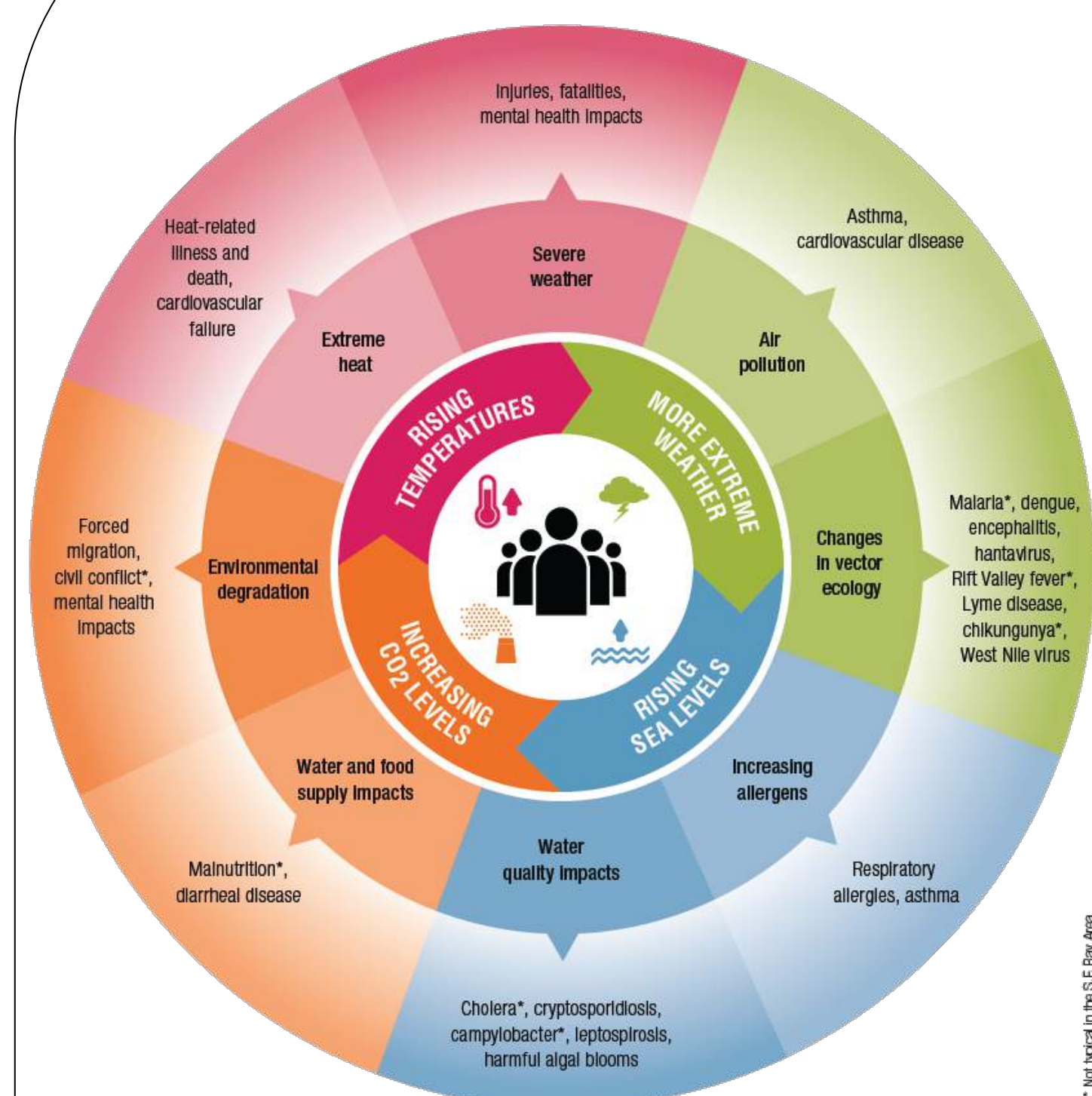


# Estimate the impacts of Greenhouse Gas (GHG) reduction on population health in Quebec

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## Introduction



In the last century, human activities such as the combustion of fossil fuels in the electric utility and transportation sectors, land-use change, and various industrial emissions have increased the greenhouse gases (GHG) in the atmosphere causing higher global temperatures. This could lead to various types of climate changes and also impact human health.

