Report to the NDSC Steering Committee
Ny-Ålesund, August 1997

From: Geir O. Braathen

Regarding: Ozonesonde station reports

This report summarises the ozonesonde activities carried out at the various NDSC ozonesonde stations

Ozonesonde working group

At present the ozonesonde working group consists of Samuel Oltmans (NOAA) and Geir Braathen (NILU). It should be considered to expand this group with a quality assurance responsible.

The network

The following NDSC stations have been included as ozonesonde stations so far and are supposed to deliver sonde data to the NDSC data base: Ny-Ålesund, Thule, Eureka, Observatoire de Haute Provence, Mauna Loa, Lauder, Dumont d'Urville, McMurdo, South Pole. One should consider whether more stations should be included as there are more NDSC stations with ozonesonde facilities either at the site or nearby. These stations are: Aberystwyth, Andøya, Kiruna (sondes are launched during campaigns), Lerwick, Scoresbysund, Sodankylä. In addition, Gardermoen is close to Harestua and Hohenpeissenberg and Payerne are close to the Alpine sites. The steering committee should agree that we ask the Payerne and Hohenpeissenberg stations to apply for NDSC membership.

Station reports

Ny-Ålesund

Report submitted by: Hartwig Gernandt

1. Personnel

PI: Hartwig Gernandt, Peter von der Gathen

PhD: Markus Rex, Jessica Steger

Station personnel: Thomas Seiler removed by Bodo Wichura in March 1997.

2. Status of the instrument

Since 1997 the ECC 6A ozonesondes have been regularly flown as part of the NDSC observations in Ny-Ålesund/Svalbard.

3. Technical developments

During the period for adjustment to the outdoor conditions the ozone partial pressure measured by the ECC sonde is compared with the values measured by a UV absorption ozone monitor (HORIBA type APOA-350E). Since the monitor is in use (May 1996) the ratios of the measured ozone concentrations o3_sonde/ o3_monitor were between 0.95 and 1.07.

In 1998 the RS-80-18NE meteorological radiosonde will be replaced by a new radiosonde using GPS for wind measurements.

4. Measurements and data evaluation

The number of launched ECC ozonesondes in 1996 and 1997 is given in Table 1.

Table 1: Number of sondes launched in Ny-Ålesund in 1996 and 1997

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct.	Nov	Dec
1996	13	14	19	16	10	4	5	8	6	6	8	9
1997	19	12	14	11	10	5	5					

In winter 1996/97 the ozonesonde launches were coordinated for more than 35 stations within the campaign Match 96/67.

5. Data transfer to NDSC data bank

The data of 105 ozonesonde launches have been transferred to the NDSC data bank (range: August 1996 - June 1997).

6. Scientific highlights

- Again severe chemical ozone destruction in the first three months of the year 1997 in the polar vortex. However, not as severe as in 1996.
- Trend analysis of nine years of ozone soundings show a significant negative trend for middle stratosphere ozone.
- Balloon-borne ozone soundings at Ny-Ålesund were used for GOME (ERS 2) validation experiments.

7. Planned activities

- Continuation of long-term measurement program, i.e. 1 launch per week at least.
- Increased launch frequency during winter as a contribution to coordinated ozone observations in high and mid latitudes (Match 1997/98).
- Continuation of GOME (ERS 2) validation experiments.
- The Science Team for the Stratospheric Aerosol and Gas Experiment III (SAGE III) scheduled for launch in August 1998 has settled on Ny-Ålesund as a key station for the Northern Hemisphere to validate SAGE III products.
- No progress for the erection of a balloon preparation and launching facility at Ny-Ålesund.

8. Publications using Ny-Ålesund ozone sounding data

P. von der Gathen and M. Rex, Match (chapter 5.4.4.) in: The contribution of EASOE and SESAME to our current understanding of the ozone layer, European research in the stratosphere, edited by G.T. Amanatidis, European Commission, DG XII/D-1, EUR 16986 EN, 155-160, 1997.

