MetaData File provided: June 2015.
Latest Revision: 21 September 2021

Data Set Description:

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Instrument: Fourier Transform Infrared Spectrometer (FTIR)

Site(s): University of Toronto (University of Toronto Atmospheric Observatory – TAO)
NDACC Station Toronto
43.66 N, 79.40 W, 174 m above sea level

Measurement Quantities: Vertical column densities above Toronto (0-120 km)
in units of [molecules/cm^2]
Vertical volume mixing ratio profiles above Eureka (0-120 km)
in units of [ppbv]

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Instrument Description:

An ABB Bomem DA8 Fourier Transform Infrared (FTIR) spectrometer has been operated at the University of Toronto Atmospheric Observator (TAO) on a continous basis since May 2002 (following installation in October 2001), with a solar tracker manufactured by Aim Controls. The FTS is operated in solar absorption geometry at its maximum optical path difference of 250 cm corresponding to a spectral resolution of 0.004 cm-1. The DA8 is equipped with both InSb and MCT detectors and a KBr beamsplitter. Combined, these resources cover the mid-infrared from about 650 to 6600 cm-1. The optical filters used are those recommended by the NDACC Infrared Working Group and are listed in the table below. Filter 7 is not standard and was acquired to enable near IR measurements. There are significant coverage gaps in F6 measurements in 2002-2003. No data were recorded in Aug-Sep 2004 and Dec 2006-Jan 2007 due to a suntracker failure. Also no data were recorded in Mar-Jun 2009 due to an alignment issue.

The Toronto measurements from December 6, 2007 to March 30, 2009 are affected by an instrument artifact, which appears to be due to instrument misalignment and gives rise to anomalous retrievals for some gases, including CH4 and OCS. Any measurements used during this period should be treated with caution.

NDACC filter	approx. range in cm^{-1}	before June 2003	after June 2003
Filter 1	4000 to 4300	routine	routine
Filter 2	2900 to 3500	routine	routine
Filter 3	2400 to 3100	routine	routine
Filter 4	2000 to 2700	routine	routine
Filter 5	1500 to 2200	not available	routine
Filter 6	750 to 1350	routine	routine
Filter 7	5800 to 6600	not available	not available

Algorithm Description:

Vertical profiles of volume mixing ratios of trace gases are derived using the Optimal Estimation Method, as implemented in SFIT4 (SFIT4:V0.9.4.4 with full error analysis) and distributed through
https://wiki.ucar.edu/display/sfit4/Infrared+Working+Group+Retrieval+Code%2C+SFIT.
Vertical profiles of volume mixing ratios are weighted by the airmasses in each retrieval layer and integrated to give the total or partial columns in molecules/cm^2. We report total columns and profiles.

The retrieval results reported here use the Signal-to-Noise-Ratio (SNR) calculated from the spectrum for each target gas to define the measurement noise covariance matrix, with the a priori covariance matrix S_a adjusted to optimize the retrievals.

The microwindows and interfering species follow the NDACC IRWG recomendations.

Spectra used in the retrievals were recorded at 250 cm maximum optical path difference (OPD), except for filter 6 measurements, which are recorded at 200 cm OPD. Prior to 2006, filter 6 measurements were made at both 200 cm and 250 cm OPD.

An optimized quality criterion has been applied using a threshold for the ratio of the spectral RMS residual (goodness of fit) and degrees-of-freedom for signal (DOFS). The thresholds were determined by a trade-off curve of the number of filtered measurements for the entire time series versus the RMS/DOFS ratio. The threshold was selected as the elbow of the trade-off curve, where the absolute second derivative is maximum. The threshold values are listed below:

Standard NDACC IRWG Species

C_2H_6	4.75 % RMS/DOFS
CH_4	0.25 % RMS/DOFS (for CAMS consolidated data product)
CO	1.00 % RMS/DOFS (for CAMS consolidated data product)
HCl	2.95 % RMS/DOFS
HCN	1.40 % RMS/DOFS
HF	4.50 % RMS/DOFS
HNO_3	4.00 % RMS/DOFS
N_2O	0.30 % RMS/DOFS
O_3	2.60% RMS/DOFS (for CAMS consolidated data product)

Non-standard NDACC IRWG Species

C_2H_2	7.50 % RMS/DOFS
CH_3OH	5.50 % RMS/DOFS
HCOOH	9.60 % RMS/DOFS
HCHO	3.50 % RMS/DOFS (for CAMS consolidated data product)
NH_3	5.40 % RMS/DOFS
OCS	4.00 % RMS/DOFS

In addition, a few random outliers are removed based on a qualitative assessment of the residuals.

