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Compilation of ozonesonde profiles from the Antarctic Georg-Forster-Station from 1985 to 1992

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Abstract

On 22 May 1985 the first balloon-borne ozonesonde was successfully launched by the staff of Georg-Forster-Station (70°46′ S, 11°41′ E). The following weekly ozone soundings mark the beginning of the continuous investigation of Germany to study the vertical ozone distribution in the southern hemisphere.

In 1985 these ozone soundings have been the only record showing the change of vertical ozone distribution in the southern polar stratosphere in September and October. The regular ozone soundings from 1985 until 1992 are a valuable reference data set since the chemical ozone loss became a significant feature in the southern polar stratosphere.

The balloon-borne soundings were performed at the upper air sounding facility of the neighbouring station Novolazarevskaya, just 2 km apart from Georg-Forster-Station. Till 1992, ozone soundings were taken without interruption. Afterwards, the ozone sounding program was moved to Neumayer-Station (70°39′ S, 8°15′ W) 750 km further west.

Data coverage and parameter measured

Repository-Reference: doi:10.1594/PANGAEA.547983
Available at: http://dx.doi.org/10.1594/PANGAEA.547983
Coverage: East: 11.8300; South: −70.7700
Location Name: Georg-Forster-Station, Antarctica
Date/Time Start: 1985-05-22T05:19:00
Date/Time End: 1992-01-29T01:19:00

Parameter	Short Name	Unit	Comment
Altitude	Altitude	m	height above mean sea level
Date/Time	Date/Time		universal time code (UTC)
Longitude	Longitude		at launching point
Latitude	Latitude		at launching point
Ozone, partial pressure	O3	mPa	
Pressure, at given altitude	PPPP	hPa	
Temperature, air	TTT	deg C	
Wind direction	dd	deg	
Wind velocity	ff	m/sec	

1 Instrumentation

Since the end of 1974 balloon-borne electrochemical ozone sondes have been regularly launched, i.e. once or three times per week, at the Aerological Observatory Lindenberg (52.22° N, 14.12° E) of the Meteorological Service of GDR. The ozone sensor was developed by Rönnebeck and Sonntag (1976) on the basis of the Brewer-Mast principle (Brewer and Milford, 1960). The sondes of the type OSE-2, OSM-2, OSR (since April 1981), OSE-3 (since September 1986) and OSE-4 (since August 1989) were manufactured in cooperation with the Scientific Instrument Laboratory of the Academy of Sciences in Berlin. Prototypes of the sonde took part in the International Ozone Sonde Intercomparisons at Hohenpeissenberg in 1970 (Attmannspacher and Dütsch, 1970) and in 1978 (Attmannspacher and Dütsch, 1981).

The ozone sensors were adapted to the Russian balloon-borne radiosonde system Meteorit/RKS-5 for data transmission, receiving and processing of ozone partial pressure. The standard data, temperature and humidity, were obtained from the radiosonde RKS-5. Pressure, wind direction and wind speed were derived from radar measurements of the ground station Meteorit tracking the balloon flight.

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The ozone partial pressure measurements were achieved by a small electrically driven gas sampling pump which forces ambient air through a sensing solution of an electrochemical cell (Brewer-Mast principle) which generates an electrical current proportional to the mass flow rate of ozone.

For balloon-borne ozone profile measurements a pump correction has to be applied in order to compensate the decreasing pump efficiency with increasing height and changing air temperature. Both, an inadequate pump correction and an erroneous estimate of residual ozone above the height of balloon burst may contribute to the overall measurement error of the ozone profile. Usually an independent column ozone observation X_D by spectrometer measurement is compared with the integrated column ozone X_S between the ground level and the height of balloon burst plus estimated residual ozone above that level to adjust the recorded profile values. The correction factor is

$$C = X_D / X_S.$$

Systematic differences and random errors of the electrochemical ozone sonde, type OSR, has been estimated by analysing 20 tandem ozone soundings at the Aerological Observatory Lindenberg in 1982 (Feister et al., 1985). Random errors are at their maximum of about 10 to 13% in the troposphere and above 32 km, and reach a minimum of 2 to 5% between 20 and 28 km. The mean random error is 11.5% in the troposphere, 7% in the stratosphere beneath the ozone maximum height (ca. 22 km), and 5.6% above that height.