M. Rex, et al., In-situ measurements of stratospheric ozone depletion rates in the Arctic winter 1991/92: a Lagrangian approach, J. geophys. Res., preliminary accepted.

M. Rex, et al., Chemical ozone loss in the Arctic winter 1994/95 as determined by the Match technique, J. atmos. Chem., preliminary accepted.

M. Rex, et al., Prolonged stratospheric ozone loss in the 1995/96 Arctic winter, Nature, preliminary accepted.

H. Gernandt, A. Herber, P. von der Gathen, M. Rex, A. Rinke, S. Wessel, and S. Kaneto, Variability of ozone and aerosols in the polar atmosphere, Mem. Natl. Inst. Polar Res., Spec. Issue, 51, 189-215, 1996.

H. Gernandt, P. von der Gathen, and A. Herber: Ozone change in the polar atmosphere. In Ground level and satellite ozone observations: Changes in the Mediterranean region, NATO ASI Series I, Vol. 53, 73-100, 1997

H. Gernandt, The Koldewey-Station in Ny-Ålesund - Contributions to atmospheric studies in the Arctic, NILU OR 19/97, Proceedings 3rd NySMAC Seminar, 23-26, 1997.

S. Wessel, S. Aoki, R. Weller, A. Herber, and H. Gernandt, O. Schrems, Aerosol and Ozone observations in the polar troposphere at Spitsbergen in spring 1994, Atmos. Res., Special Issue, Vol. 44, Issue 1-2,

175-189, 1997.

Eureka

Report submitted by: Hans Fast

From December 1996 to the end of April 1997 a total of 63 ECC sondes were flown successfully from the Eureka weather station. In collaboration with the 1997 European Match ozonesonde program, 32 of the sondes were released within the launch windows recommended by the Match program. The processed ozonesonde data were sent within a few days via ftp to the Match data base. A few sondes were launched specifically in support of lidar measurements of polar stratospheric clouds. Prior to December 1996 and after April 1997 the ozonesonde program at Eureka operated on its normal schedule of one launch per week on Wednesdays.

Eureka ozonesonde data from March 1, 1996, to April 7, 1997, have been archived on the NDSC data host facility. New ozonesonde data will be archived on a regular basis. The archiving of data prior to March 1996 is also being planned.

OHP

Report submitted by: Claude Vialle

Instrumental description

The ECC ozonesonde used to obtain vertical profiles of atmospheric ozone were SPC5A type from 1991 to 1996. Since march 1997 ECC sondes manufactured by ENSCI (Z type) are currently used. Both types are operated without modification. The ozonesonde is tied to a standard meteorological radiosonde (RS80-15 type and RS80-18H since february 1997). The balloon (1200g, natural rubber or chloroprene latex) is provided by Totex or by Delasson, more recently by Kaysam. The equipment is tied to the balloon by

a 9 m cord. The sensor current is converted in a numerical value by a T-Max interface board which also manage the meteorologial parameters (PTU) and convert them into an audio frequencies shift keyed (AFSK) signal. This telemetry signal is received and demodulated by a 403-Mhz Fortier receiver. The AFSK signal is then converted to an RS232 signal with a modem and fed into a serial port of a PC computer.

Data processing

Data processing is performed in two steps, the first one uses a PC computer and the second one, an Unix machine. During the first step the data from telemetry are converted in geophysical data i.e. pressure, air temperature, relative humidity, boxes temperatures and ozone sensor current. The second step begins by filtering and elimination of wrong lines. The ozone partial pressure is calculated from the measured ECC current during this step. Corrections due to the background current and pump efficiency at lower pressures are calculated according to the standard guidelines of Ozone sondes users' manual (Vaisala Technical Manual - 1988). The height is calculated using hydrostatic equation. Any correction for radiation or ventilation is made.

