MetaData File provided: November 1996.
Latest Revision : 08-August-2023.

Data License:

Data Set Description:
---- --- ---

PI: Daniel. SMALE
National Institute for Water and Atmospheric Research Ltd
(NIWA)
Lauder, New Zealand

Co-PI: John. ROBINSON
National Institute for Water and Atmospheric Research Ltd
(NIWA)
Lauder, New Zealand

Instrument: Infrared Fourier Transform Spectrometer (FTIR)

Site(s): National Institute for Water and Atmosphere
Lauder, NDACC Primary Station, New Zealand
45.0 S, 169.7 E, 370m
(see also separate meta file for Arrival Heights, Antarctic site)

Measurement Quantities: Profile and total vertical column abundances above measurement site
(profile: volume mixing ratio. total column: number of molecules per sq. cm)

Contact Information:

Name: D.SMALE, J.ROBINSON
Address: National Institute for Water and Atmospheric Research
Private Bag 50061
Omakau
Central Otago
New Zealand
Phone: +64/3.4400424 or +64/3.4400055
FAX: +64/3.4473348
Email: dan.smale@niwa.co.nz, john.robinson@niwa.co.nz

Note:

Until the end of 2001, the P.I. for this programme was Nicholas B. Jones,
who is now at the University of Wollongong, NSW, Australia.

From 2001 to 2011, the P.I. for this programme was Stephen W. Wood.

The current MIR-FTIR team would like to thank the former PI's for their past and

continuing contribution to the current MIR research program.

Instrument Description and History:

Campaign based measurements with a Bomen DA2 were made at lauder over the period 1986-1987 (NIWA005).
This data is currently not submitted to the NDACC database. Any inquires on this data can be directed to the current PI.

A commercial Bruker IFS 120 HR operated from September 1990 to August 1992,
and was then replaced by a Bruker IFS 120M (NIWA002). Both instruments were/are fitted
with MCT and INSb detectors. The nominal range covered is
750-1250, 1900-2200, 2400-3100, and 4000-4300 cm-1, based on a standard
set of NDSC filters. Some measurements have also been made out to 5000 cm-1
The 120M instrument is also uv/vis capable, and preliminary measurements
from 15,000-35,000 cm-1 have been made.

In 2000 a new Bruker IFS 120HR (NIWA001) was purchased.
NDACC filters were installed and the standard range of NDACC measurements
are being made on a daily basis, when weather permits.
It became the primary instrument for NDACC MIR-FTS measurements in October 2001.

From 2003-2011 NIR obs were also taken on the 120HR, time-share was required.

In 2011 a Bruker 125HR (NIWA006) was installed at Lauder for dedicated NIR TCCON observations.
Thus a MIR-120HR and NIR-125HR collected spectra in parallel.

In May 2017 a new Bruker 125HR (NIWA008) was installed at Lauder to replace the 120HR (NIWA001).
NIWA006 became the primary MIR-FTIR, with the new 125HR (NIWA008) becoming the primary NIR-FTIR.
An over lap of MIR obs (for inter-comparison purposes) between NIWA001 and NIWA006 was conducted
from Nov 2017 to Apr 2018.

Instrument IDs:
Lauder 125HR: NIWA006 (May 2017 - present)
Lauder 120HR: NIWA001 (Oct 2001- April 2017)
Lauder 120M: NIWA002 (1990- Oct 2001)
Bomem DA2: NIWA005 (1986-1987)

also:
Lauder 125HR NIWA008 NIR/TCCON obs

Algorithm Description:

Vertical abundances for total and selected partial columns are retrieved by matching
synthetic spectra to the measured absorption spectra in selected micro-windows
containing isolated and well characterized line(s) of the target gas.

The algorithm algorithm in use for the curve fitting is SFIT4 (version 0.9.4.4)
developed by B.J.Connor, C. P. Rinsland, J. Hannigan and M. Palm. It uses a forward
model that simulates the measured spectrum given a model atmosphere, instrument
parameters and viewing direction. The SFIT4 codes use optimal estimation techniques
and can vary mixing ratios of fitted gases in individual layers to achieve the fit
(profile fitting). Uncertainty estimates are also produced.

