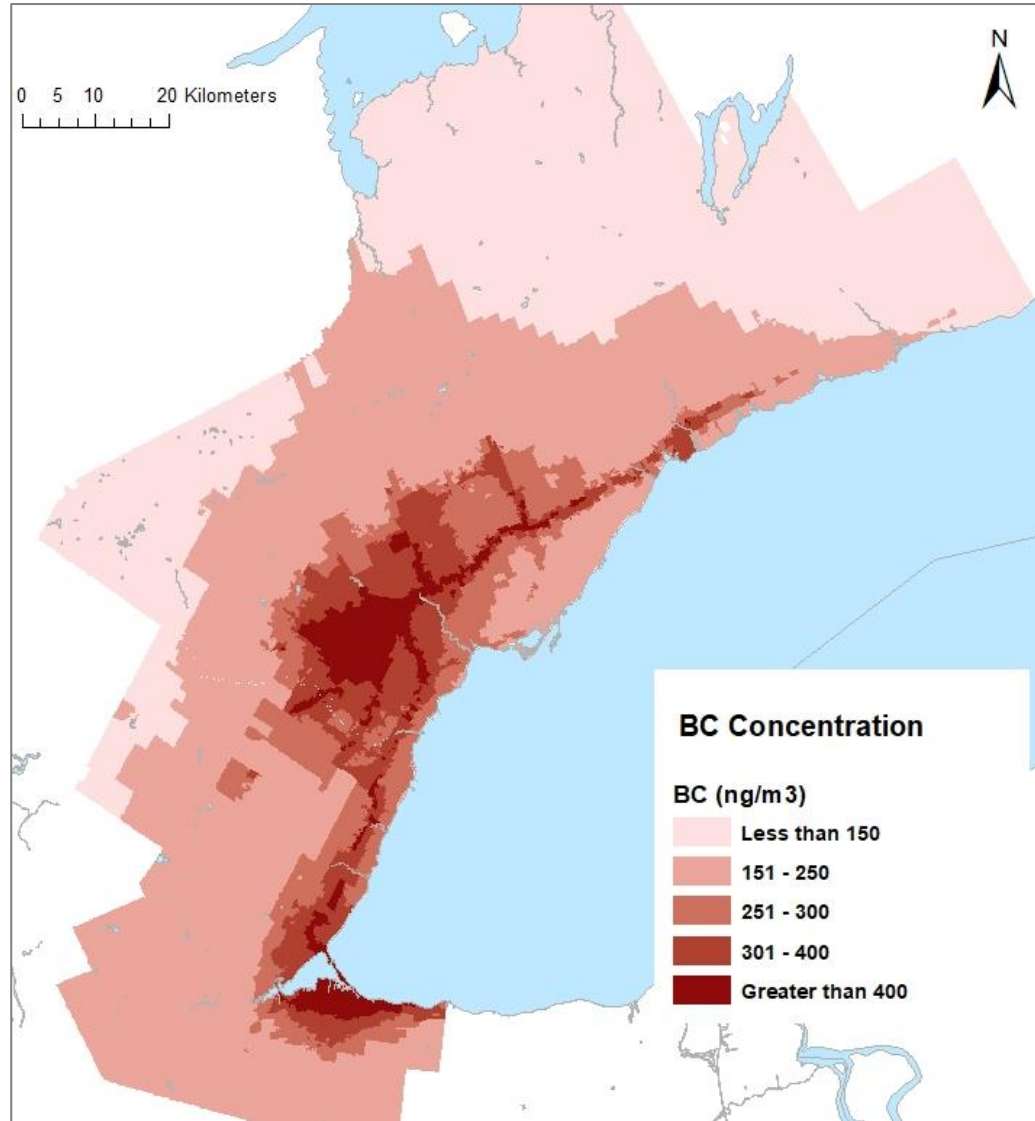
- Proportion of the population aged 20+ without a high-school diploma
- Proportion of families who are lone parent families
- Proportion of total income from government transfer payments for population aged 15+
- Proportion of the population aged 15+ who are unemployed
- Proportion of the population considered low-income
- Proportion of households living in dwellings that are in need of major repair