Recent modifications/improvements

Ozonesondes from OHP were one of the different types tested during the last international intercomparison experiment (JOSIE, conducted in February 1996 at the Research Centre Jülich - Germany) managed by WMO GAW/GLONET. The results, published by Smit and al. in proceedings of XVIIIth Ozone Symposium at L'Aquila, show that the OHP ozonesondes exhibit a mean value for the total ozone normalization factor of 1.04 with a standard deviation of 0.04. During this experiment, the OHP team learnt about some points to improve the measurements. Particularly, since March 1996 the sensor cathodes used in OHP are filled with 3 cm3 for better results at stratospheric level and the related table of values for efficiency pump correction is used.

Recent activities

Typical activity for OHP site is to perform a launch once a week. Under normal weather condition (quasi-no wind) the launch time is 09h UT on wednesday.

Ozone sondes from OHP are also involved in specific campaigns. During winter 1996/97 seven sondes

were launched for the OSDOC/MATCH campaign.

From 1st to 18th July 1997 a NDSC Lidar intercomparison campaign at OHP

(referee: Geir O. Braathen) needed some O3 and PTU profiles using the balloon-borne sondes. Seven sondes were launched but unfortunately two of them did not work.

Data delivery

One of the results obtained during the JOSIE intercomparison was that data before 1996 needed a new calibration. Now, this correction is made and the data obtained are debugged from this bias. A data set was submitted to NDSC data base manager some months ago and it was agreed. So, the OHP team is now able to submit the data from 1991 to 1996 and the delivery will begin during the summer. When non special format is needed, the data are submitted in the OHP internal format. This was made for OHP Lidar intercomparison campaign (July 97) and for the OTA-SPARC trends studies (May-June 97).

Hilo and South Pole

Report submitted by: Samuel Oltmans

The two ozonesonde sites that NOAA/CMDL operates as part of the NDSC network are Hilo, Hawaii and South Pole, Antarctica. At Hilo weekly soundings have continued throughout the year. At South Pole weekly soundings are made except during the spring Antarctic stratosphere depletion season when soundings are done every 3 days. Ozonesonde data at Hilo from 1991-1996 have been submitted to the NDSC data base. Data from South Pole for 1986-1996 are undergoing final corrections to provide a homogeneous data set through this period. Data for Hilo for 1982-1991 have just been reprocessed and will be submitted by 20 August 1997.

Considerable work has been done characterizing ECC ozonesonde performance during the past year. Pump efficiency tests have been run on a large number of pumps and basically confirm the results reported last year that the correction for pump efficiency made using the technique developed by Bryan Johnson in our lab gives larger corrections than previously determined by Komhyr which are in the 1986 User's Manual or in his 1995 paper. The correction is approximately 10% larger at 7 hPa.

The new result is that we have done numerous tests with the concentration of the potassium iodide in the sensing solution of the ECC sensor and found that the ozone response is only weakly dependent on the KI concentration. Much more importantly the buffer plays a much larger role in the performance of the sensor than previously thought. Past changes in sensor response that were attributed to the KI concentration in fact came about because the buffer concentration was also changed. Much of the “over-sensitivity” to ozone that is seen in the 1% KI solution in the upper part of the ozone profile if the higher pump efficiency correction is used can be attributed to the deleterious effects of the buffer. Although there is a weak dependence on the pH of the solution in the sensing solution response it is very minor compared to the impact of the buffering chemicals. We plan to do much more work in this area but we are strongly convinced that a number of features of the ozonesonde sensor performance such as the long tail on the zero current when the ozone signal is removed are a result of the effects of the buffer. A good deal of work also needs to be done to determine how ozone profiles obtained using current practices can be improved based on our better knowledge of how the sensor actually performs.