Ancillary data:
-Line compilation : HITRAN 2000-2012 with published updates, TOON GFIT linelists 'ATM' also used.
(special files -psuedolines- for ClONO2, CHClF2, ...)
-Physical models : PT profiles used are daily NMC.
-ILS: parameterized based on HBr and N2O cell measurements and analysis (LINEFIT)

Current retrieval strategy:
-SFIT4_v0944 (f90) with FITBIN41 (f90) or WRAPDAT(IDL) batching codes
  Column and profile retrievals
    IRWG compliant micro-windows
    NCEP daily P,T profiles
    A priori species profiles: from WACCMv6 CCM model simulations
    47 layer atmosphere
    Hitran 2000-2012 and/or Geoff Toon's (JPL) ATM linelist (2012,2016) compilation (species dependent)
-Prepdat5 spectra pre-processing (f90)
    OPUS to BNR
    Contains hard-coded legacy timing adjustments, site specific coding.
-IDL post processing, visualization, QC/QA, HDF formatting
-Linefit14 for Hbr and N2O Cell analysis
-Monthly routine processing (bare minimum):
    HBr and N2O cell tests, Pre-processing Spectra QA/QC, retrieval of CO, O3 and CH4

Expected Precision/Accuracy of Instrument:
-------- ------------------ -- -----------

Based on tests with NDACC N2O and HCl-sealed cells, precision and accuracy are estimated
at +/- 2% and +/- 4% respectively.

Uncertainty analysis is performed per retrieval and reported as systematic and random components

An inter-comparison between the Lauder 120M (NIWA002) and the NPL 120M was carried out in
1996. A paper describing the inter-comparison (Griffith et al 2002) has been published.

HBr (and/or N2O) cell tests are performed monthly to quantify precision, accuracy and ILS.
HBr cell measurements started in 2002.
N2O cell measurements started in 2016.

An inter-comparison between the NIWA001 and NIWA006 was carried out between Nov 2017-Apr 2018.
Comparison results presented at the NDACC IRWG 2019:
"An inter-comparison of solar MIR-FTS measurements of atmospheric gases between a Bruker 120HR and a Bruker 125HR at Lauder, New Zealand (45S)",
Smale, D, et al. 2019, NDACC IRWG 2019
Available at:
https://www.acom.ucar.edu/irwg/IRWG_2019_posters/Smale_irwg_2019_lauder_120hr_125hr_comp_v1.pdf

NDACC Submission to date:
----- ---------- -- -----
Profile: CO , N2O HNO3, CH4, C2H6, O3, HCl, HF, HCN, OCS from 2001 onwards (NIWA001)
Total column: ClONO2 and all molecules taken with NIWA002 (1990-2001)
HDF4 format
Data template: GEOMS-TE-FTIR-002
NIWA001 current till May 2018. NIWA006 data is from May 2018 onwards.

Data rules of use in NDACC HDF files:
These data have been provided with the understanding
that anyone accessing the data will contact the PI of the Lauder FTIR program, Dan Smale
(dan.smale@niwa.co.nz), to discuss the intended uses of the data. Measurement work at NIWA is funded
under a contract that requires identification of end-users of the data. Use of these data
without consultation with the programme PI may jeopardize the renewal of this contract and hence the
future of the FTIR measurement programme.'

Peer reviewed reference articles:

Bader, W., et al. (2017) "The recent increase of atmospheric methane from 10 years of ground-based NDACC FTIR observations since 2005", Atmos. Chem. Phys., 17, 2255-2277, doi:10.5194/acp-17-2255-2017, 2017.

