File Revision Date:
2026 November 17

Data Set Description:
PI: Wolfgang Steinbrecht
Instrument: Ozone Sonde
Site(s): Hohenpeissenberg
Measurement Quantities: ozone and temperature profiles

Contact Information:
Name: Dr. Wolfgang Steinbrecht; Dr. Voltaire Velazco
Address: Deutscher Wetterdiens
Meteorological Observatory Hohenpeissenberg
Albin-Schwaiger-Weg 10
D-82383 Hohenpeissenberg
Germany
Phone: +49 (0)69 8062 9772
FAX: N/A
Email: Wolfgang.Steinbrecht@dwd.de; Voltaire.Velazco@dwd.de

DOI:
https://dx.doi.org/10.60897/tkhf-kf23

Data License:
CC-By-SA 4.0 license (open – but credits required – share alike)

Reference Articles:

Steinbrecht, W., Velazco, V. A., Dirksen, R., Doppler, L., Oelsner, P., Van Malderen, R., et al.: Ground-based monitoring of stratospheric ozone and temperature over Germany since the 1960s. Earth and Space Science, 12, e2024EA003821, 2025, https://doi.org/10.1029/2024EA003821

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, 2021, https://doi.org/10.5194/amt-14-3773-2021

World Meteorological Organization (WMO), H.G.J. Smit and A.M. Thompson (eds.): Ozonesonde Measurement Principles and Best Operational Practices, ASOPOS 2.0 (Assessment of Standard Operating Procedures for Ozonesondes), GAW Report No. 268, 173 p., 2021, https://library.wmo.int/idurl/4/57720

Tarasick, D. W., Smit, H. G. J., Thompson, A. M., Morris, G. A., Witte, J. C., Davies, J., et al.: Improving ECC ozonesonde data quality: Assessment of current methods and outstanding issues. Earth and Space Science, 8, e2019EA000914, 2021, https://doi.org/10.1029/2019EA000914

Pattantyús-Ábrahám, M., and W. Steinbrecht: Temperature Trends over Germany from Homogenized Radiosonde Data. J. Climate, 28, 5699–5715, 2015, https://doi.org/10.1175/JCLI-D-14-00814.1. 2015.

Steinbrecht, W., McGee, T. J., Twigg, L. W., Claude, H., Schönenborn, 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, 2009, https://doi.org/10.5194/amt-2-125-2009

Steinbrecht, W., H. Claude, F. Schönenborn, U. Leiterer, H. Dier, and E. Lanzinger: Pressure and Temperature Differences between Vaisala RS80 and RS92 Radiosonde Systems. J. Atmos. Oceanic Technol., 25, 909–927, 2008, https://doi.org/10.1175/2007JTECHA999.1.

Steinbrecht, W., Schwarz, R. and Claude, H., New Pump Correction for the Brewer Mast Ozone Sonde: Experimental Determination and Application to Instrument Intercomparisons, J. Atmospheric & Oceanic Technology, Vol. 15, p144-156, 1998, https://doi.org/ 10.1175/1520-0426(1998)015<0144:NPCFTB>2.0.CO;2

World Meteorological Organization (WMO), D. Kley (ed.): Jülich Ozone Sonde Intercomparison Experiment (JOSIE): 5 February - 8 March 1996, GAW Report No. 130, WMO/TD-No. 926, 132 p., 1997, https://library.wmo.int/idurl/4/41139

Kerr J.B., Fast H., McElroy C.T., Oltmans S.J., Lathrop J.A., Kyro E., Paukkunen A., Claude H., Koehler U., Sreedharan C.R., Takao T., Tsukagoshi Y.: The 1991 WMO International Ozonesonde Intercomparison at Vanscoy Canada, Atmosphere Ocean, 32, No. 4, 685-716, 1994, https://doi.org/10.1080/07055900.1994.9649518

Claude, H., Hartmannsgruber R., and Koehler, U., Measurements of atmospheric ozone profiles using the Brewer-Mast sonde. WMO Global Research and Monitoring Project Report No. 17, 1987, https://library.wmo.int/idurl/4/41514

Instrument Description:

Hohenpeissenberg is an isolated mountain, 30 km north of the Alps, in a hilly rural area. It rises 300 m above the surrounding area, which is partly covered by meadows (~70%) and forests (~30%) and populated to an extent typical for central Europe. The Meteorological Observatory is situated on top of Hohenpeissenberg at 980 m a.s.l., 47.8° North, 11.0° East.