**Project Objective : Development of a framework for estimating the impacts of GHG reduction on population health in Quebec, one of Canada's most industrial provinces.**

Figure 1: Health Impacts of Climate Change. Figure Credit: [San Francisco Department of Public Health, City and County of San Francisco](#)

In this project we use an air quality model, Polair3d, to estimate the hourly averaged air pollutant concentrations in Quebec to then evaluate the health implications of a series of emission scenarios.

## Study Domain

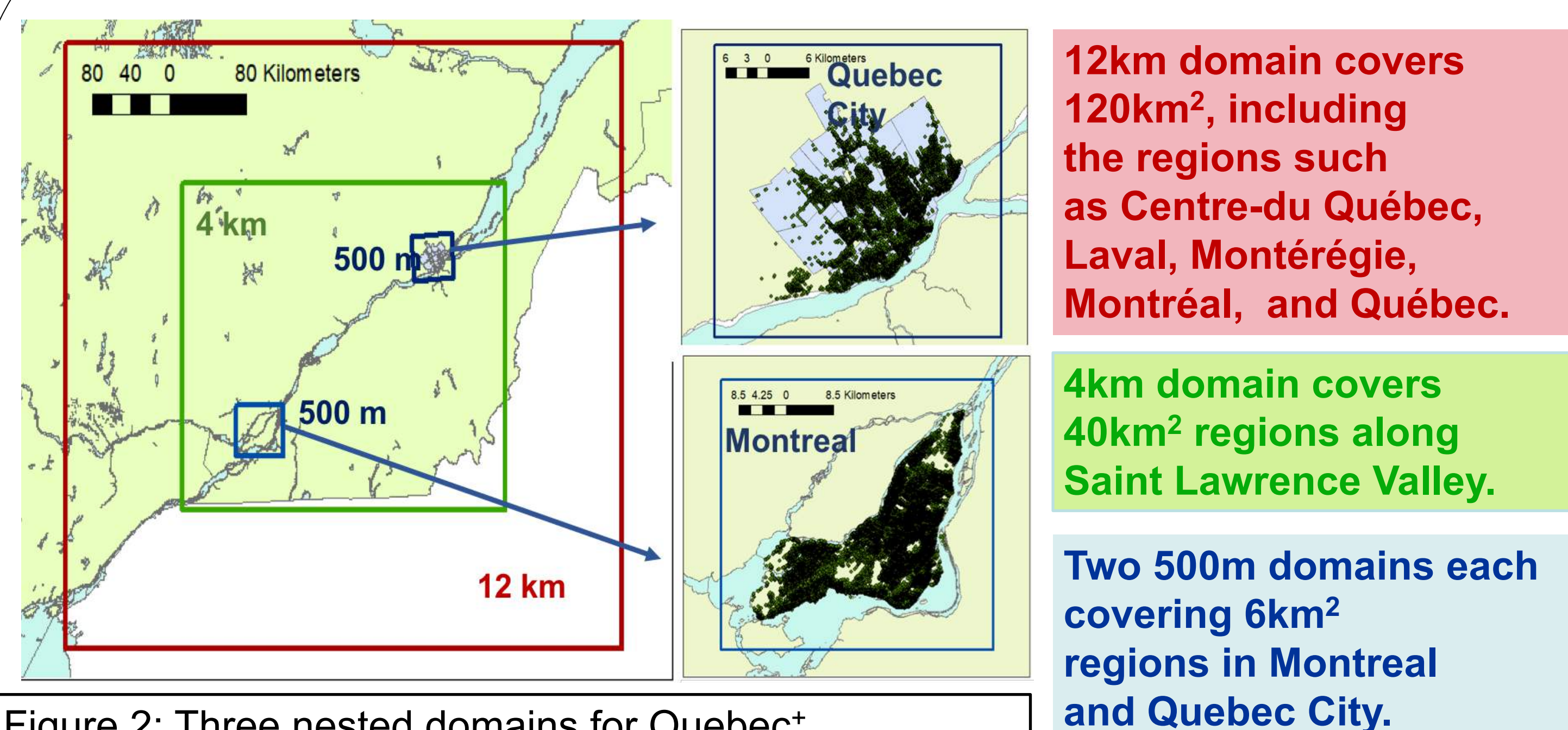


Figure 2: Three nested domains for Quebec\*.