## Ethnic Concentration

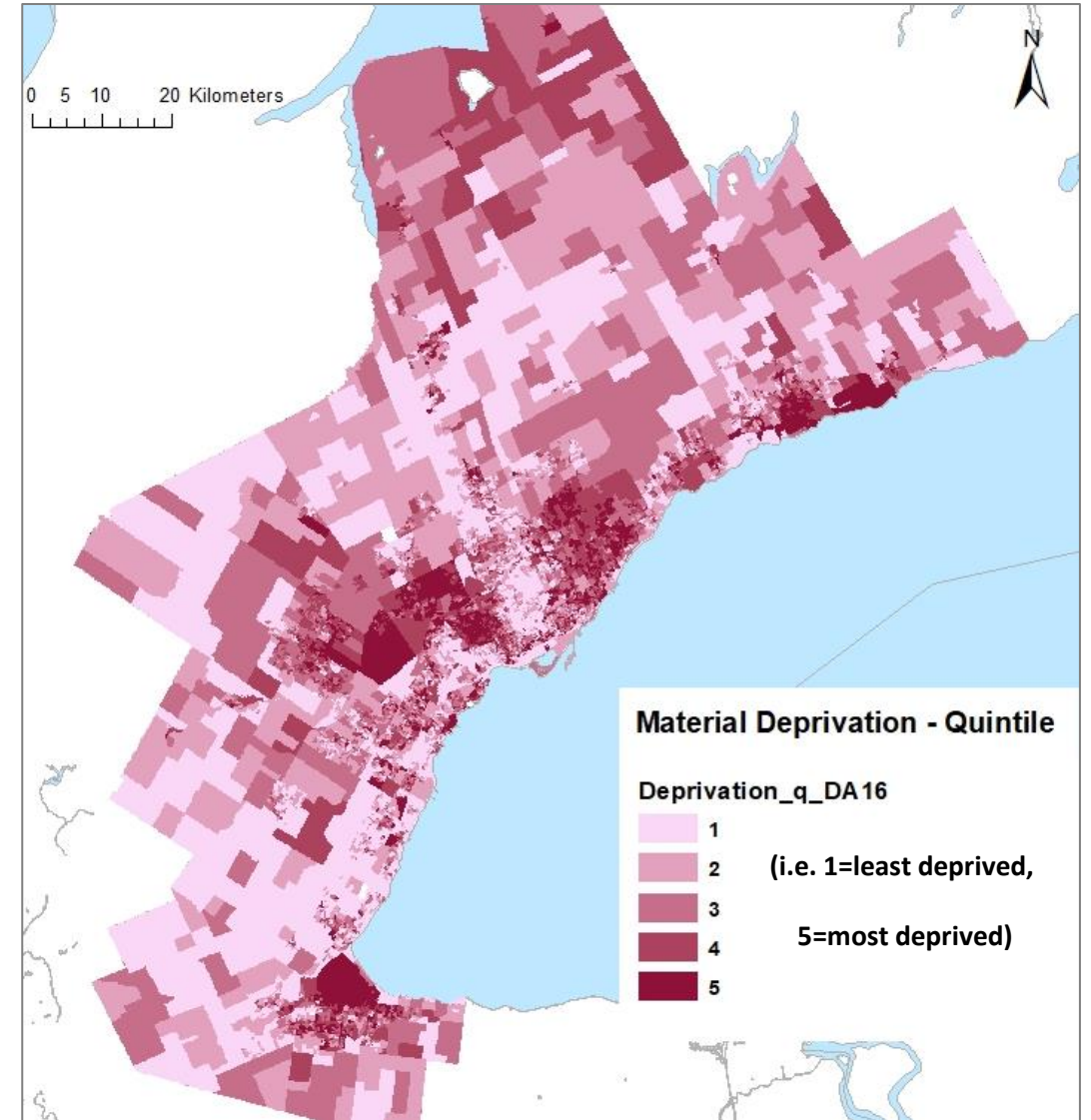
- Proportion of the population who are recent immigrants (arrived in the past 5 years)
- Proportion of the population who self-identify as a visible minority