Barthlott, S., et al. (2015) "Using XCO2 retrievals for assessing the long-term consistency of NDACC/FTIR data sets." Atmos. Meas. Tech. , amt-2014-260

Barthlott, S., et al. (2017) "Tropospheric water vapour isotopologue data (H216O, H218O, and HD16O) as obtained from NDACC/FTIR solar absorption spectra" http://www.earth-syst-sci-data.net/9/15/2017/

Bègue N., et al. (2021) "Transport and variability of tropospheric ozone over Oceania and southern pacific during the 2019–20 Australian bushfires", Remote Sensing. 2021 Jan;13(16):3092.

Blumenstock, Thomas, et al. "Characterization and potential for reducing optical resonances in Fourier transform infrared spectrometers of the Network for the Detection of Atmospheric Composition Change (NDACC)." Atmospheric Measurement Techniques 14.2 (2021): 1239-1252.

Buchholz, R. R., et al. (2017) "Validation of MOPITT carbon monoxide using ground-based Fourier transform infrared spectrometer data from NDACC", Atmos. Meas. Tech., 10, 1927-195

Boynard, A., et al. (2018) "Validation of the IASI FORLI/EUMETSAT ozone products using satellite (GOME-2), ground-based (Brewer–Dobson, SAOZ, FTIR) and ozonesonde measurements", Atmos. Meas. Tech., 11, 5125-5152

Cantos, I. P., et al., (2022). Determination and analysis of time series of CFC-11 from FTIR solar spectra, in situ observations, and model data in the past 20 years above Jungfraujoch (46° N), Lauder (45° S), and Cape Grim (40° S) stations. Environmental Science: Atmospheres, 2(6), 1487-1501.

Cortesi, U., et al. (2007). "Geophysical validation of MIPAS-ENVISAT operational ozone data." Atmospheric Chemistry and Physics 7: 4807-4867.

Dammers, E., et al (2015),"Retrieval of ammonia from ground-based FTIR solar spectra", Atmos. Chem. Phys., 15, 12789-12803, doi:10.5194/acp-15-12789-2015, 2015.

Dammers, E., et al. (2016) "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

Dammers, E., et al. (2017) "Validation of the CrIS fast physical NH3 retrieval with ground-based FTIR" https://www.atmos-meas-tech.net/10/2645/2017/

De MaziÃ¨re, M., et al. (2007). "Validation of ACE-FTS v2.2 methane profiles from the upper troposphere to lower mesosphere." Atmospheric Chemistry and Physics 8: 2421-2435.

Dils, B., et al. (2006). "Comparisons between SCIAMACHY scientific products and ground-based FTIR DATA for total columns of CO, CH4, CO2 and N2O." Atmospheric Chemistry and Physics 6: 1953-1976.

Edwards, D. P., et al. (2006). "Satellite Observed Emissions From Southern Hemisphere Biomass Burning." Journal of Geophysical Research 111(D14312).

Gaudel, A, et al. (2018). "Tropospheric Ozone Assessment Report: Present-day distribution and trends of tropospheric ozone relevant to climate and global atmospheric chemistry model evaluation". Elem Sci Anth, 6: 39.

Geddes, A.,et al. (2018) "Python-based dynamic scheduling assistant for atmospheric measurements by Bruker instruments using OPUS" Appl. Opt. 57(4), 689-691

Godin-Beekmann, S., et al. (2022) "Updated trends of the stratospheric ozone vertical distribution in the 60° S–60° N latitude range based on the LOTUS regression model", Atmos. Chem. Phys. Discuss, https://doi.org/10.5194/acp-2022-137, 2022.

Griffith, D.W.T.; Jones, N.B.; Matthews, W.A. (1998). Interhemispheric ratio and annual cycle of carbonyl sulphide (OCS) total column from ground-based FTIR spectra. Journal of Geophysical Research 103(D7): 8447-8454.

Griffith, D.W.T.; Jones, N.B.; McNamara, B.; Paton-Walsh, C.; Bell, W.; Bernardo, C. (submitted 2002). Intercomparison of ground-based solar FTIR measurements of atmospheric trace gases at Lauder, New Zealand. Journal of Atmospheric Technology.