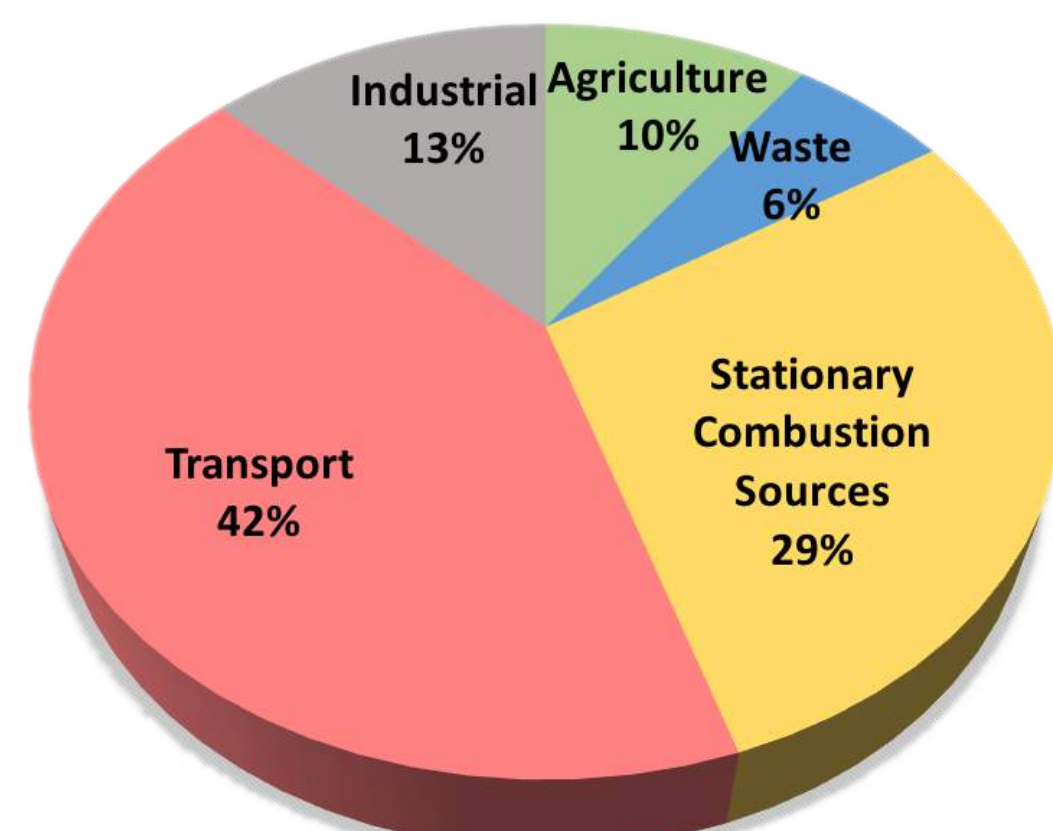


Figure 3: Quebec sources of GHG emissions based on [National Inventory Report, 2015](#)

- Quebec is home for various industries including various metal smelters and refineries. However, traffic and stationary combustion sources contribute most towards the Quebec's air pollution.
- In this project we mainly focus on emissions from the two main metropolitan areas Montreal and Quebec City.

## Future Work

We will apply Polair3d CTM to the three nested Quebec domains to obtain the hourly air pollutant concentrations at each domain. The results of different mitigation scenarios will be used to assess the public health impacts such as Years of Life Lost (YLL), number of premature deaths, etc.

