

The GTA Greenhouse Gas Observatory Network

An update for 2022

Lawson Gillespie^{1,2}, Nasrin Pak^{1,2}, Sébastien Ars², Romina Piunno^{1,3}, Dan Weaver⁴, Felix Vogel², and Debra Wunch¹

1. Department of Physics, University of Toronto
 2. Environment and Climate Change Canada (CCMR)
 3. Department of Chemical and Physical Sciences, University of Toronto Mississauga
 4. Department of Physical and Environmental Sciences, University of Toronto Scarborough
- lgillespie@physics.utoronto.ca—



The Greater Toronto Area Greenhouse Gas Observatory Network (GTA-GHG-ON) is a network of four permanently installed Bruker EM27/Sun spectrometers at different locations throughout the GTA. Spectra are processed using the EGI wrapper for the GGG retrieval software. XCH₄, XCO₂, XCO, and XH₂O are retrieved from near infrared spectra. This poster presents data from the updated network, and early examples of the scientific analysis using the data from the network.

Introduction

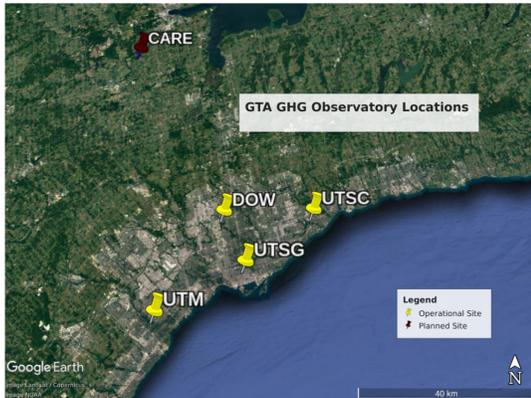


Figure 1: Locations of the current and proposed observatory sites.

Total column observations of greenhouse gases (GHGs) have been used to quantify emission on local, regional, and continental scales [3, 6, 5].

In order to quantify emissions on a regional scale, networks of low resolution EM27/Sun spectrometers have been used to measure urban emissions of GHGs [2, 1]. The GTA-GHG-ON consists of four permanent installations of EM27/Sun spectrometers. The longest serving station, operational since July 2017, is located at the downtown University of Toronto St. George Campus (UTSG), and it home to the instrument we label *ta*. The second permanent station was installed at the Downsview (DOW) Environment and Climate Change Canada (ECCC) site. It is currently home to the *td* spectrometer, and it has been operational since summer 2019. The observatory at the University of Toronto, Mississauga (UTM), home to the *tc* was installed in November 2021, with the University of Toronto, Scarborough being home to the fourth spectrometer *tb*, installed in May 2022.

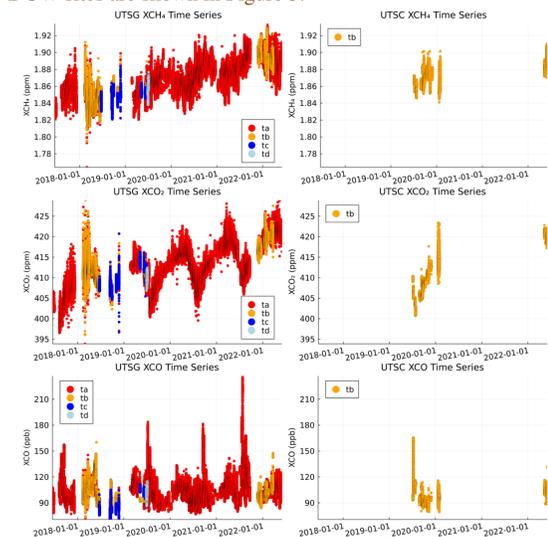


Figure 2: The complete time series of X_{GHG} at left: UTSG observatory at McLennan Physical Laboratories, home of the Department of Physics at the University of Toronto, and right the observatory at the University of Toronto Scarborough located on the roof of the Arts and Administration building.