Jones, N.B.; Koike, M.; Matthews, W.A.; McNamara, B.M. (1994). Southern hemisphere mid-latitude seasonal cycle in total column nitric acid. Geophysical Research Letters 21(7): 593-596.

Hannigan JW, et al, (2022) "Global atmospheric OCS trend analysis from 22 NDACC stations" Journal of Geophysical Research: Atmospheres. 2022 Feb 27;127(4):e2021JD035764.

Hase, F., et al. (2004). "Intercomparison of retrieval codes used for the analysis of high-resolution, ground-based FTIR measurements." Journal of Quantitative Spectroscopy and Radiative Transfer 87(1): 25-52.

Hausmann, P., et al. (2015) "Contribution of oil and natural gas production to renewed increase of atmospheric methane (2007–2014): top-down estimate from ethane and methane column observations." Atmospheric Chemistry and Physics Discussions 15.24 (2015): 35991-36028.

Helmig, D., et al. (2016). “Reversal of global atmospheric ethane and propane trends largely due to US oil and natural gas production”. Nature Geoscience. 2016 Jun 13

Jones, N.B.; Rinsland, C.P.; Liley, J.B.; Rosen, J. (2001). Correlation of aerosol and carbon monoxide at 45° S: Evidence of biomass burning emissions. Geophysical Research Letters 28(4): 709-712.

Jones, N. B., et al. (2007). "Long-term tropospheric formaldehyde concentrations deduced from ground-based fourier transform solar infrared measurements." Atmospheric Chemistry and Physics Discussions 7: 14543-14568.

Kloss, Corinna, et al. "Australian fires 2019-2020: tropospheric and stratospheric pollution throughout the whole fire season." Frontiers in Environmental Science 9 (2021): 220.

Koike, M.; Jones, N.B.; Matthews, W.A.; Johnston, P.V.; McKenzie, R.L.; Kinnison, D.; Rodriguez, J. (1994). Impact of Pinatubo aerosols on the partitioning between NO2 and HNO3. Geophysical Research Letters 21(7): 597-600.

Kohlhepp, R., et al. (2012). "Observed and simulated time evolution of HCl, ClONO2, and HF total column abundances." Atmospheric Chemistry and Physics 12: 3527-3556.

Kremser, S., et al. (2015) “Positive trends in Southern Hemisphere carbonyl sulfide”, Geophys. Res. Lett., 42, 9473–9480, doi:10.1002/2015GL065879.

Liley, J.B.; Rosen, J.M.; Kjome, N.T.; Jones, N.B.; Rinsland, C.P. (2001). Springtime enhancement of upper tropospheric aerosol at 45° S. Geophysical Research Letters 28(8): 1495-1498.

Mahieu, E., et al. (2008). "Validation of ACE-FTS v2.2 measurements of HCl, HF, CCl3F and CCl2F2 using space-, balloon- and ground-based instrument observations." Atmospheric Chemistry and Physics 8: 6199-6221.

Mahieu, E., et al. (2015) "Recent Northern Hemisphere stratospheric HCl increase due to atmospheric circulation changes." Nature, 515,104–107 doi:10.1038/nature13857

Meier, A.; Goldman, A.; Manning, P.; Stephen, T.; Rinsland, C.; Jones, N.B.; Wood, S.W. (2002). Improvements to Air Mass Calculations for Ground-Based Infrared Measurements. J. Quant. Spectrosc. Radiat. Transfer.

Minganti, D., et al., (2022). Evaluation of the N2O Rate of Change to Understand the Stratospheric Brewer-Dobson Circulation in a Chemistry-Climate Model. Journal of Geophysical Research: Atmospheres, 127(22), e2021JD036390.

Morgenstern, O., et al. (2012). "Long-range correlations in FTIR, satellite, and modeled CO in the Southern Hemisphere." Journal of Geophysical Research. doi:10.1029/2012JD017639

Olsen, K. S., et al. (2017) "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, https://doi.org/10.5194/amt-10-3697-2017, 2017.

