MetaData File provided: July 1996.
Latest Revision: 18-Oct-2024.

Data Set Description:

PI: Emmanuel Mahieu
Department of Astrophysics, Geophysics and Oceanography (UR SPHERES)
University of LIEGE

Instrument in operation:
A Bruker 125HR Infrared Fourier Transform Spectrometer (FTIR)

Site(s): High-altitude Jungfraujoch Research Station
NDACC Station, Swiss Alps,
46.55 N, 7.98 E, 3580m a.s.l., Switzerland

Measurement Quantities:
Total & Partial Vertical Column Abundances above Jungfraujoch (in number molecules per sq. cm)

Creative Commons license type for the archived Jungfraujoch FTIR data:

Starting with version IRWG2023:
CC-BY-SA-4.0 (Attribution-ShareAlike-No Commercial Restrictions)

For earlier versions (v001 up to v007):
refer to the DATA_RULES_OF_USE statement available in each hdf archive

Contact Information:

Name: MAHIEU E.
Address: Department of Astrophysics, Geophysics and Oceanography - University of LIEGE
Allee du 6 Aout, 19 - B-4000 LIEGE - BELGIUM
Phone: +32/4.366.97.86
Email: emmanuel.mahieu@uliege.be

Reference Articles:

A complete list is available from https://www.girpas.uliege.be/cms/c_5895270/en/publications

Selection of key publications (chronological order, from 2008 until 2024):

Zander, R., Mahieu, E., Demoulin, P., Duchatelet, P., Roland, G., Servais, C., Mazière, M. De, Reimann, S. and Rinsland, C. P.: Our changing atmosphere: Evidence based on long-term infrared solar observations at the Jungfraujoch since 1950, Sci. Total Environ., 391(2–3), 184–195, doi:10.1016/j.scitotenv.2007.10.018, 2008.

Mahieu, E., Chipperfield, M. P., Notholt, J., Reddmann, T., Anderson, J., Bernath, P. F., Blumenstock, T., Coffey, M. T., Dhomse, S. S., Feng, W., Franco, B., Froidevaux, L., Griffith, D. W. T., Hannigan, J. W., Hase, F., Hossaini, R., Jones, N. B., Morino, I., Murata, I., Nakajima, H., Palm, M., Paton-Walsh, C., Russell, J. M., Schneider, M., Servais, C., Smale, D. and Walker, K. A.: Recent Northern Hemisphere stratospheric HCl

increase due to atmospheric circulation changes, Nature, 515(7525), 104–107, doi:10.1038/nature13857, 2014.

Franco, B., Mahieu, E., Emmons, L. K., Tzompa-Sosa, Z. A., Fischer, E. V, Sudo, K., Bovy, B., Conway, S., Griffin, D., Hannigan, J. W., Strong, K. and Walker, K. A.: Evaluating ethane and methane emissions associated with the development of oil and natural gas extraction in North America, Environ. Res. Lett., 11(4), 44010, doi:10.1088/1748-9326/11/4/044010, 2016.

Helmig, D., Rossabi, S., Hueber, J., Tans, P., Montzka, S. A., Masarie, K., Thoning, K., Plass-Duelmer, C., Claude, A., Carpenter, L. J., Lewis, A. C., Punjabi, S., Reimann, S., Vollmer, M. K., Steinbrecher, R., Hannigan, J. W., Emmons, L. K., Mahieu, E., Franco, B., Smale, D. and Pozzer, A.: Reversal of global atmospheric ethane and propane trends largely due to US oil and natural gas production, Nature Geoscience, 9(7), 490–495, doi:10.1038/ngeo2721, 2016.

Bader, W., Bovy, B., Conway, S., Strong, K., Smale, D., Turner, A. J., Blumenstock, T., Boone, C., Collaud Coen, M., Coulon, A., Garcia, O., Griffith, D. W. T., Hase, F., Hausmann, P., Jones, N., Krummel, P., Murata, I., Morino, I., Nakajima, H., O'Doherty, S., Paton-Walsh, C., Robinson, J., Sandrin, R., Schneider, M., Servais, C., Sussmann, R. and Mahieu, E.: The recent increase of atmospheric methane from 10 years of ground-based NDACC FTIR observations since 2005, Atmos. Chem. Phys., 17(3), 2255–2277, doi:10.5194/acp-17-2255-2017, 2017.

Lejeune, B., Mahieu, E., Vollmer, M. K., Reimann, S., Bernath, P. F., Boone, C. D., Walker, K. A. and Servais, C.: Optimized approach to retrieve information on atmospheric carbonyl sulfide (OCS) above the Jungfraujoch station and change in its abundance since 1995, J. Quant. Spectrosc. Radiat. Transf., 186, 81–95, doi:10.1016/j.jqsrt.2016.06.001, 2017.

Prignon, M., Chabrillat, S., Minganti, D., O'Doherty, S., Servais, C., Stiller, G., Toon, G. C., Vollmer, M. K. and Mahieu, E.: Improved FTIR retrieval strategy for HCFC-22 ($CHClF_2$), comparisons with in situ and satellite datasets with the support of models, and determination of its long-term trend above Jungfraujoch, Atmos. Chem. Phys., 19(19), 12309–12324, doi:10.5194/acp-19-12309-2019, 2019.

Bernet, L., Brockmann, E., von Clarmann, T., Kämpfer, N., Mahieu, E., Mätzler, C., Stober, G. and Hocke, K.: Trends of atmospheric water vapour in Switzerland from ground-based radiometry, FTIR and GNSS data, Atmos. Chem. Phys., 20(19), 11223–11244, doi:10.5194/acp-20-11223-2020, 2020.