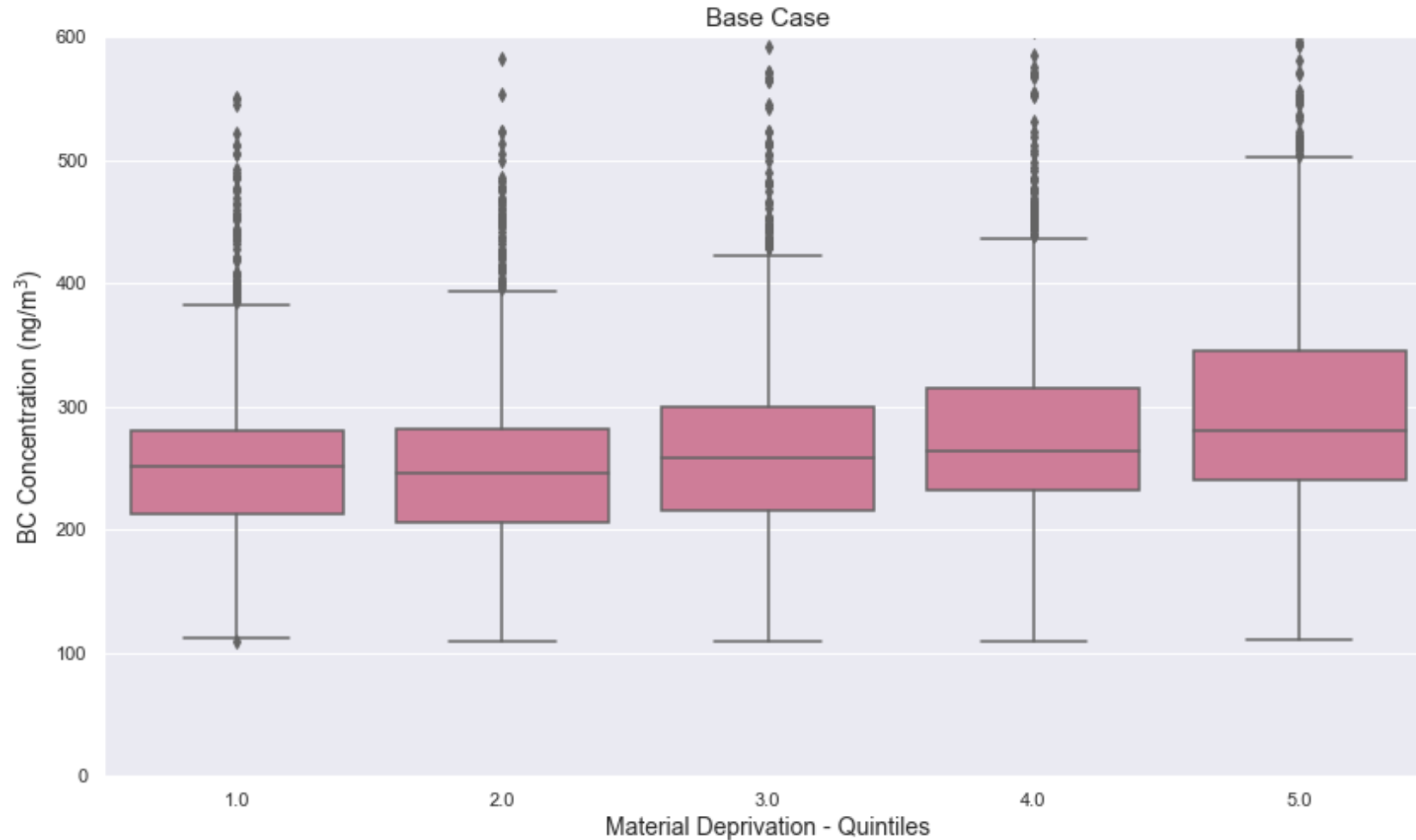
**Base case**



**Material Deprivation Quintile**