2 Data Provenance and Structure

The first permanently operated German research base – later named Georg-Forster-Station – was established in 1976 in the Schirmacher Oasis at 70°46′ S, 11°41′ E. Since then the station was permanently used and operated as an annex to the Russian station Novolazarevskaya until 1987, and then as a German Antarctic station named after

Georg Forster until 1993.

Long-term studies of magnetospheric-ionospheric processes, geophysical investigations, biological studies and sea ice observations using satellite imaging were performed.

The station became known to the international scientific community when the vertical extension of the "ozone hole" in the southern polar stratosphere was firstly recorded by regular balloon-borne ozone observations in 1985 (Gernandt, 1987).

The ozone sounding programme was a major contribution of the Meteorological Service to the Antarctic research of GDR. It was established as a long-term balloon-borne observation in cooperation with the Russian Arctic and Antarctic Research Institute (AARI) and the Aerological Observatory Lindenberg (AOL) in order to study the climatology of the ozone layer in the southern polar stratosphere. The scientific and technical preparations were performed at AOL, where also the training of personnel working at the station took place regularly.

In 1985 these ozone soundings have been the only record showing the change of vertical ozone distribution in the southern polar stratosphere in September and October. These results supplemented the observed trend of large losses in total ozone recorded above the British station Halley since few years (Farman et al., 1985). Further studies were focussed to understand the dynamical control of the chemical ozone loss in spring (Gernandt et al., 1989). For spring 1987 these investigations were extended by including balloon-borne observations from Halley, and the American Amundsen-Scott South Pole Station (Gernandt et al., 1995). The ozone data of Georg-Forster-Station were also compared with Arctic observations in order to qualitatively understand possible chemical ozone losses in the Arctic stratosphere (Müller et al., 1997).

The regular ozone soundings form 1985 until 1992 are a valuable reference data set since the chemical ozone loss became a significant feature in the southern polar stratosphere.

2.1 Subsets of data

The dataset compiles 426 individual subsets of data, one for each sounding. Figure 2 presents an overview of the ozone measurements from the whole dataset.

The data were taken while the balloons were ascending. The soundings were terminated at the burst level of the balloons. The ascent velocity was about 5 m/s. During summertime – when the stratosphere was relatively warm – frequently the balloons reached levels above 30 000 m. During wintertime the low temperatures in the stratosphere (below −80°C) lead to lower burst heights. Regular launches were performed once per week and during spring (September, October) up to three soundings per week. Occasionally strong winds or technical problems (1989) made the measurements impossible.

2.2 Related datasets

Related datasets which were used with the data from Georg-Forster-Station:

Syowa:

Irregular ozone soundings since 1966. These data are used as a very important reference for the pre-ozone hole period in the Dronning Maud Land region (Gernandt et al., 1996).

Halley:

Ozone soundings gained in 1987 were used for dynamical studies of ozone variations (Gernandt, 1995).

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Amundsen-Scott South Pole Station:

Ozone soundings gained in 1987 were used for dynamical studies of ozone variations (Gernandt, 1995).

Koldewey-Station:

Ozone soundings gained since October 1991 data are used for bipolar comparisons (Gernandt et al., 1998; Rex et al., 2000).

Neumayer-Station:

After January 1992 the ozone soundings at Georg-Forster-Station were continued at Neumayer-Station (70°39′ S, 8°15′ W) 750 km further west (König-Langlo et al., 2006). The results of both stations can be regarded as one time series, see Fig. 3. It is the longest nearly continuously measured time series of balloon-borne ozone observations since the chemical ozone loss became a significant feature in the stratosphere.