Lauder

Report submitted by: Greg Bodeker and Andrew Matthews

Over the period 1 July 1996 to 30 June 1997, a total of 65 ozonesondes were flown from Lauder (169.68E, 45.04S), to an average altitude of 32.5 km, with one flight per week and an additional flight each week through the period October 3 to December 18, 1996. This brings the total number of ozonesonde flights made since 3 August 1986 to 767. Furthermore, the entire historical data base was revised to correct for errors that had been made in the data processing in the past. New data reduction algorithms were developed to aid identification of poor quality data in the historical data base and revised data for 1994, 1995 and 1996 were submitted to the NDSC archives.

A number improvements to the Lauder ozonesonde programme were implemented during the last year, viz.:

1) Previously, a linear least squares regression model was used to derive long-term trends in vertical ozone profiles above Lauder. By incorporating event function switches into the model to account for changes in ECC ozonesonde series and in data processing techniques, it was possible to identify poor quality or erroneous data in the historical data base. These poor quality data were examined more closely and, where necessary, the original data were recovered and reprocessed (primarily data from 1986 to 1989).

2) An algorithm was developed to calculate the volume of active solution that evaporates during an ozonesonde flight and the altitude at which the solution starts to boil. Since the ozonesonde does not actually measure the solution temperature, an ozonesonde flight containing an extra sensor for measuring the solution temperature was flown. It was found that the solution temperature is closely related to the internal pump temperature which is measured during a typical ozonesonde flight. Based on this relationship, it was then possible to estimate the quantity of evaporated active solution from the measured internal sonde temperature. Criteria were established based on evaporated solution amounts and boiling point altitudes to identify poor quality data in any flight.

3) Work has also been done on quantifying the systematic differences between the 4A, 5A and 1Z series ozonesonde that have been flown as part of the Lauder ozonesonde measurement programme. Seven ozonesondes were modified to include additional temperature sensors to better understand inter-sonde internal temperature differences which are believed to contribute to systematic differences in measured ozone partial pressures.

4) The concentration of the electrolyte solution used in the ozonesondes was changed from 1% to 0.5% following the suggestion of Dr. Walter Komhyr (EN-SCI) who manufactures the 1Z series ozonesondes. Tests at the U.S. National Institute of Standards and Technology have shown that when charged with the standard 1% KI ECC sensor cathode electrolyte, the sonde tends to over-estimate ozone by 5-8% in the region of the atmospheric ozone maximum. Following the change from 1% to 0.5% solution concentration, a campaign has been undertaken at Lauder to systematically quantify the differences between the 1% concentration and 0.5% concentration sondes. This campaign consisted of three dual ozonesonde flights on 29 October 1996, 11 March 1997 and 24 June 1997 where two ozonesondes, one with a 1% concentration cathode solution, and one with a 0.5% concentration cathode solution were flown on the same balloon. By comparing the results with simultaneous lidar ozone profile measurements, it was possible to both quantify the differences between the two sondes, and determine whether the change resulted in an improvement in sonde performance. Improvements in sonde accuracy were shown in all cases and this has been verified through interspersed sonde/lidar comparisons made throughout the year.

5) Previously, the 4A series ozonesondes had been processed assuming a background current that did not vary with altitude. Recent work, both at Lauder and by overseas research groups, has shown that this is probably not true and that the background current should be scaled according to the ambient pressure. All 4A series flights in the historical ozonesonde data base were reprocessed accordingly.

6) New pump efficiency correction curves for the 1Z series ozonesondes have been supplied by EN-SCI and this change has been incorporated into the data processing. The changes between the old and the new data are generally very small but were included to ensure the best possible quality of the data set.

7) The installation of a pressure sensor at the Lauder automatic weather station has made it possible to apply pressure corrections to the sonde pressure sensors which previously introduced significant error into the geopotential height calculation at high altitudes.

McMurdo

Submitted by: Terry Deshler

During 1996, the University of Wyoming released 38 ozonesondes at McMurdo Station, Antarctica, between 21 August and 31 October. The 1994 and 1995 ozone measurements at McMurdo were summarized in Nardi et al. (1997), and the 1986 - 1995 data were used in an investigation of the correlation between Pinatubo aerosol and ozone loss in the lower stratosphere (Deshler et al., 1996). The 1986 - 1988 data have been prepared and included in the NDSC data base.