Current Data Versions:

Standard NDACC IRWG Species

C_2H_6	version 002
CH_4	version 004 (CAMS consolidated product), version 003 (CAMS rapid delivery)
CO	version 005 (CAMS consolidated product), version 004 (CAMS rapid delivery)
HCl	version 002
HCN	version 002
HF	version 002
HNO_3	version 002
N_2O	version 003
O_3	version 004 (CAMS consolidated product), version 003 (CAMS rapid delivery)

Non-standard NDACC IRWG Species

C_2H_2	version 002
CH_3OH	version 002
HCOOH	version 003
HCHO	version 003 (CAMS consolidated product), version 004 (CAMS rapid delivery)
NH_3	version 002
OCS	version 001

Ancillary Data:

March 2018 – Began submitting CO, CH_4, and O_3 to CAMS Rapid Delivery service. These species are processed using the CAMS consolidated retrieval procedure, which features a hard-coded error analysis routine and more stringent QA requirements via the additional CAMS-QC checker. Additionally, the archived versions of these species are processed using the CAMS consolidated retrieval procedure as well.

October 2016 – for the QA4ECV CO data product (CO data version 003):
The ATM line list (http://mark4sun.jpl.nasa.gov/toon/linelist/linelist.html) is used in the forward calculation. For interfering species, the HITRAN 2008 line list with additional pseudo-line parameters is used.

July 2015:

Line compilation: The HITRAN 2008 line list with additional pseudo-line parameters is used in the forward calculation. Details regarding the C2H6 pseudo line list can be found in Franco et al., 2015.

Physical models: Temperature and pressure profiles are derived from NCEP analyses for each day to approx. 1.0 mbar and WACCM monthly mean above.

A priori profiles of trace gas volume mixing ratios are from the WACCM v4 model, where possible and/or appropriate. HALOE climatologies, MkIV balloon flight results (http://mark4sun.jpl.nasa.gov/science.html) and "Standard Profiles" used in MIPAS retrievals (http://www.atm.ox.ac.uk/group/mipas/species) are also used as a priori information for some species when no WACCM profiles are available or where their use improves the retrievals

The Instrumental Line Shape (ILS) is monitored with HBr cell spectra (and since 2016 also with an N2O cell) on a quasi-regular basis. The cell spectra are analysed with Linefit [Hase, Applied Optics, 1999].

A local weather station was installed in Oct. 2001 and records surface temperature, pressure, humidity, solar radiation, UV intensity and winds.

Expected Precision/Accuracy of Instrument:

The error calculations are based on the methodology of Rodgers [1,2]. In addition to the measurement (S_m) errors calculated as described in those papers, random forward model parameter errors have been calculated as described by Rodgers [3] the K_b values calculated by SFIT4 and our best estimate of the uncertainties in temperature (S_{temp}) and solar zenith angle (S_{sza}). Systematic forward model errors, i.e. errors due to uncertainties in line intensity and line widths, are calculated based HITRAN 2008 errors. Interference errors, as described by Rodgers and Connor [4] have also been calculated to account for uncertainties in retrieval parameters (wavelength shift, instrument line shape, background slope and curvature, phase error) and in interfering gases simultaneously retrieved. These interference errors are included in the random uncertainty estimate. The error budget calculation is described in depth by Batchelor et al. [5]. The total error (S_{total}) has been determined by adding all components in quadrature:

S_{total} = square root of $\{(S_m^2+S_{temp}^2+S_{int1}^2+S_{int2}^2+S_{sza}^2)+S_{lint}^2+S_{lwdth}^2\}$

N.B. Smoothing error is not included in the error estimate.

The data user is referred to a careful discussion of error analysis for ground-based FTIR observations presented in:

[1] C.D. Rodgers. Retrieval of atmospheric temperature and composition from remote measurements of thermal radiation. Rev Geophys, 14(4), 609-624, 1976.

[2] C.D. Rodgers. Characterization and error analysis of profiles retrieved from remote sounding measurements. J Geophys Res, 95, 5587-5595, 1990.

[3] C.D. Rodgers. Inverse Methods for Atmospheric Sounding: Theory and Practice. Series on Atmospheric, Oceanic and Planetary Physics, vol. 2. New Jersey: World Scientific Publishing Co Pte Ltd, 2000.