Payan, S., et al. (2007). "Validation and data characteristics of methane and nitrous oxide profiles observed by MIPAS and processed with Version 4.61 algorithm." Atmospheric Chemistry and Physics Discussions 7: 18043-18111.

Pougatchev, N.S.; Connor, B.J.; Jones, N.B.; Rinsland, C.P. (1996). Validation of ozone profile retrievals from infrared ground-based solar spectra. Geophysical Research Letters 23(13): 1637-1640.

Prignon M, et al.,(2021), "Stratospheric Fluorine as a Tracer of Circulation Changes: Comparison Between Infrared Remote-Sensing Observations and Simulations With Five Modern Reanalyses", Journal of Geophysical Research: Atmospheres. 2021 Oct 16;126(19):e2021JD034995.

Reisinger, A.R.; Jones, N.B.; Matthews, W.A.; Rinsland, C.P. (1994). Southern hemisphere ground based measurements of carbonyl fluoride (COF2) and hydrogen fluoride (HF): Partitioning between fluoride reservoir species. Geophysical Research Letters 21(9): 797-800.

Reisinger, A.R.; Jones, N.B.; Matthews, W.A.; Rinsland, C.P. (1995). Southern hemisphere mid-latitude ground based measurements of ClONO2: method of analysis, seasonal cycle, and long term trend. Journal of Geophysical Research 100(D11): 23183-23193.

Rinsland, C.P.; Jones, N.B.; Matthews, W.A. (1994). Infrared spectroscopic measurements of the total column abundance of ethane (C2H6) above Lauder, New Zealand. Journal of Geophysical Research 99(D12): 25941-25945.

Rinsland, C.P.; Connor, B.J.; Jones, N.B.; Boyd, I.S.; Matthews, W.A.; Goldman, A.; Murcray, F.J.; Murcray, D.G.; David, S.J.; Pougatchev, N.S. (1996). Comparison of infrared and Dobson total ozone columns measured from Lauder, New Zealand. Geophysical Research Letters 23: 1025-1028.

Rinsland, C.P.; Jones, N.B.; Connor, B.J.; Logan, J.A.; Goldman, A.; Murcray, F.J.; Stephen, T.M.; Pougatchev, N.S.; Zander, R.; Demoulin, P.; Mahieu, E. (1998). Northern and southern hemisphere ground-based infrared spectroscopic measurements of tropospheric carbon monoxide and ethane. Journal of Geophysical Research 103(D21): 28,197-28,218.

Rinsland, C.P.; Goldman, A.; Connor, B.J.; Stephen, T.M.; Jones, N.B.; Wood, S.W.; Murcray, F.J.; David, S.R.; Blathewick, R.S.; Pougatchev, N.S.; Zander, R.; Mahieu, E.; Demoulin, P. (2000). Correlation relationships of

stratospheric molecular constituents from high spectral resolution, ground-based infrared solar absorption spectra. Journal of Geophysical Research 105(D11): 14637-14652.

Rinsland, C.P.; Zander, R.; Mahieu, E.; Demoulin, P.; Jones, N.B.; Goldman, A.; Stephen, T.M.; Murcray, F.J.; Chiou, L.S.; Russell III, J.M.; Anderson, J.; Sussmann, R.; Notholt, J. (2001). "Stratospheric Inorganic Chlorine Decline from Ground-Based IR HCl and ClONO2 Measurements at 6 NDSC Stations". Presented at Network for the Detection of Stratospheric Change (NDSC) 2001 Symposium "Celebrating 10 Years of Atmospheric Research", Palais des Congrès "Le Palatium", Arcachon, France, 24-27 September 2001.

Rinsland, C.P.; Zander, R.; Mahieu, E.; Chiou, L.S.; Goldman, A.; Jones, N.B. (accepted 2001). Stratospheric HF Column Abundances above Kitt Peak (31.9N Latitude): Trends from 1977 to 2001 and Correlations with Stratospheric HCl Columns. J. Quant. Spectrosc. Radiat. Transfer.