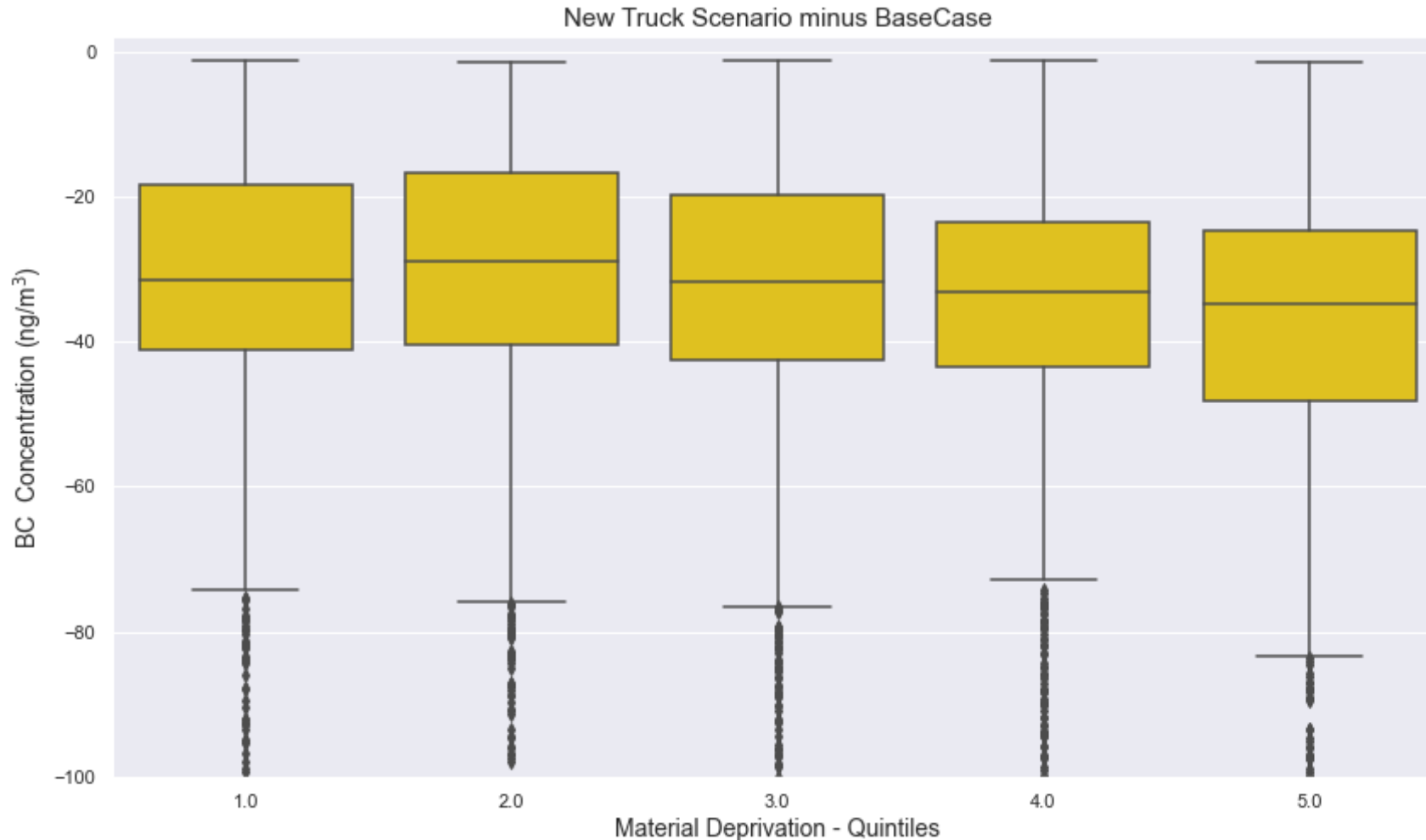


# A. Base case BC concentrations across material deprivation quintiles



