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Carbon dioxide and methane measurement on urban roads in Nanjing, China

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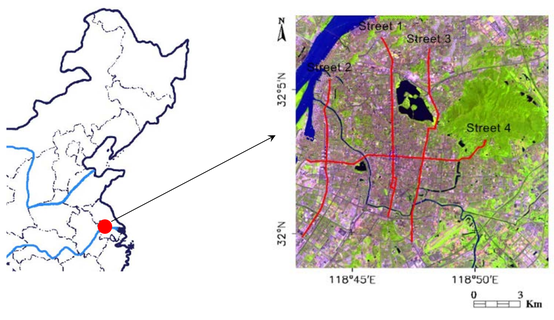
Introduction

- Many conventional passenger gasoline vehicles have been converted for the natural gas (NG) fuel supply. It is an ideal alternative fuel for reduction of carbon dioxide and air pollutant emissions for each unit of heat produced.
- Vehicle methane emissions are thought to be an insignificant methane source on the global scale. It has been shown, however, that locally, in areas with a high traffic density, they can account for a larger proportion, reaching even 30% of the total emission.
- The emissions of CH_4 are more difficult to estimate and depend strongly on technology, vehicle type and driving conditions. In comparison, CO_2 emissions from traffic can be computed accurately from fuel consumption statistics.

Objectives

- This paper presents a result of carbon dioxide and methane measurements on urban roads and develops a top-down methodology to update the vehicle emission inventory.
- This paper also quantifies the CH_4 contribution from the taxi and bus after they have been switching to natural gas as energy source.

Experiment site



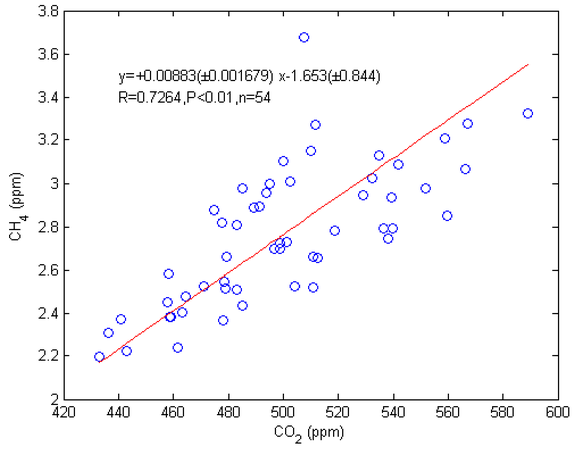
Schematic diagram of the observation routes. CH4 and CO2 concentrations were measured on Street 1, Street 3 and Street 4 showed in red.

Instrument and experiment

Portable Greenhouse Gas Analyzers (UGGA, Los Gatos Research, Mountain View, CA)

Date	Oct. 17, 2014	Oct. 18, 2014	Oct. 20, 2014	Oct. 23, 2014
Weather	Partly cloudy	Partly cloudy	Partly cloudy~Shower	Clear~Partly cloudy
temperature	24℃-15℃	26℃-17℃	29℃-17℃	24℃-13℃
Wind	Southeast 3-6 m/s	Southeast 3-6 m/s	Southeast ~North 3-6 m/s	Southeast 3-6 m/s

CH_4 and CO_2 concentrations on urban roads



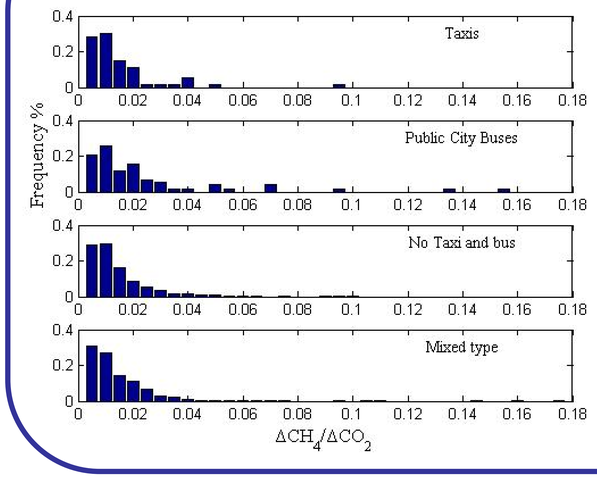
Scatter plot of CH_4 and CO_2 mixing. Lines represent the regression equation shown. The 95% confidence bound (numbers in parentheses), the number of observations (n) and the regression coefficient (R) are also shown.

IPCC method to estimate the GHG emission

$$E_{v,j} = \sum_{v,j} (EF_{v,j} \times VP_{v,j} \times VMT_{v,j}) \times 10^{-6}$$

- *E* – annual emission in metric tons;
- *v* – vehicle group; *j* is the fuel type;
- *EF* – emission factor (g/km)
- *VP* – vehicle population;
- *VMT* – average vehicle mileage traveled.

Probability distribution of $\Delta CH_4/\Delta CO_2$



Emissions ratio according to vehicle type in front of the observation platform. The median of $\Delta CH_4/\Delta CO_2$ for bus is 0.0106. The median value for taxi is 0.00896. When no bus or taxi was present, the median is relatively lower (0.00784).

Effects of fuel switch on emissions ratio

Scenarios	CH_4 emission ($\times 10^6$ ton)	CO_2 equivalent for CH_4	CO_2 emission ($\times 10^6$ ton)	$\Delta CH_4/\Delta CO_2$
Current status*	0.00255	0.0713	0.769	0.00911
Oil only	0.000256	0.00717	0.969	0.00073
Natural gas only	0.00386	0.108	0.841	0.0126

* 95.9 percent of all taxi and 33.6 percent of the buses in Nanjing were powered by NG.