Our latest Antarctic proposal has been approved by the National Science Foundation to continue these measurements for another three years; however, due to funding cuts the frequency of ozonesonde measurements has been reduced to once every three days during the August to October period. The field team left

on 16 August to conduct the 1997 measurements.

The optimum concentration of the cathode cell dilute KI solution for ozonesondes has been recently examined, and it has been suggested that a cathode KI concentration of 0.5% instead of 1% leads to a better overall agreement in total column ozone when compared to lidar and microwave instruments. We conducted three double-ozonesonde flights in Antarctica during September and October 1996 to compare the relative performance of the 1% KI and the 0.5% KI cathode solutions. Comparisons of the integrated ozone column from these measurements with a collocated Dobson Spectrometer give an averaged ratio (sonde/spectrometer) of 1.09 for the 1% solution and 0.97 for the 0.5% solution. The largest differences between the solutions were observed above 15 km, which suggests that the solution concentration has a minor effect on tropospheric measurements. We will carry out further tests in Antarctica during the 1997 season, but we will maintain a 1% KI solution for the standard measurements.

Deshler, T., B. J. Johnson, D. J. Hofmann, and B. Nardi, Correlations between ozone loss and volcanic aerosol at altitudes below 14 km over McMurdo Station, Antarctica, Geophys. Res. Lett., 21, 2931- 2934, 1996.

Nardi, B., T. Deshler, M. E. Hervig, and L. Oolman, Ozone measurements over McMurdo Station, Antarctica, during spring 1994 and 1995, Geophys. Res. Lett., 22, 285-288, 1997.

Dumont d'Urville

Submitted by: Florence Goutail

Regular ECC ozone sondes have started at DDU in 1990. For financial reasons the number of soundings has been variable from one year to the other. It has been kept around 25 sondes per year during the last years and will probably be reduced to 15-20 sondes /year in the future.

Quality:

The maximum altitude reached by the sondes is limited specially in winter by very cold temperatures leading to balloon failures (this has not been completely solved with totex balloons) and fast winds leading to telemetry lost (this has not been solved with a tracking antenna). In addition, since the team is changed every year, the performances may vary from one year to another. The statistics are the following

Table 2: Number of sondes at Dumont d'Urville

Year	ECC/year	Reaching 25 Km
1990	20	9
1991	28	18
1992	40	27
1993	32	22
1994	34	24
1995	25	13
1996	23	12
1997	10+	6+

Schedule:

There is one flight planed per month reinforced during the winter-spring period. For example, in 1996, 2 flights in july, 3 in august, 5 in september, 3 in october and 3 in november. The decision of additional ascent is taken by the local team looking at the SAOZ total ozone measurements indicative of the location of the station compared to the vortex. As an example on 6 and 16 August 1997 (figure attached) SAOZ was measuring on the morning 254 DU and 384 DU respectively.

Future Improvements

In order to improve the top altitude reached by the sondes in summer and autumn use of Kaysam 2000 g balloons which have a very good behaviour at warm temperature and may reach 38 km.

Data Base: Present status

All data are transmitted in near-real time through modem in ASCII format (without header) to the Archive data base of Service d'Aeronomie of CNRS. The data are then validated. The data will be encapsulated in Nasa Ames format, a test file will be send in October 1997, and the whole set of data will be installed on NDSC data base before the end of this year. The future soundings will be then introduced on the data base every three months.

Status on data delivery

Below follows a table showing the number of ozonesonde files submitted to the NDSC data base as of 21 August 1997.

Table 3: Number of submitted sondes

Station	Number of sondes in database Nov. 1996	Number of sondes in database Aug. 1997
Ny-Ålesund	532	637
Thule	18	18
Eureka	0	105
OHP	0	0
Mauna Loa (Hilo)	0	0
Lauder	111	209
Dumont d’Urville	0	0
McMurdo	0	76
South Pole	0	0

Quality control

Submitted by: Esko Kyrö

Within the EU project OSDOC there is an activity on quality control. This is carried out as a cooperation between FMI, NILU and Univ. of Wales. The work described below has been carried out by FMI.