[4] C.D. Rodgers and B.J. Connor. Intercomparison of remote sounding instruments. J Geophys Res, 108, doi:10.1029/2002JD002299, 2003.

[5] R.L. Batchelor, K. Strong, R. Lindenmaier, R.L. Mittermeier, H. Fast, J.R. Drummond, and P.F. Fogal. A new Bruker IFS 125HR FTIR spectrometer for the Polar Environment Atmospheric Research Laboratory at Eureka, Canada - measurements and comparison with the existing Bomem DA8 spectrometer. J. Atmos. Oceanic Technology, 26 (7), 1328-1340, 2009. https://doi.org/10.1175/2009JTECHA1215.1

Instrument History:

- December 2000: Installation of the DA8.
- 2001: Installation of the suntracker and commissioning of the complete FTIR system.
- Early 2002: Additional work by Bomem to improve the alignment.
- Summer 2002: Exit apertures installed on MCT and InSb detectors.
- November 2002: MCT detector replaced (to improve sensitivity).
- August-September 2004 and Dec 2006-Jan 2007: No data due to suntracker failure.
- November 2007: Bomem service visit: laser beam and mirror alignment optimized.
- December 6, 2007 to March 30, 2009: Measurements are affected by an instrument artifact and should be treated with caution.

- March-June 2009: No data were recorded due to an alignment issue.
- July 2009 and September 2009: Bomem service visits: instrument alignment.
- April 2011: Scanning mirror motor replacement.
- September 2012: Bomem service visit: metrology laser replaced.
- August 2013: Bomem service visit: instrument alignment improved.
- March-May 2014: No measurements due to computer failure.
- August 12, 2014: Began operations with a "Community Solar Tracker" suntracker. This uses the same mirrors as the previous Aim Controls heliostat but provides active tracking with a CCD camera rather than four photodiodes.
- March-May 2015: Vector Processing computer and IEM33 power board replaced. IEK0100L back plane electronics board repaired.
- June 2015: Suntracker cover automated, allowing increase in measurement time.
- July 2015: DA8 white light replaced.
- October-November 2015: New scan motor bearing and instrument alignment.
- February 2016: First N2O cell tests.
- June 7, 2016: DA8 internal source mirror motor failed. Replaced July 25.
- November 2018: DA8 source motor and beam selector solenoid failure. Both replaced.
- July 2019: ABB service visit, including alignment to obtain ILS from emission input (solar beam).
- October 2019: Started recording ILS measurements though DA8 emission point using the sun as the source.
- April 2020: Vaisala PTB330 replaced PTB300.
- April 2021: Azimuth stepper motor replaced on AIMS heliostat.

Reference Articles:

PhD Theses

Shoma Yamanouchi, Long-term Analysis of Toronto-Area Atmospheric Composition, PhD Thesis, Department of Physics, University of Toronto, 2021.
https://tspace.library.utoronto.ca/handle/1807/106479

Cynthia Whaley, Improvements to our Understanding of Toronto-area Atmospheric Composition, PhD Thesis, Department of Physics, University of Toronto, 2014.
https://tspace.library.utoronto.ca/handle/1807/68411

Jeffrey R. Taylor, Assessment of Trace Gas Observations from the Toronto Atmospheric Observatory, PhD Thesis, Department of Physics, University of Toronto, 2008.
https://tspace.library.utoronto.ca/handle/1807/17305

Aldona Wiacek, First Trace Gas Measurements Using Fourier Transform Infrared Solar Absorption Spectroscopy at the University of Toronto Atmospheric Observatory, PhD Thesis, Department of Physics, University of Toronto, 2006.

https://www.atmosp.physics.utoronto.ca/people/strong/Wiacek_PhD_thesis_June2006.pdf

Selected Articles

For a complete list, see: http://www.atmosp.physics.utoronto.ca/people/strong/papers.html and http://www.atmosp.physics.utoronto.ca/TAO/Publications.html

S. Yamanouchi, K. Strong, O. Colebatch, S. Conway, D.B.A. Jones, E. Lutsch, and S. Roche. Atmospheric trace gas trends obtained from FTIR column measurements in Toronto, Canada from 2002-2019. Environmental Research Communications, 3, 051002, 2021. https://iopscience.iop.org/article/10.1088/2515-7620/abfa65

W. Steinbrecht et al. COVID-19 crisis reduces free tropospheric ozone across the Northern Hemisphere. Geophys. Res. Lett., 48, e2020GL091987, 2021. https://doi.org/10.1029/2020GL091987