The combined time series of both stations show the development of the stratospheric ozone layers since 1985 until now. Height-dependent trend and forcing studies were performed for the combined time series of balloon-borne ozone soundings (Gernandt et al., 1998).

3 Data access

The whole data set is published at http://dx.doi.org/10.1594/PANGAEA.547983. It contains the 426 doi-references of each single sounding. The whole dataset can be downloaded as one zipped file of tab-delimited textfiles. Each textfile includes all necessary metadata and a table containing all parameters of one sounding. No special software is needed to access the data. Special software is offered to convert or visualize the

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data, see http://pangaea.de/software/. Figure 2 can be taken as an example produced using ODV (Ocean Data View).

Acknowledgements. The ozone sounding programme at Georg-Forster-Station was funded by the Meteorological Service of GDR as a contribution to the East-German Antarctic research programme. The scientific supervision and technical preparations of the Antarctic observations were performed at the Aerological Observatory Lindenberg (since 1990 Meteorological Observatory of the German Weather Service – DWD).

The ozone sounding programme was developed and performed in cooperation with the Russian Arctic and Antarctic Research Institute (AARI), which provided the balloon launching facilities and radiosonde ground station Meteorit at Novolazarevskaya.

Support was given by the Japanese National Institute of Polar Research, which delivered special balloons to perform the ozone soundings during the winter period 1988.

Peter Plessing from the Meteorological Main Observatory of the Meteorological Service started the regular ozone soundings on 22 May 1985 and stayed for the first winter at the Georg-Forster-Station. Special thanks are given to him and to all following wintering over personal at Georg-Forster-Station and their Russian colleagues at Novolazarevskaya who performed and supported the ozone soundings from 1985 until 1992.

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Table 1. Correction factor *C* and standard deviation *SD* as obtained by spectrometer measurements of column ozone and column ozone obtained by profile integration at Georg-Forster-Station for October 1987 to 1991.

Year	number of profiles	*C*	*SD*
1987	10	1.087	0.376
1988	6	0.930	0.097
1989	3	0.894	0.146
1990	8	1.129	0.153
1991	7	1.038	0.389

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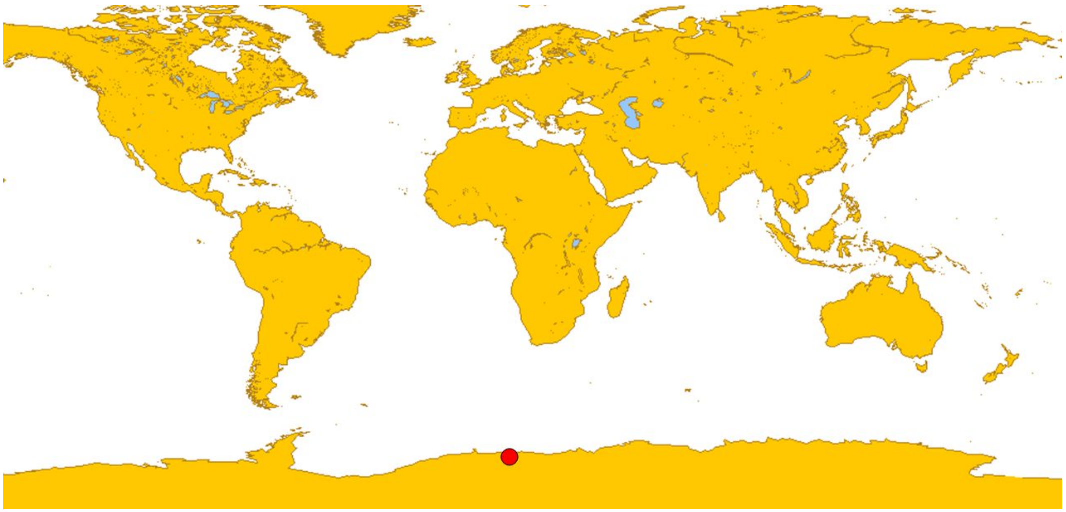

Fig. 1. Location of Georg-Forster-Station.