Rinsland, C. P., et al. (2000). "Correlation relationships of stratospheric molecular constituents from high spectral resolution, ground-based infrared solar absorption spectra." Journal of Geophysical Research - Atmospheres 105(D11): 14637-14652.

Rinsland, C. P., et al. (2005). "Long term trends in CH4 at northern mid-latitudes: comparison between ground-based infrared solar and surface sampling measurements." Journal of Quantitative Spectroscopy and Radiative Transfer 97(3): 457-466.

Rinsland, C. P., et al. (2005). "Long-term evolution in the tropospheric concentration of chlorofluorocarbon 12 (CCl2F2) derived from high-spectral resolution infrared solar absorption spectra: retrieval and comparison with in situ surface measurements." Journal of Quantitative Spectroscopy and Radiative Transfer 92: 201-209.

Rinsland, C. P., et al. (2002). "Multiyear infrared solar spectroscopic measurements of HCN, CO, C2H6, and C2H2 tropospheric columns above Lauder, New Zealand (45oS latitude)." Journal of Geophysical Research 107(D14): 10.1029/2001JD001150.

Rinsland, C. P., et al. (2004). "Free tropospheric measurements of formic acid (HCOOH) from infrared ground-based solar absorption spectra: retrieval approach, evidence for a seasonal cycle and comparison with model calculations." Journal of Geophysical Research 109(D18): D18308: 18310.11029/12004JD004917.

Rinsland, C. P., et al. (2003). "Long-term trends of inorganic chlorine from ground-based infrared solar spectra: Past increases and evidence for stabilization." Journal of Geophysical Research 108(D8): 10.1029/2002JD003001.

Rinsland, C. P., et al. (2005). "High spectral resolution solar absorption measurements of ethylene (C2H4) in a forest fire smoke plume using HITRAN parameters: Tropospheric vertical profile retrieval." Journal of Quantitative Spectroscopy and Radiative Transfer 96(2): 301-309.

Risi, C., et al. (2012). "Process-evaluation of tropospheric humidity simulated by general circulation models using water vapor isotopologues: 1. Comparison between models and observations." Journal of Geophysical Research 117: D05303.

Ronsmans, G., et al (2016) "First characterization and validation of FORLI-HNO3 vertical profiles retrieved from IASI/Metop", Atmos. Meas. Tech., 9, 4783-4801, doi:10.5194/amt-9-4783-2016

Robinson J, et al. (2020). "Solar tracker with optical feedback and continuous rotation", Atmospheric Measurement Techniques. 2020 Nov 6;13(11):5855-71.

Ryan, Robert G., et al. "Comparison of formaldehyde tropospheric columns in Australia and New Zealand using MAX-DOAS, FTIR and TROPOMI." Atmospheric Measurement Techniques 13.12 (2020): 6501-6519.

Schneider, M., et al. (2012): "Ground-based remote sensing of tropospheric water vapour isotopologues within the project MUSICA", Atmos. Meas. Tech., 5, 3007-3027, doi:10.5194/amt-5-3007-2012, 2012 .

Sepulveda, E., et al (2014): "Tropospheric CH4 signals as observed by NDACC FTIR at globally distributed sites and comparison to GAW surface in situ measurements" Atmos. Meas. Tech., 7, 2337-2360, doi:10.5194/amt-7-2337-2014, 2014

Schaefer, H., et al (2018), "Limited impact of El Niño–Southern Oscillation on variability and growth rate of atmospheric methane", Biogeosciences, 15, 6371-6386

Sha, M.K., et al, (2021), "Validation of methane and carbon monoxide from Sentinel-5 Precursor using TCCON and NDACC-IRWG stations." Atmos. Meas. Tech., 14(9): 6249-6304. 10.5194/amt-14-6249-2021

Sherlock, V.J.; et al. (1997). "Increase in the vertical column abundance of HCFC-22 (CHClF2) above Lauder, New Zealand, between 1985 and 1994". Journal of Geophysical Research 102(D7): 8861-8865.