## Framework

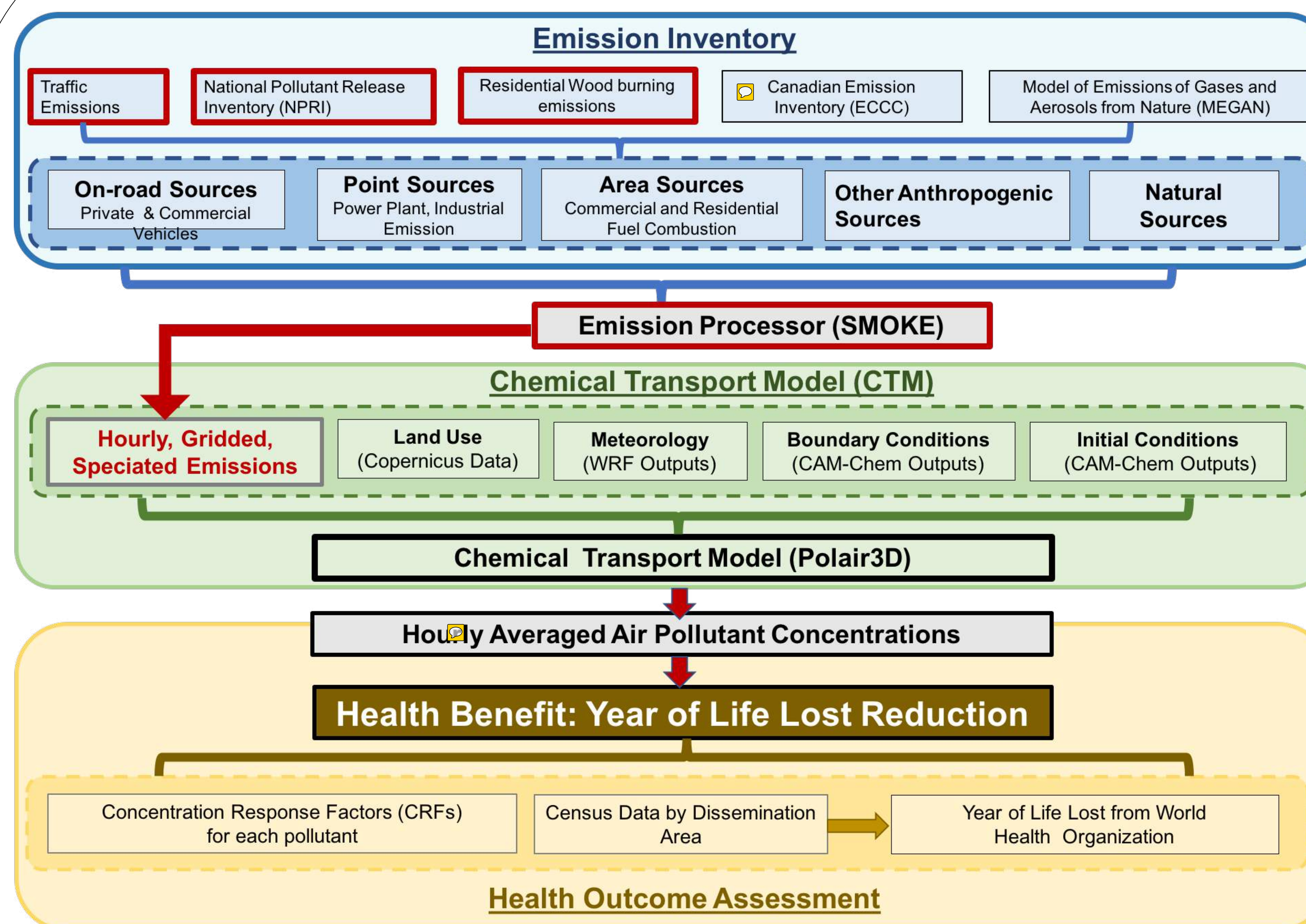


Figure 4: Project flow chart consists of three main section, Emission Inventory, Chemical Transport Model (CTM), and Health Outcome Assessment.

• TRAQ team is in the process of developing more refined emission data for two sectors: transportation and residential wood burning.

• Poster title "Downscaling Emissions From Residential Wood Burning using Real Estate data and Thermal Imagery" by Jad Zalzal presents the development of residential wood burning for Quebec.

• TRAQ team is also working on the modification of the National Pollutant Release Inventory (NPRI) for Quebec.