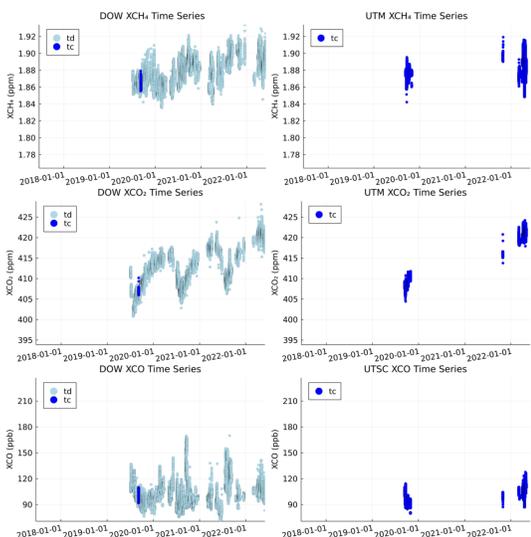


Figure 3: The complete time series of X_{GHG} the left: UTM observatory William G. Davis building at the University of Toronto, Mississauga and right: the DOW observatory at the Downsview ECCC laboratory.

Please note, some of the data (those from 2022 and later) have not yet had instrument-to-instrument bias correction applied to the time series data.

Comparing Coincidental Data

The *tb* instrument was deployed at UTSG alongside *ta* from January to March, 2022 to compare instrument-to-instrument bias. With 10 minute averaged data, a linear correction brings instruments into agreement within 0.1ppb for XCH₄. In this observation series, we noticed that the less protected *tb* instrument had a tendency to drift as the difference between the internal temperatures grew thanks in part to the frigid outdoor conditions (-15°C).

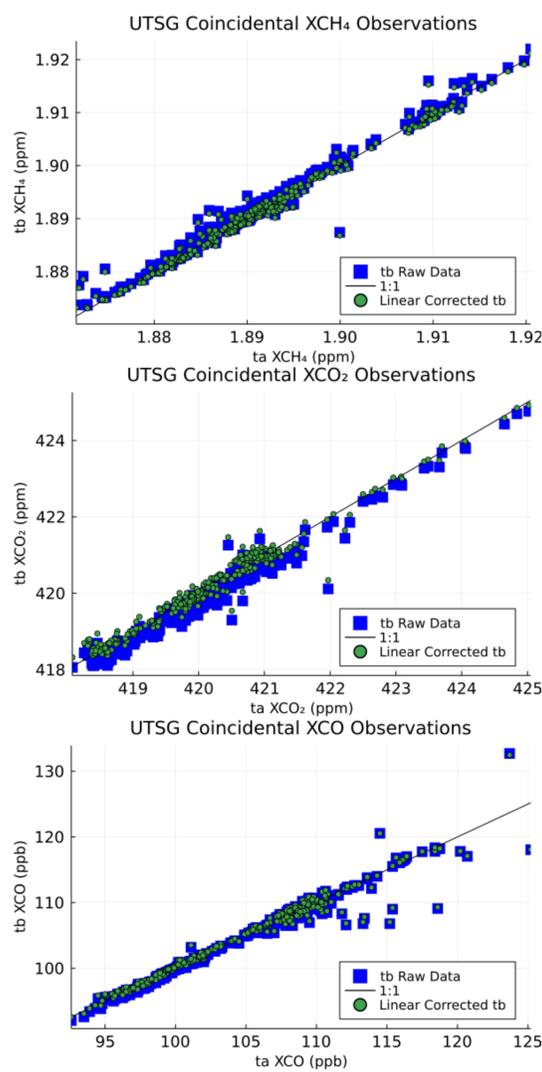


Figure 4: *tb* vs *ta* when the instruments were deployed side-by-side from January 2022 until April 2022. Top: XCH₄. Middle: XCO₂. Bottom: XCO.