T. Blumenstock, F. Hase, A. Keens, D. Czurlok, O. Colebatch, O. Garcia, D.W.T. Griffith, M. Grutter, J.W. Hannigan, P. Heikkinen, P. Jeseck, N. Jones, R. Kivi, E. Lutsch, M. Makarova, H.K. Imhasin, J. Mellqvist, I. Morino, T. Nagahama, J. Notholt, I. Ortega, M. Palm, U. Raffalski, M. Rettinger, J. Robinson, M. Schneider, C. Servais, D. Smale, W. Stremme, K. Strong, R. Sussmann, Y. Té, and V.A. Velazco. Characterization and potential for reducing optical resonances in Fourier transform infrared spectrometers of the Network for the Detection of Atmospheric Composition Change (NDACC). Atmos. Meas. Tech., 14, 1239-1252, 2021. https://doi.org/10.5194/amt-14-1239-2021

S. Yamanouchi, C. Viatte, K. Strong, E. Lutsch, D.B.A. Jones, C. Clerbaux, M. Van Damme, L. Clarisse, and P.-F. Coheur. Multiscale observations of NH3 around Toronto, Canada, Atmos. Meas. Tech., 14, 905-921, 2021. https://doi.org/10.5194/amt-14-905-2021

S. Yamanouchi, K. Strong, E. Lutsch, and D.B.A. Jones. Detection of HCOOH, CH3OH, CO, HCN, and C2H6 in wildfire plumes transported over Toronto using ground-based FTIR measurements from 2002-2018. J. Geophys. Res. Atmos., 125, e2019JD031924, 2020. https://doi.org/10.1029/2019JD031924

C. Vigouroux, B. Langerock, C.A. Bauer Aquino, T. Blumenstock, Z. Cheng, M. De Mazière, I. De Smedt, M. Grutter, J. W. Hannigan, N. Jones, R. Kivi, Lutsch, E. Loyola, D., E. Mahieu, M. Makarova, J.-M. Metzger, I. Morino, I. Murata, T. Nagahama, J. Notholt, I. Ortega, M. Palm, G. Pinardi, A. Röhling, D. Smale, W. Stremme, K. Strong, R. Sussmann, Y. Té, M. van Roozendael, P. Wang, and H. Winkler. TROPOMI–Sentinel-5 Precursor formaldehyde validation using an extensive network of ground-based Fourier-transform infrared stations, Atmos. Meas. Tech., 13, 3751-3767, 2020. https://doi.org/10.5194/amt-13-3751-2020

Y. Sun, C. Liu, L. Zhang, M. Palm, J. Notholt, H. Yin, C. Vigouroux, E. Lutsch, W. Wang, C. Shan, T. Blumenstock, T. Nagahama, I. Morino, E. Mahieu, K. Strong, B. Langerock, M. De Mazière, Q. Hu, H. Zhang, C. Petri, and J. Liu. Fourier transform infrared time series of tropospheric HCN in

eastern China: seasonality, interannual variability, and source attribution, Atmos. Chem. Phys., 20, 5437–5456, 2020. https://doi.org/10.5194/acp-20-5437-2020

B. Franco, L. Clarisse, T. Stavrakou, J.-F. Muller, D. Taraborrelli, J. Hadji-Lazaro, J.W. Hannigan, F. Hase, D. Hurtmans, N. Jones, E. Lutsch, E. Mahieu, I. Ortega, M. Schneider, K. Strong, C. Vigouroux, C. Clerbaux, and P.-F. Coheur. Spaceborne measurements of formic and acetic acids: A global view of the regional sources. Geophysical Research Letters, 47, e2019GL086239, 2020. https://doi.org/10.1029/2019GL086239

B. Byrne, K. Strong, O. Colebatch, Y. You, D. Wunch, S. Ars, D.B.A. Jones, P. Fogal, R.L. Mittermeier, D. Worthy, and D.W.T. Griffith. Monitoring Urban Greenhouse Gases Using Open-Path Fourier Transform Spectroscopy, Atmosphere-Ocean, 58(1), 25-45, 2020. https://doi.org/10.1080/07055900.2019.1698407

Z.A. Tzompa-Sosa, B.H. Henderson, C.A. Keller, K. Travis, E. Mahieu, B. Franco, M. Estes, D. Helmig, A. Fried, D. Richter, P. Weibring, J. Walega, D.R. Blake, J.W. Hannigan, I. Ortega, S. Conway, K. Strong, and E.V. Fischer. Atmospheric implications of large C2-C5 alkane emissions from the U.S. oil and gas industry. J. Geophys. Res. Atmos., 124, 1148-1169, 2019. https://doi.org/10.1029/2018JD028955