Strahan, S. E., Smale, D., Douglass, A. R., Blumenstock, T., Hannigan, J. W., Hase, F., Jones, N. B., Mahieu, E., Notholt, J., Oman, L. D., Ortega, I., Palm, M., Prignon, M., Robinson, J., Schneider, M., Sussmann, R. and Velazco, V. A.: Observed Hemispheric Asymmetry in Stratospheric Transport Trends From 1994 to 2018, Geophys. Res. Lett., 47(17), doi:10.1029/2020GL088567, 2020.

Mahieu, E., Fischer, E. V., Franco, B., Palm, M., Wizenberg, T., Smale, D., Clarisse, L., Clerbaux, C., Coheur, P.-F., Hannigan, J. W., Lutsch, E., Notholt, J., Cantos, I. P., Prignon, M., Servais, C. and Strong, K.: First retrievals of peroxyacetyl nitrate (PAN) from ground-based FTIR solar spectra recorded at remote

sites, comparison with model and satellite data, Elem. Sci. Anthr., 9(1), doi:10.1525/elementa.2021.00027, 2021.

Prignon, M., Chabrillat, S., Friedrich, M., Smale, D., Strahan, S. E., Bernath, P. F., Chipperfield, M. P., Dhomse, S. S., Feng, W., Minganti, D., Servais, C. and Mahieu, E.: Stratospheric fluorine as a tracer of circulation changes: comparison between infrared remote-sensing observations and simulations with five modern reanalyses, J. Geophys. Res. Atmos., doi:10.1029/2021JD034995, 2021.

Pardo Cantos, I., Mahieu, E., Chipperfield, M. P., Smale, D., Hannigan, J. W., Friedrich, M., Fraser, P., Krummel, P., Prignon, M., Makkor, J., Servais, C. and Robinson, J.: Determination and analysis of time series of CFC-11 ($CCl_3F$) 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, Environ. Sci. Atmos., doi:10.1039/D2EA00060A, 2022.

Minganti, D., Chabrillat, S., Errera, Q., Prignon, M., Schneider, M., Smale, D., Jones, N. and Mahieu, E.: Evaluation of the $N_2O$ Rate of Change to Understand the Stratospheric Brewer-Dobson Circulation in a Chemistry-Climate Model Journal of Geophysical Research: Atmospheres, J. Geophys. Res. Atmos., 127, 1–22, doi:10.1029/2021JD036390, 2022.

Pardo Cantos, I., Mahieu, E., Chipperfield, M. P., Servais, C., Reimann, S. and Vollmer, M. K.: First HFC-134a retrievals from ground-based FTIR solar absorption spectra, comparison with TOMCAT model simulations, in-situ AGAGE observations, and ACE-FTS satellite data for the Jungfraujoch station, J. Quant. Spectrosc. Radiat. Transf., 318, 108938, doi:10.1016/j.jqsrt.2024.108938, 2024.

Instrument Description:

The Fourier Transform Spectrometer in operation at Jungfraujoch since September 2024 is a commercial "Bruker IFS 125 HR". Spectra are recorded either in the 1-5.4 or 8-14 micrometers intervals (atmospheric windows) depending on beamsplitters and detectors selections. Spectra are recorded with resolutions spanning the 0.0061 to 0.0019 $cm^{-1}$ (OPD between ~82 and 257 cm), depending on the optical filter and sun height. The 125HR replaced a 120HR model of the same manufacturer, an instrument that performed regular observations during more than 30 years, with equivalent spectral performance and coverage.

Beforehand, a FTIR instrument built at the Institute of Astrophysics in Liege ("home-made") has been routinely used from 1984 until 2008 by Ph. Demoulin. It achieved an ultimate resolution of 0.0025 $cm^{-1}$ (max OPD of 2m) and both spectral domains mentioned above were also covered with this instrument.

Algorithm Description:

As of October 2017, vertical total and partial column abundances were retrieved using the SFIT4 algorithm (v.0.9.4.4 in place of SFIT2) implementing the Optimal Estimation Method of Rodgers, fitting one or several carefully selected microwindows containing isolated and well characterized line(s) of the target gas. In Spring 2024, the latest official version of SFIT-4 (v.1.0.21) has been implemented at ULiège. Progressively, the time series will be reprocessed with this new algorithm, new spectroscopy (mostly

HITRAN2020; visit hitran.org, in combination with pseudolines produced by G.C. Toon, NASA-JPL) and a new set of *a priori* profiles. The corresponding hdf archives are identified by the "irwg2023" keyword.

Ancillary data: -Line compilations: HITRAN 2008, progressivel replaced by HITRAN2020, complemented by pseudolines for ClONO2, C2H6... -Physical models: PT profiles provided by the NCEP (National Centers for Environmental Prediction) for noontime are systematically used. A priori vertical distributions for the target and interfering gases correspond in most cases to a mean of monthly profiles derived for 1980-2020 (then 1980-2040) from dedicated WACCM simulations, except for water vapor for which NCEP, ERA-Interim or ERA-5 reanalyses are used.

Expected Precision/Accuracy of Instrument:
Based on regular tests with NDACC HBr-or $N_2O$-sealed cells, precision and accuracy are estimated at +/- 2%.

Instruments History:
-See Zander et al. (2008).
- or in French: Mahieu, E., Bader, W., Bovy, B., Demoulin, P., Flock, O., Franco, B., Lejeune, B., Prignon, M., Roland, G. and Servais, C.: Surveillance de l'atmosphère terrestre depuis la station du Jungfraujoch : une épopée liégeoise entamée voici plus de 65 ans !, Bull. la Société Géographique Liège, 68(Hommage au Professeur Michel Erpicum), 119–130 [online] Available from: http://popups.ulg.ac.be/0770-7576/index.php?id=4592&file=1, 2017.