Here we present tropospheric trace gas measurements made in downtown Toronto using ground-based solar absorption Fourier transform infrared (FTIR) spectroscopy. Measured gases include acetylene (C2H2), formic acid (HCOOH) and formaldehyde (H2CO). These gases are important to study for the following reasons:

- Acetylene is an indicator of biomass and fossil fuel burning. It is a useful tracer of atmospheric transport and may act as precursor of secondary organic aerosol. The relationship with CO can give an estimate of the age of air.
- Formic acid is one of the most abundant organic acids in the atmosphere. It is an important source of free acidity in precipitation and a sink for OH (aq) in clouds. It also influences pH-dependent chemical reactions in clouds.
- Formaldehyde is important for understanding photo-oxidation pathways of methane and non-methane volatile organic compounds (NMVOCs) in the atmosphere, and provides constraints on the emissions of reactive NMVOCs.

**METHOD**

**Instrumentation.** The University of Toronto Atmospheric Observatory (TAO, 43.66°N, 79.40°W, 174 masl) employs an ABB Bomem DA8 FTIR spectrometer coupled to a suntracker (Fig. 1). Data. The retrievals of C2H2 were performed on the TAO FTIR spectra for the period from January 2002 to September 2011, HCOOH from January 2002 to May 2007, and H2CO from October 2001 to April 2007.

**Retrievals.** Atmospheric profiles and columns of trace gas abundances were retrieved from TAO spectra using the optimal estimation method [Rodgers, 2000] implemented with SFIT2 v3.94 and spectral line parameters from the HITRAN2008 database. The a priori gas profiles are obtained from the WACCM version 6 model. The constraint matrix was based on the Tikhonov regularization method [Steck, 2002].

It is defined as

\[ R = \alpha L_1 \]  

where \( L_1 \) is the first derivative operator and \( \alpha \) is the strength of regularization, chosen so as to minimize total error (measurement error + smoothing error) for each individual retrieval [Vigouroux et al., 2012]. The noise covariance matrix is chosen to be diagonal, with the signal-to-noise ratio defined for each retrieval microwindow of a target gas.

The parameters used in the retrievals of target species, including microwindows and interfering species, are summarized in Table 1. The profiles of interfering species for HCOOH and H2CO were retrieved beforehand and used as a priori profiles in the retrievals of the target gases.

**FUTURE WORK**

We plan to optimize retrievals of methanol, ammonia and ethylene from the TAO spectra using the same approach. All of these trace gas measurements will then be used together with the Stochastic Time-Inverted Lagrangian Transport (STILT) model [Lin et al., 2003] to interpret the TAO observations. STILT will derive the upstream influence region on TAO measurements at high spatial and temporal resolution. We will also exploit coupling between STILT and the GEOS-Chem chemical transport model to include atmospheric chemical mechanisms in the STILT model.