Steinbrecht, W., et al. (2017) "An update on ozone profile trends for the period 2000 to 2016", Atmos. Chem. Phys. Discuss., doi:10.5194/acp-2017-391

Strahan, S. E., et al. (2020) "Observed hemispheric asymmetry in stratospheric transport trends from 1994 to 2018." Geophysical Research Letters 47.17 (2020): e2020GL088567.

Strahan, S. E., et al., (2022). Unexpected Repartitioning of Stratospheric Inorganic Chlorine After the 2020 Australian Wildfires. Geophysical Research Letters, 49(14), e2022GL098290.

Velazco, V., et al. (2007). "Annual variation of strato-mesospheric carbon monoxide measured by ground-based Fourier transform infrared spectrometry." Atmospheric Chemistry and Physics 7: 1205-1312.

Vandenbussche S, et al., (2022) "Nitrous Oxide Profiling from Infrared Radiances (NOPIR): Algorithm Description, Application to 10 Years of IASI Observations and Quality Assessment.", Remote Sensing. 2022 Apr 8;14(8):1810.

Vigouroux, C., et al. (2007). "Comparisons between ground-based FTIR and MIPAS N2O and HNO3 profiles before and after assimilation in BASCOE." Atmospheric Chemistry and Physics 7: 1-20.

Vigouroux, C., et al. (2008). "Evaluation of ozone tropospheric and stratospheric trends over Western Europe from ground-based FTIR network observations." Atmos. Phys. Chem. 8: 6865-6886.

Vigouroux, C., et al. (2015) "Trends of ozone total columns and vertical distribution from FTIR observations at eight NDACC stations around the globe." Atmospheric Chemistry and Physics, 2015, 15, pp. 2915-2933

Vigouroux, C., et al. (2018) "NDACC harmonized formaldehyde time series from 21 FTIR stations covering a wide range of column abundances.", Atmos. Meas. Tech., 11, 5049-5073

Vigouroux, Corinne, et al. (2020) "TROPOMI–Sentinel-5 Precursor formaldehyde validation using an extensive network of ground-based Fourier-transform infrared stations." Atmospheric Measurement Techniques 13.7 (2020): 3751-3767.

Wang, D. Y., et al. (2007). "Validation of MIPAS HNO3 operational data." Atmospheric Chemistry and Physics 7: 4905-4934.

Wolff, M. A., et al. (2008). "Validation of HNO3, ClONO2, and N2O5 from the Atmospheric Chemistry Experiment Fourier Transform Spectrometer (ACE-FTS)." Atmospheric Chemistry and Physics 8: 3529-3562.

Wood, S. W., et al. (2002). "Validation of version 5.20 ILAS HNO3, CH4, N2O, O3 and NO2 using ground-based measurements at Arrival Heights and Kiruna." Journal of Geophysical Research 107(D24): 10.1029/2001JD000581.

Yin, H.,et al., (2020) "Ground-based FTIR observation of hydrogen chloride (HCl) over Hefei, China, and comparisons with GEOS-Chem model data and other ground-based FTIR stations data," Opt. Express 28, 8041-8055

Zeng, G., et al. (2012). "Trends and variations in CO, C2H6 and HCN in the Southern Hemisphere point to the declining anthropogenic emissions of CO and C2H6." Atmospheric Chemistry and Physics 12: 7543 - 7555.

Zeng, G., et al. (2015) "Multi-model simulation of CO and HCHO in the Southern Hemisphere: comparison with observations and impact of biogenic emissions." Atmos. Chem. Phys., 15, 7217-7245, doi:10.5194/acp-15-7217-2015

Zhou, M., et al. (2019) "An intercomparison of total column-averaged nitrous oxide between ground-based FTIR TCCON and NDACC measurements at seven sites and comparisons with the GEOS-Chem model", Atmos. Meas. Tech., 12, 1393-1408

Zhou, M., et al. (2019) "TCCON and NDACC XCO measurements: difference, discussion and application", Atmos. Meas. Tech., 12, 5979-5995