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Data Set Description:

PI: Wolfgang Steinbrecht
Instrument: Differential Absorption Lidar
Site(s): Hohenpeissenberg
Measurement Quantities: stratospheric ozone and temperature profiles

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None at this point

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Reference Articles:

Wing, R., Godin-Beekmann, S., Steinbrecht, W., McGee, T. J., Sullivan, J. T., Khaykin, S., Sumnicht, G., and Twigg, L.: Evaluation of the new DWD ozone and temperature lidar during the Hohenpeissenberg Ozone Profiling Study (HOPS) and comparison of results with previous NDACC campaigns, *Atmos. Meas. Tech.*, 14, 3773–3794, <https://doi.org/10.5194/amt-14-3773-2021>, 2021.

Steinbrecht, W., McGee, T. J., Twigg, L. W., Claude, H., Schöenborn, F., Sumnicht, G. K., and Silbert, D.: Intercomparison of stratospheric ozone and temperature profiles during the October 2005 Hohenpeissenberg Ozone Profiling Experiment (HOPE), *Atmos. Meas. Tech.*, 2, 125–145, <https://doi.org/10.5194/amt-2-125-2009>, 2009.

Steinbrecht, W., Winkler, P., Claude, H., Ozone and temperature measurement using lidar at Hohenpeissenberg, *Berichte des Deutschen Wetterdienstes*, Nr. 200, <http://nbn-resolving.de/urn:nbn:de:101:1-201601282329>, 1997.

Claude, H., Schöenborn, F., Steinbrecht, W. and Vandersee, W.: (1994), New evidence for ozone depletion in the upper stratosphere. *Geophys. Res. Lett.*, 21, 2409-2412, <https://doi.org/10.1029/94GL02590>, 1994.

W. Steinbrecht, K. Rothe, and H. Walther: Lidar setup for daytime and nighttime probing of stratospheric ozone and measurements in polar and equatorial regions, *Appl. Opt.* 28, 3616-3624, <https://doi.org/10.1364/AO.28.003616> , 1989.

Werner, J., Rothe, K.W. & Walther, H.: Monitoring of the stratospheric ozone layer by laser radar, *Appl. Phys. B*, 32, 113, <https://doi.org/10.1007/BF00688815> , 1983.

Leblanc, T., Sica, R.J., van Gijssel, J.A.E., Godin-Beekmann, S., Haefele, A., Trickl, T., Payen, G., and Gabarrot, F.: Proposed standardized definitions for vertical resolution and uncertainty in the NDACC lidar ozone and temperature algorithms – Part 1: Vertical resolution, *Atmos. Meas. Tech.*, 9, 4029–4049, <https://doi.org/10.5194/amt-9-4029-2016> , 2016.

Leblanc, T., Sica, R. J., van Gijssel, J. A. E., Godin-Beekmann, S., Haefele, A., Trickl, T., Payen, G., and Liberti, G.: Proposed standardized definitions for vertical resolution and uncertainty in the NDACC lidar ozone and temperature algorithms – Part 2: Ozone DIAL uncertainty budget, *Atmos. Meas. Tech.*, 9, 4051–4078, <https://doi.org/10.5194/amt-9-4051-2016> , 2016.

Leblanc, T., Sica, R. J., van Gijssel, J. A. E., Haefele, A., Payen, G., and Liberti, G.: Proposed standardized definitions for vertical resolution and uncertainty in the NDACC lidar ozone and temperature algorithms – Part 3: Temperature uncertainty budget, *Atmos. Meas. Tech.*, 9, 4079–4101, <https://doi.org/10.5194/amt-9-4079-2016> , 2016.

Hubert, D., Lambert, J.-C., Verhoelst, T., Granville, J., Keppens, A., Baray, J.-L., Bourassa, A. E., Cortesi, U., Degenstein, D. A., Froidevaux, L., Godin-Beekmann, S., Hoppel, K. W., Johnson, B. J., Kyrölä, E., Leblanc, T., Lichtenberg, G., Marchand, M., McElroy, C. T., Murtagh, D., Nakane, H., Portafaix, T., Querel, R., Russell III, J. M., Salvador, J., Smit, H. G. J., Stebel, K., Steinbrecht, W., Strawbridge, K. B., Stübi, R., Swart, D. P. J., Taha, G., Tarasick, D. W., Thompson, A. M., Urban, J., van Gijssel, J. A. E., Van Malderen, R., von der Gathen, P., Walker, K. A., Wolfram, E., and Zawodny, J. M.: Ground-based assessment of the bias and long-term stability of 14 limb and occultation ozone profile data records, *Atmos. Meas. Tech.*, 9, 2497–2534, <https://doi.org/10.5194/amt-9-2497-2016> , 2016.

Nair, P. J., Godin-Beekmann, S., Froidevaux, L., Flynn, L. E., Zawodny, J. M., Russell III, J. M., Pazmiño, A., Ancellet, G., Steinbrecht, W., Claude, H., Leblanc, T., McDermid, S., van Gijssel, J. A. E., Johnson, B., Thomas, A., Hubert, D., Lambert, J.-C., Nakane, H., and Swart, D. P. J.: Relative drifts and stability of satellite and ground-based stratospheric ozone profiles at NDACC lidar stations, *Atmos. Meas. Tech.*, 5, 1301–1318, <https://doi.org/10.5194/amt-5-1301-2012> , 2012.