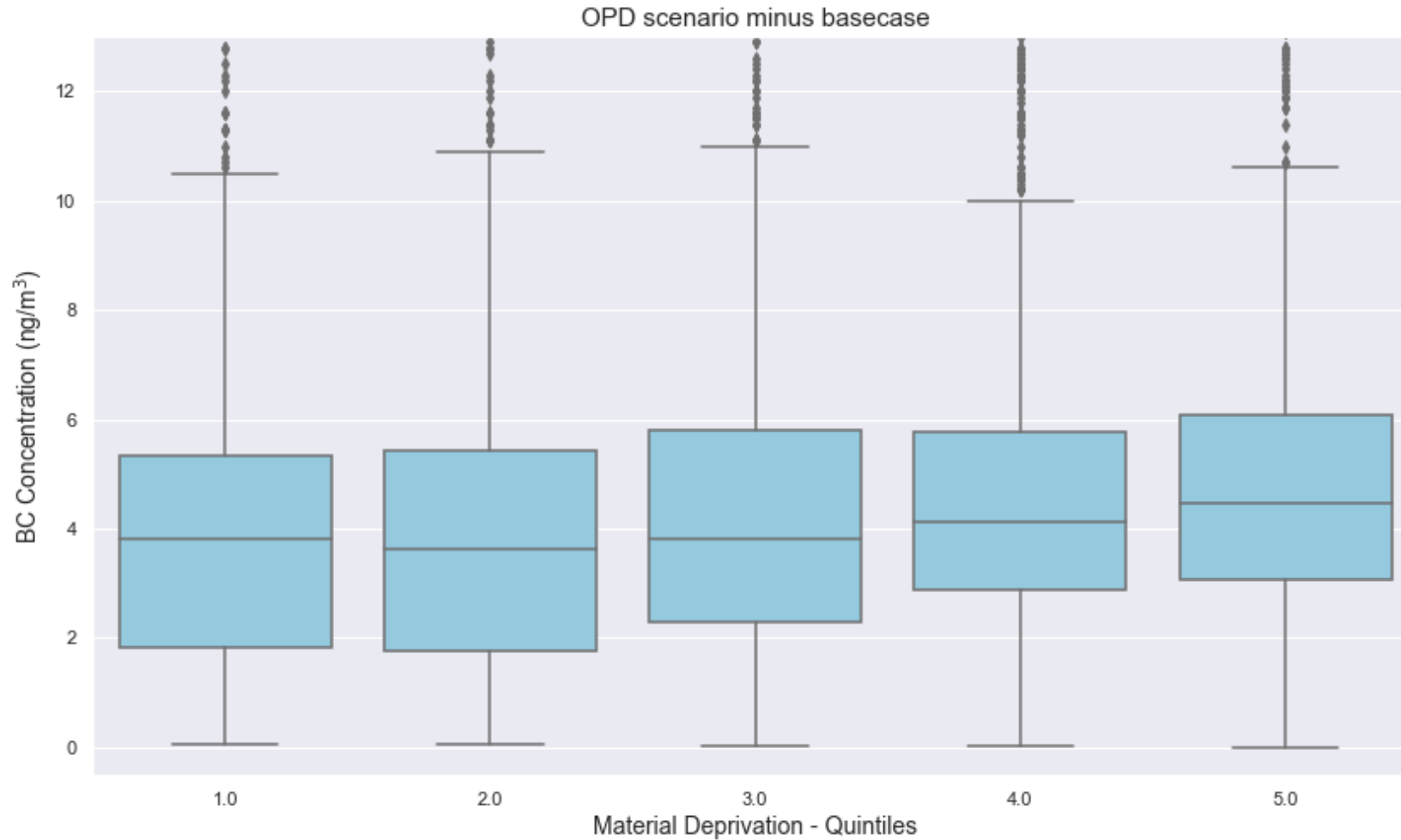
Most disadvantaged group is exposed to higher levels of BC