Ozone soundings by balloons using the Brewer/Mast ozonesonde have been carried out since 1967. For the first 11 years, sounding frequency was once per week on Wednesdays. Since 1978, sounding frequency is increased to 3 per week from November to-April (Mondays, Wednesdays and Fridays) and 2 per week from May to October (Mondays and Wednesdays).

The Brewer Mast sonde is a low-cost instrument, consisting of an electrochemical cell with a platinum cathode and a silver anode, filled with a potassium-iodide solution, and a small gas-sampling pump. During sounding ambient air is continuously pumped into the cell where ozone molecules react with the solution to form free iodine according to the redox reaction

$2KI + O3 + H20 \text{---> } 2KOH + I2 + O2$

The net effect is a flow of two electrons per ozone molecule. The output current of a few microamperes is proportional to the ozone partial pressure and follows the same equation as for ECC sondes (see GAW Report 268, WMO, 2021). The main sources of uncertainty are:

- uncertainty of pump efficiency during the sounding
- wall losses in the oiled pump (Brewer-Mast sondes do not have a teflon pump)
- incomplete absorption of ozone in the reaction cell
- interference with other trace substances, especially in the troposphere
- uncertainties of the pump temperature which is assumed to be 300K.

For the Brewer-Mast sonde, these factors generally result in an ozone raw profile which is low by 5 to 10%. At Hohenpeissenberg, each ozone profile is, however, normalized to the independently measured total ozone amount (usually from a Dobson or Brewer spectrometer). This reduces the error of the ozone profile a lot. It also helps to detect faulty soundings. Data are much improved by this Dobson normalization procedure, especially around the stratospheric ozone maximum.

The resulting uncertainty of ozone profiles measured by Brewer-Mast sondes varies with altitude (Kerr et al. 1991; WMO 1997; Steinbrecht et al., 1998; WMO, 2021; Tarasick et al., 2021). Typically, it is smaller than 5% around the ozone maximum (from 100 hPa to 20 hPa / 16 km to 26 km). At 10 hPa / 30km and above, uncertainty increases to 10% and more. In the troposphere uncertainty is 10 to 15%.

Calibration and Quality Control Procedures: The sondes are prepared in an extensive and well-established procedure (Claude et al. 1987). There is no calibration before launch. However, only sondes showing response better than 80 % and background current less than 3 nbar (0.3mPa) are launched. Soundings with Dobson correction factor less than 0.9 or higher than 1.25 are rejected, and there will a relaunch the same morning. On clear nights, a lidar at Hohenpeissenberg produces highly accurate ozone profiles from 15 and 45 km. Whenever a lidar-measured profile is available within a reasonable time from the sounding, it is compared with the balloon profile.

For the Version 4.0 data submitted to the NDSC, the effects of radiosonde-changes (VIZ 1393 to Vaisala RS80-30NES in August 1994 and to Vaisala RS80-30NE in August 1996), and effects of a colder pump-motor (throughout 1994) have been corrected.

Apart from the change from VIZ to Vaisala RS80 radiosondes in 1994, there were two more changes in radiosonde type:

- From Vaisala RS80 to Vaisala RS92 in 2005/2006
- From Vaisala RS92 to Vaisala RS41 in 2019/2020

For ozone (and temperature) below 25 to 30 km, effects of these two radiosonde changes are minor, and the ozone sounding data are not corrected for these radiosonde changes. Overall, changes in sonde-type and procedures have been kept to a minimum.

Expected Precision/Accuracy of Instrument:

Altitude [km]	ozone [%]	temperature [K]
Below 10	10	0.2
Below 25	5	0.2
Above 25	10	0.4

Instrument History:

2027:	NDACC data provided also in GEOMS *.hdf. Same data as in NASA Ames format, but with additional information. Consistent with HEGIFTOM / WMO GAW 268.
2025:	data with additional uncertainty information available from the HEGIFTOM initiative https://hegiftom.meteo.be . Note that HEGIFTOM is not updated, while NDACC data are updated all the time.
Since 2020:	Vaisala RS41 radiosondes
2006 to 2019:	Vaisala RS92 radiosndes
1995 to 2006:	Vaisala RS80 radiosondes
1967 to 1994:	VIZ 1x92 and 1x93 radiosondes, usually with hypsometer In the early years also AMT and other radiosondes
Since 1967:	Brewer-Mast ozone sondes