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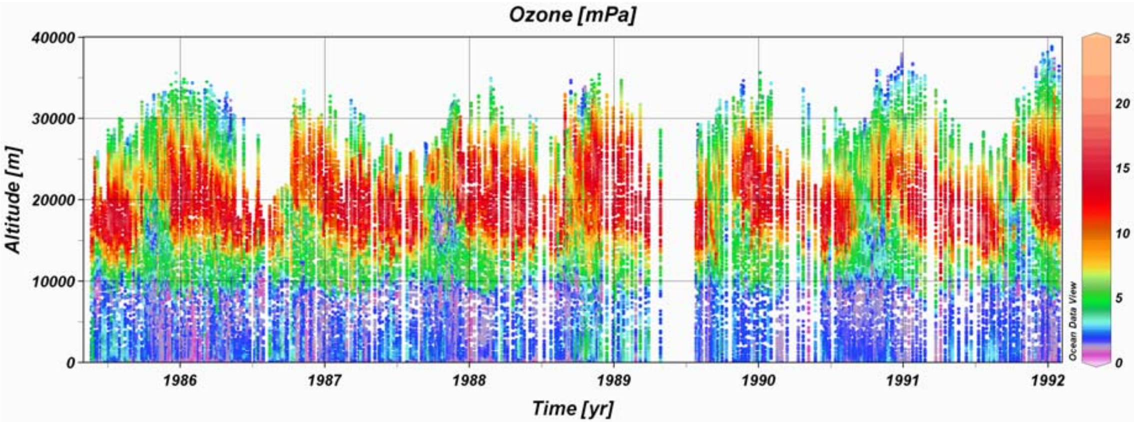

Fig. 2. Time-height section of the annual ozone variation over Georg-Forster-Station.

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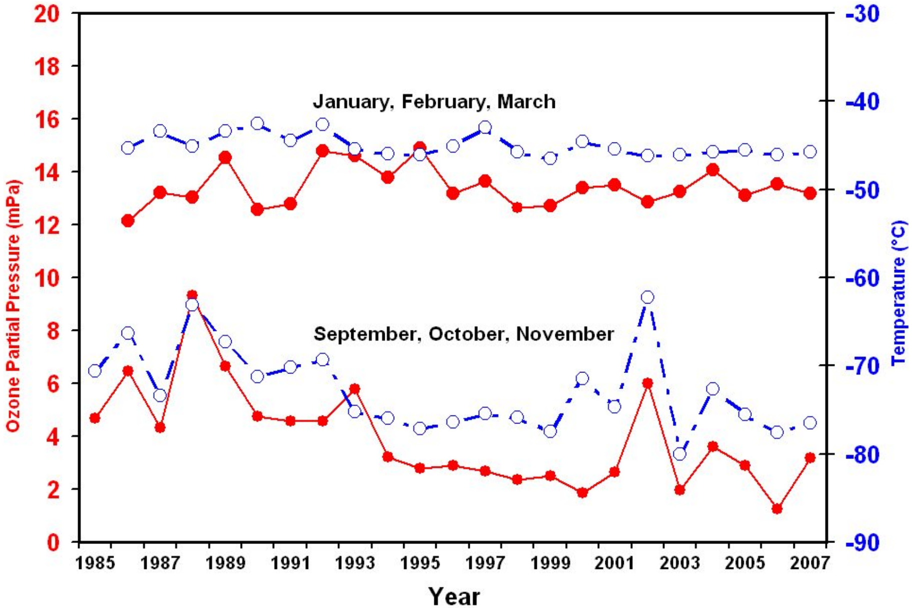

Fig. 3. Time series of seasonal averaged stratospheric parameters from Georg-Forster-Station and Neumayer-Station at 70 hPa. Solid red line with filled dots: Ozone Partial Pressure (mPa), dashed blue line with open dots: Temperature (˚C).

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