# B. BC reductions under new truck scenario across material deprivation quintiles



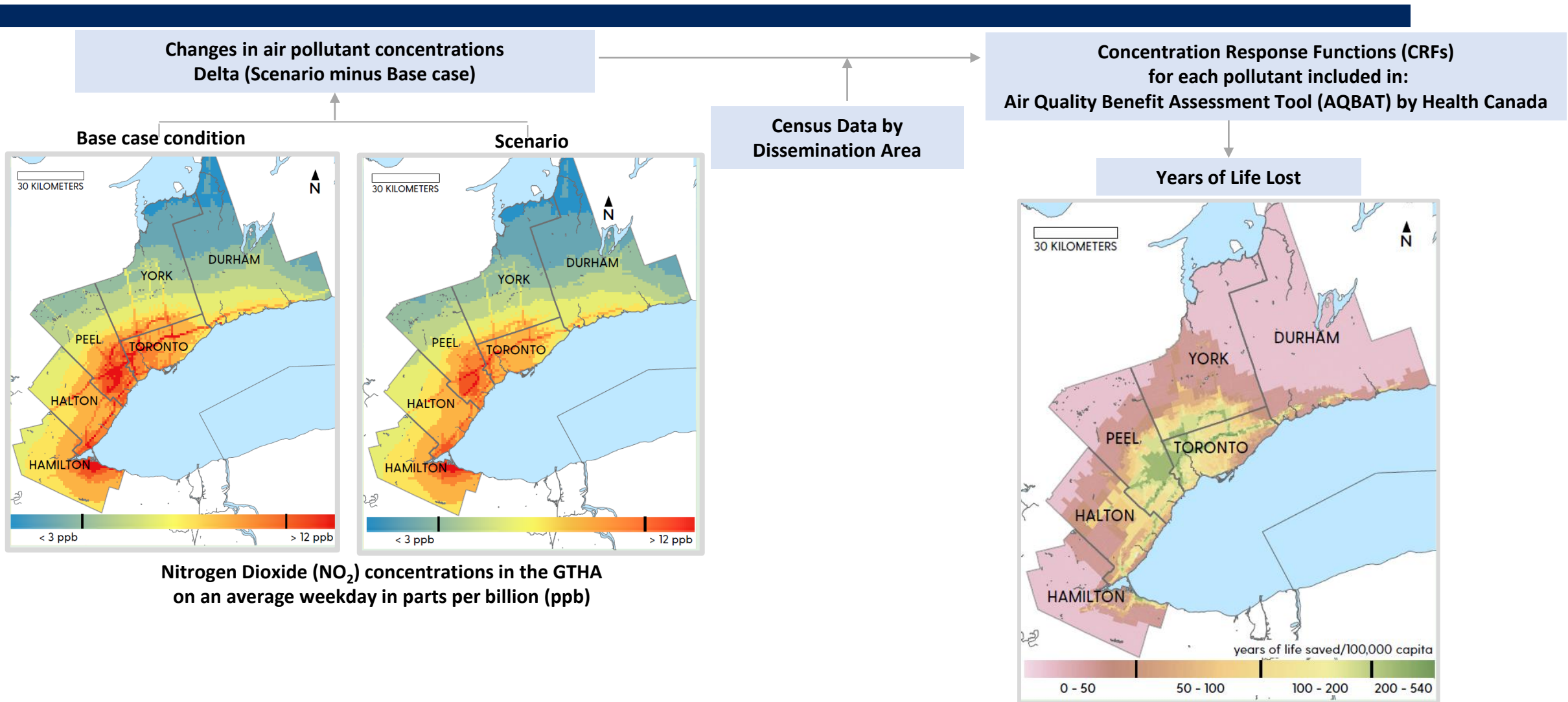
Most disadvantaged group experiences the largest reduction in air pollution

# C. BC increases under OPD scenario across material deprivation quintiles



Most disadvantaged group experiences the highest deterioration of air quality

# Future direction: Health outcomes analysis



# References

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Thank You!