C. Vigouroux, C.A. Bauer Aquino, M. Bauwens, C. Becker, T. Blumenstock, M. De Mazière, O. García, M. Grutter, C. Guarin, J. Hannigan, F. Hase, N. Jones, R. Kivi, D. Koshelev, B. Langerock, E. Lutsch, M. Makarova, J.-M. Metzger, J.-F. Müller, J. Notholt, I. Ortega, M. Palm, C. Paton-Walsh, A. Poberovskii, M. Rettinger, J. Robinson, D. Smale, T. Stavrakou, W. Stremme, K. Strong, R. Sussmann, Y. Té, and G. Toon. NDACC harmonized formaldehyde time-series from 21 FTIR stations covering a wide range of column abundances. Atmos. Meas. Tech., 11, 5049-5073, 2018. https://doi.org/10.5194/amt-11-5049-2018

K.S. Olsen, K. Strong, K.A. Walker, C.D. Boone, P. Raspollini, J. Plieninger, W. Bader, S. Conway, M. Grutter, J.W. Hannigan, F. Hase, N. Jones, M. de Mazière, J. Notholt, M. Schneider, D. Smale, R. Sussmann, and N. Saitoh. Comparison of the GOSAT TANSO-FTS TIR CH4 volume mixing ratio vertical profiles with those measured by ACE-FTS, ESA MIPAS, IMK-IAA MIPAS, and 16 NDACC stations, Atmos. Meas. Tech., 10, 3697-3718, 2017. https://doi.org/10.5194/amt-10-3697-2017

E. Dammers, M.W. Shephard, M. Palm, K. Cady-Pereira, S. Capps, E. Lutsch, K. Strong, J.W. Hannigan, I. Ortega, G.C. Toon, W. Stremme, M. Grutter, N. Jones, D. Smale, J. Siemons, K. Hrpcek, D. Tremblay, M. Schaap, J. Notholt, and J.W. Erisman. Validation of the CrIS Fast Physical NH3 Retrieval with ground-based FTIR. Atmos. Meas. Tech., 10, 2645-2667, 2017. https://doi.org/10.5194/amt-10-2645-2017

R.R. Buchholz, M.N. Deeter, H.M. Worden, J. Gille, D.P. Edwards, J.W. Hannigan, N.B. Jones, C. Paton-Walsh, D.W.T. Griffith, D. Smale, J. Robinson, K. Strong, S. Conway, R. Sussmann, F. Hase, T. Blumenstock, E. Mahieu, and B. Langerock. Validation of MOPITT carbon monoxide using ground-based Fourier transform infrared spectrometer data from NDACC. Atmos. Meas. Tech., 10, 1927-1956, 2017. https://doi.org/10.5194/amt-10-1927-2017

Z.A. Tzompa-Sosa, E. Mahieu , B. Franco, C.A. Keller , A.J. Turner, D. Helmig, A. Fried, D. Richter, P. Weibring, J. Walega, T.I. Yacovitch , S.C. Herndon, D.R. Blake, F. Hase, J.W. Hannigan, S. Conway, K. Strong, M. Schneider, and E.V. Fischer. Revisiting global fossil fuel and biofuel emissions of ethane, J. Geophys. Res. Atmos., 122, 2493-2512, 2017. https://doi.org/10.1002/2016JD025767

W. Bader, B. Bovy, S. Conway, K. Strong, D. Smale, A.J. Turner, T. Blumenstock, C. Boone, M. Collaud Coen, A. Coulon, O. Garcia, D.W.T. Griffith, F. Hase, P. Hausmann, N. Jones, P. Krummel, I. Murata, I. Morino, H. Nakajima, S. O'Doherty, C. Paton-Walsh, J. Robinson, R. Sandrin, M. Schneider, C. Servais, R. Sussmann, and E. Mahieu. The recent increase of atmospheric methane from 10 years of ground-based NDACC FTIR observations since 2005. Atmos. Chem. Phys., 17, 2255-2277, 2017. https://doi.org/10.5194/acp-17-2255-2017

E. Dammers, M. Palm, M. Van Damme, C. Vigouroux, D. Smale, S. Conway, G.C. Toon, N. Jones, E. Nussbaumer, T. Warneke, C. Petri, L. Clarisse, C. Clerbaux, C. Hermans, E. Lutsch, K. Strong, J.W. Hannigan, H. Nakajima, I. Morino, B. Herrera, W. Stremme, M. Grutter, M. Schaap, R.J. Wichink Kruit, J. Notholt, P.-F. Coheur, and J.W. Erisman. An evaluation of IASI-NH3 with ground-based Fourier transform infrared spectroscopy measurements, Atmos. Chem. Phys., 16, 10351-10368, doi:10.5194/acp-16-10351-2016, 2016.