Enhancement Ratios

Ratios of observed GHG enhancements have been used to quantify emissions based on well constrained inventories of a single GHG tracer gas [6, 5]. The current stations of the GTA-GHG-ON are well suited for characterizing emissions from the City of Toronto at the core of the GTA. Figure 5 show an example of the enhancement ratio data.

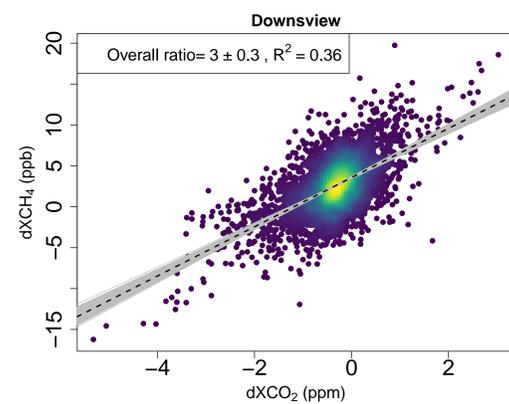


Figure 5: The difference in XCH₄ vs the difference in XCO₂ between the UTSG and DOW observatories. Colour indicates the datapoint frequency.

Comparison with TROPOMI Observations

XCH₄ and XCO observations from the TROPOMI satellite [4] agree well with observations from the EM27/Sun spectrometers in the network. Of the coincidental observations within 30 minutes of a TROPOMI measurement in 2021, the median difference is 1.5ppb for XCH₄ and 2 ppb for XCO.

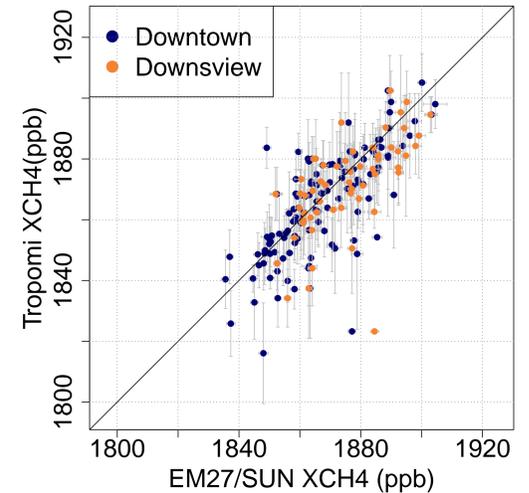


Figure 6: Comparing 2021 TROPOMI XCH₄ observations over Toronto with measurements from UTSG (Downtown) and DOW (Downsview).

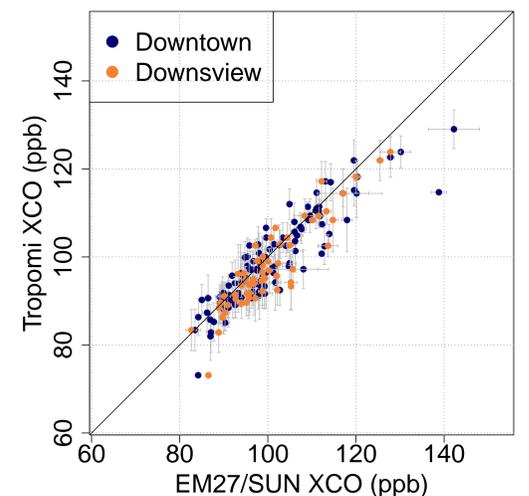


Figure 7: Comparing 2021 TROPOMI observations over Toronto with measurements from UTSG (Downtown) and DOW (Downsview).

Future Research

- Deploy a fifth permanent observatory at the Centre for Atmospheric Research Experiments (CARE) to measure ‘clean air’ background concentrations.
- Compare observed enhancement ratios with emissions modelled using high resolution inventories.
- Compare XCO₂ observations from OCO-2 and OCO-3 with measurements from the GTA-GHG-ON.

References

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