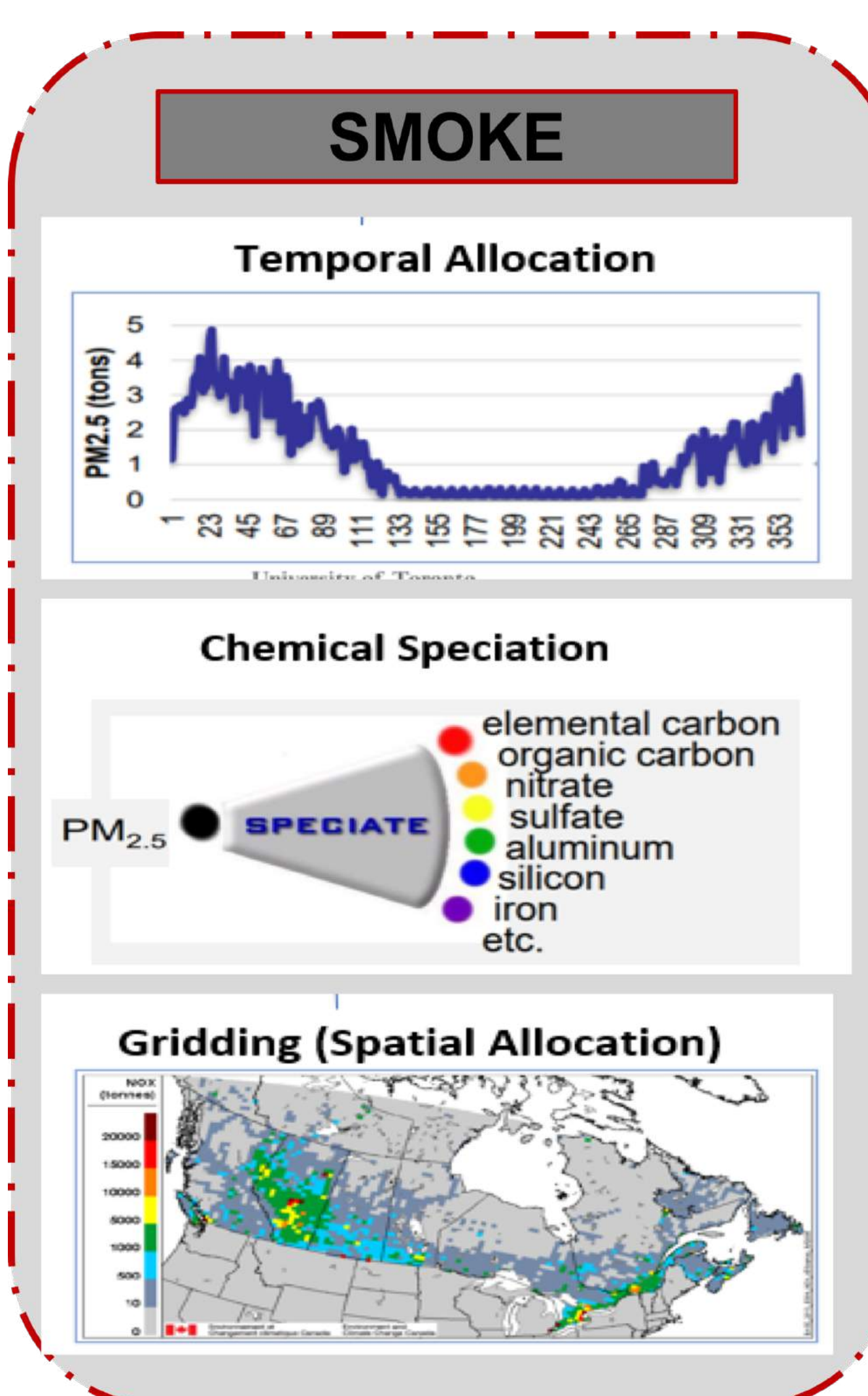
• Improved emission inventories will be used to process emissions using the Sparse Matrix Operator Kernel Emissions (SMOKE) software.

• Processed emissions will be interpolated to the hourly, gridded speciated emissions to use in the Polair3d, chemical transport model (CTM) along with other inputs such as land use data, meteorological data, etc.

• Weather Research and Forecasting (WRF) meteorological data. Boundary and initial conditions are obtained from Community Atmosphere Model with Chemistry (CAM-chem).

• CTM output hourly averaged air pollutants then will be used to assess the public health benefits.

## Emission Processor (SMOKE)\*



The Sparse Matrix Operator Kernel Emissions (SMOKE) is an emissions data processor that has the primary function of translating emissions data for use in photochemical grid models.

- A few advantages of SMOKE are,
- Fast computing capability
  - Parallel processing paradigm for multiple grids, control strategies, different chemical mechanisms
  - Application of the year-specific growth factors to project inventories to future or past years
  - Quality Assurance Module (validate and compare emission totals after each stage of processing)

Figure 5: Schematic of SMOKE emission processing system. Figure is based on [EPA Emission Modeling Training Documentation](#).