W. Steinbrecht, H. Claude, F. Schönenborn, I. S. McDermid, T. Leblanc, S. Godin-Beekmann, P. Keckhut, A. Hauchecorne, J.A.E. Van Gijssel, D.P.J. Swart, G.E. Bodeker, A. Parrish, I. S. Boyd, N. Kämpfer, K. Hocke, R.S. Stolarski, S.M. Frith, L. W. Thomason, E.E. Remsberg, C. Von Savigny, A. Rozanov & J.P. Burrows: Ozone and temperature trends in the upper stratosphere at five stations of the Network for the Detection of Atmospheric Composition Change, *International Journal of Remote Sensing*, 30:15-16, 3875-3886, <https://doi.org/10.1080/01431160902821841> , 2009.

S. Godin, A. Carswell, D. Donovan, H. Claude, W. Steinbrecht, I. McDermid, T. McGee, M. Gross, H. Nakane, D. Swart, H. Bergwerff, O. Uchino, P. von der Gathen, and R. Neuber, Ozone differential absorption lidar algorithm intercomparison, *Appl. Opt.* 38, 6225-6236, <https://doi.org/10.1364/AO.38.006225> , 1999.

Instrument Description:

The Hohenpeissenberg ozone DIAL is designed to measure stratospheric ozone profiles from 15 to 50 km altitude (by differential absorption) and stratospheric temperature profiles from 28 to 75 km altitude (by Rayleigh backscattering). Together with an older previous system, lidars at Hohenpeissenberg have been measuring 80 to 100 profiles per year in clear nights since September 1987. A XeCl Excimer laser at 308 nm produces light at a wavelength absorbed by ozone. A tripled NdYAG laser generates light at 355 nm, a wavelength not absorbed by ozone. (The old system used an H₂ Raman-Cell to generate light at 353 nm). A high speed chopper is used to block the intense light returned from lower altitudes, thus avoiding over-exposure of the photomultipliers and signal induced noise. Profiles are acquired in two steps: A high altitude step (where return signals are blocked below about 20 to 30 km) and a low altitude step (where a light attenuating grey filter is used and return signals are blocked below about 10 km). The receiver uses a 100cm diameter main mirror Newtonian telescope (old system 60 cm), dichroic filters for wavelength separation, interference filters for background rejection, and photomultipliers. The photomultipliers convert returned photons into electrical pulses which are then counted as a function of altitude (=time for the laser light to travel up and be scattered back to the receiver). Typically the weak return signals are averaged over an entire night to derive a nightly mean ozone and temperature profile.

In 2016, the old lidar system running since 1987 was supplemented by a new and improved system. The new system also detects N₂ Raman return signals at 332 and 387 nm. Since January 2018, the new system provides the operational NDACC profiles. Return signals for the new system are substantially higher than for the old system - resulting in better precision and higher top altitudes for the ozone and temperature profiles. Operation of the old system ended in November 2019.

Algorithm Description:

Main steps of the data processing are:

- correction of photon-counting deadtime
- selection of good return signals and averaging over the night
- estimation and subtraction of signal background
- merging of low and high altitude acquisitions
- derivation of stratospheric temperature profile
- correction for Rayleigh extinction using nearby radiosonde profile
- merging of lidar and radiosonde temperature profile (would also allow derivation of stratospheric aerosol)
- derivation of stratospheric ozone profile

For more details see Steinbrecht et al. <https://doi.org/10.5194/amt-2-125-2009>, 2009.

Expected Precision/Accuracy of Instrument:

Old system (1987 to 2017)

Altitude [km]	ozone [%]	temperature [K]
15	10	NA
20	5	NA
25	2	NA
30	2	0.5
35	2	0.5
40	3	1
45	10	2
50	3	3
60	NA	5

New system (since 2018)

Altitude [km]	ozone [%]	temperature [K]
15	5	NA
20	2	NA
25	2	NA
30	1	0.5
35	1	0.5
40	2	0.5
45	5	0.5
50	15	0.5
60	NA	0.5
70	NA	1

Detailed and profile-specific estimates for precision, accuracy and altitude resolution are given in the NDACC *.hdf files (and to a lesser degree in the AMES files).

See also Leblanc et al. 2016 (<https://doi.org/10.5194/amt-9-4029-2016>, <https://doi.org/10.5194/amt-9-4051-2016>, <https://doi.org/10.5194/amt-9-4079-2016>)

Instrument History:

11/2019 end of old lidar system
10/2018 and 03/2019 HOPS Intercomparison with NASA GSFC STROZ System
11/2019 (old lidar: new thyatron)
since 01/2018 NDACC data from new lidar system
until 12/2017 NDACC data from old lidar system
04/2016 begin of regular test measurements with new lidar system
08/2015 1st light / return signals with new lidar system
04/2014 new HV power supply for laser
01/2013 new thyatron
09/2009 complete reprocessing of entire time series, archived at NDACC

11/2006 new thyatron trigger-board
10/2005 HOPE Intercomparison with NASA GSFC STROZ System
09/2005 Excimer laser refurbished, new Reservoir, ...
09/2003 new thyatron
03/1999 new achromat on Raman-Cell
11/1998 transmitter and receiver main mirrors recoated (Zeiss Jena)
10/1998 new interference filters (Barr Associates)
05/1995 complete data reprocessing & submission to NDACC
06/1994 new data acquisition 486-Computer & OPTECH counter-board
07/1994 new Excimer Laser LPX210i Novatube
11/1993 new Excimer Laser LPX210i
10/1990 new thyatron
09/1989 major laser damage, water in reservoir
05/1989-08/1989 data lost by harddisk crash
03/1988 begin of semi-automatic measurements, no operator during the night
09/1987 begin of regular measurements DG10 Computer + LeCroy counters