E. Lutsch, E. Dammers, S. Conway, and K. Strong. Long-range Transport of NH3, CO, HCN and C2H6 from the 2014 Canadian Wildfires. Geophys. Res. Lett., 43, 8286–8297, doi:10.1002/2016GL070114, 2016.

C.H. Whaley, K. Strong, D.B.A. Jones, T.W. Walker, Z. Jiang, D.K. Henze, M. Cooke, C.A. McLinden, M. Pommier, R.L. Mittermeier, and P.F. Fogal. Toronto area ozone: Long-term measurements and modeled sources of poor air quality events. J. Geophys. Res. Atmos., 120 (D21), 11,368-11,390, doi:10.1002/2014JD022984. 2015.

D. Griffin, K. A. Walker, J. E. Franklin, M. Parrington, C. Whaley, J. Hopper, J. R. Drummond, P. I. Palmer, K. Strong, T. J. Duck, I. Abboud, P. F. Bernath, C. Clerbaux, P.-F. Coheur, K. R. Curry, L. Dan, E. Hyer, J. Kliever, G. Lesins, A. Saha, K. Tereszchuk, M. Maurice, and D. Weaver. Investigation of CO, C2H6 and aerosols in a boreal fire plume over Eastern Canada during BORTAS 2011 using ground- and satellite- based observations, and model simulations. Atmos. Chem. Phys., 13, 10227-10241, 2013.

C. Whaley, K. Strong, C. Adams, A.E. Bourassa, W.H. Daffer, D.A. Degenstein, H. Fast, P.F. Fogal, G.L. Manney, R.L. Mittermeier, B. Pavlovic, and A. Wiacek. Using FTIR measurements of stratospheric composition to identify mid-latitude polar vortex intrusions over Toronto. J. Geophys. Res. Atmos., 118 (2), 12766-12783, 2013.

J.R. Taylor, D. Wunch, C. Midwinter, A. Wiacek, J.R. Drummond, and K. Strong, An Extended Intercomparison of Simultaneous Ground-Based Fourier Transform Spectrometer Measurements at the Toronto Atmospheric Observatory. J. Quant. Spectrosc. Radiat. Transfer, 109 (12-13), 2244-2260, 2008.

A. Wiacek and K. Strong. Effects of Vertical Grid Discretization in Infrared Transmission Modeling. J. Quant. Spectrosc. Radiat. Transfer, 109, 2463-2490, 2008.

A. Wiacek, J.R. Taylor, K. Strong, R. Saari, T. Kerzenmacher, N.B. Jones and D.W.T Griffith. Ground-Based Solar Absorption FTIR Spectroscopy: Characterization of Retrievals and First Results from a Novel Optical Design Instrument at a New NDACC Complementary Station. J. Atmos. Oceanic Technology, 24 (3), 432- 448, 2007.

D. Wunch, J.R. Taylor, D. Fu, P.F. Bernath, J.R. Drummond, C. Midwinter, K. Strong, and K.A. Walker. Simultaneous Ground-Based Observations of O3, HCl, N2O, and CH4 over Toronto, Canada by Three Fourier Transform Spectrometers with Different Resolutions. Atmos. Chem. Phys. (MANTRA Special Issue), 7, 1275-1292, 2007.

J.R. Taylor, K. Strong, C.A. McLinden, D.A. Degenstein, and C.S. Haley. Comparison of OSIRIS tratospheric O3 and NO2 measurements with ground-based Fourier Transform Spectrometer measurements at the Toronto Atmospheric Observatory. Can. J. Phys, 85, 1301-1316, 2007.

A. Wiacek, N.B. Jones, K. Strong, J.R. Taylor, R.L. Mittermeier, and H. Fast. First Detection of Meso- Thermospheric Nitric Oxide (NO) by Ground-Based FTIR Solar Absorption Spectroscopy. Geophys. Res. Lett., 33 (3), L03811, doi:10.1029/2005GL024897, 2006.