## Traffic Emission Predictions\*\*

Traffic Emission Prediction scheme (TEPs) uses a long record of traffic counts to extend downstream daily traffic counts and to identify some coefficients to estimate Annual Average Daily Traffic (AADT) from daily values. This model also provides a unique basis to use short-term traffic volumes (e.g., satellite counts) for AADT prediction.

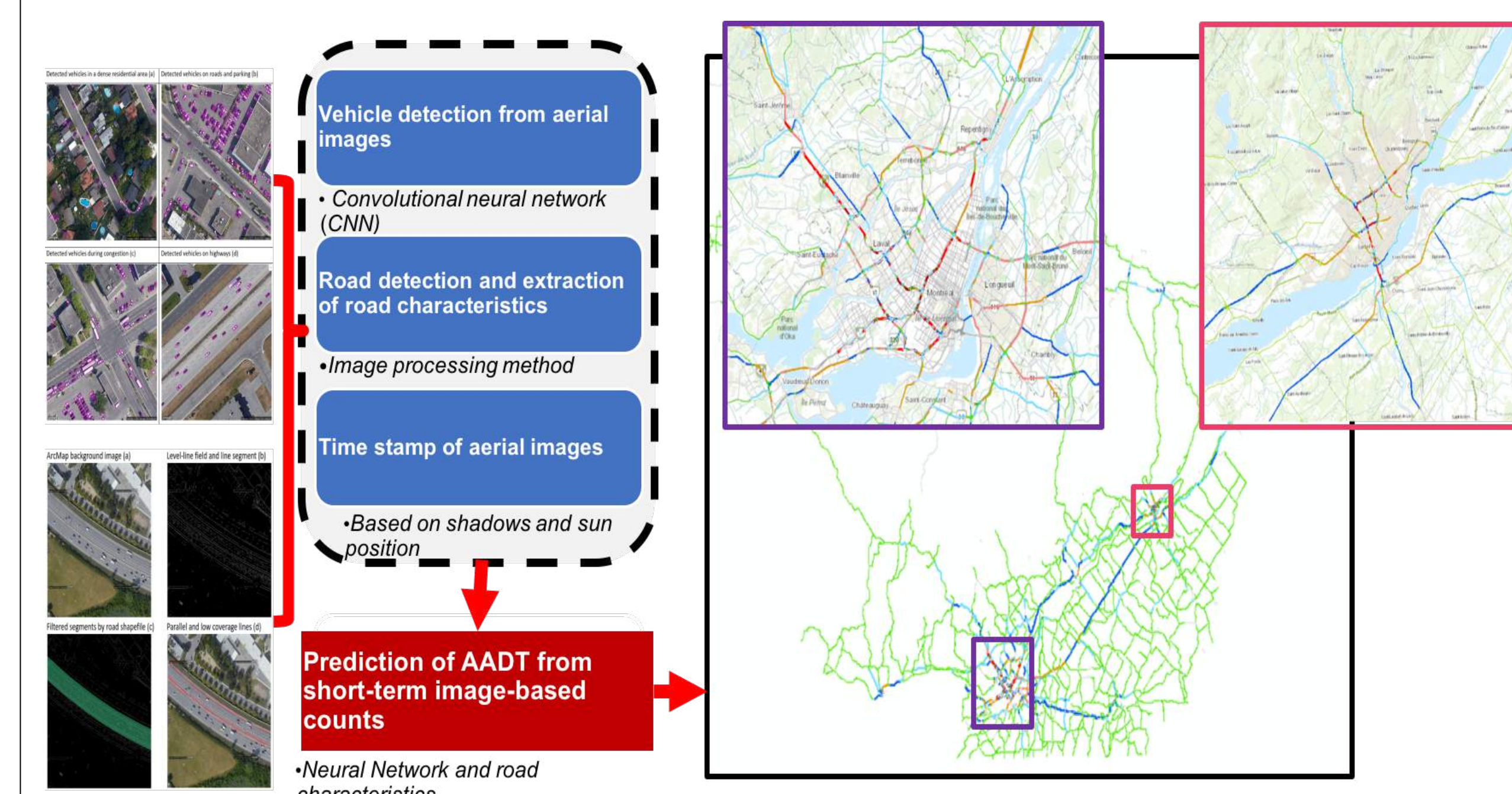


Figure 6: Predicted AADT at Montreal and Quebec City, using Traffic-Emission Prediction Scheme ([Ganji et al., 2020](#))