We has now finished our own QC inspection of the OSDOC ozone profiles at zardoz. What is still remaining is the exchange of experiences with the analysis groups (and of course check outs in our own results). At least AWI and DMI (Bjørn sent a nice draft manuscript) has been using OSDOC data and I would first like to send our QC report to you and then of course I would like to hear if there are QC-related stuff which you would like to add from your data analysis exercise.

Here are our results:

REMARK 1: ANALYSIS IS BASED ON THE FILES AT ZARDOZ IN THE END OF JUNE, 1997
REMARK 2: THE ESSENTIAL INFORMATION IS GATHERED IN THE TWO self-explanatory EXCEL TABLES
"OSDOCSUM.xls" AND "OSDOCQC.xls" WHICH ARE ATTACHED.

"OSDOCSUM.xls"

This table contains the summary of our QC analysis. The columns are self-explanatory (I think). The interesting detail is the behaviour of correction coefficient at different stations. The correction coefficient is defined here as a ratio:

EP-TOMS TOZ/Sonde TOZ

We have used TOMS because we get better statistics from it. We also have checked Brewer data from the two "Pilot stations" Uccle (middle latitude) and Sodankylä (high latitude). The correction coefficient (Brewer/Sonde) agrees within 1% with the (TOMS/Sonde). We believe that the results in figure "Ratio Ept-TOMS/Sonde at OSDOC stations" in "OSDOCSUM.xls" is reasonably representative except perhaps at high polar stations with only a few soundings made (you can check yourself). The Adeos-TOMS TOZ are 1% or so higher than EP-TOMS but this is again only a bias and general behaviour is the same. Both are calculated but EP-TOMS results are only plotted.

NOTE: In the file-headers at ZARDOZ the correction coefficient is often reciprocal to above i.e."the error" instead of "the correction". Among other things we will have to ask PI's to homogenize this part of the header.

Conclusions

Generally we can be very happy with the performance of the OSDOC network. For 26 stations out of 36 total the AVERAGE corr.coeff. is between 0.95 AND 1.05 and only two stations: Bear Island and Resolute were outside the (0.9 to 1.1) range. For Resolute the sample was small, only 5 soundings, so we cannot be sure there. Most of the other Canadian stations had the corr.coeffs. very close to unity. By the way, the statement in the Canadian header that the correction coefficients are already applied in the files is not true.

Bear Island had only one sounding good/high enough for corr.coef. calculation. It was a pity that the station submitted the data afterwards, in end of April, giving us no possibility to interfere in real time. There is obviously an misunderstanding of the amount of sensing solution and it is possible that the drop in Bear Island O3 profiles higher up comes from running out of the sensing solution. There was a lot of "reject flags" in B-I data but some data can be used, with care, usually at lower Theta levels.

In the figure we have arranged the stations in ascending order with the growing AVERAGE corr.coefficient. There seem to be a danger of a systematic bias between stations at the opposite ends of this plot. A group of stations(Resolute,Camborre, Keflavik, Yakutsk, Gardermoen) seem to be systematically on the low side whereas another group (Uccle, De Bild, and perhaps Søndre Strømfjord and Hohenpeissenberg) seem to be in the high side in their corr. coeff. values. The two groups differ by 10-15% from each other. This could affect the mixing ratio analysis of the match-pairs if there will be a lot of pairs in the opposite groups.

PV-theta analysis

Total ozone is good QC measure but it is not available in polar night conditions. Another good QC tool, which applies also for the polar night soundings, is the consistency of the mixing ratios of the whole network in PV-Theta coordinate system within a short time span (a few days only at high PV!). The "outliers can be easily detected there. By "an outlier" we mean a gross deviation, more than 30%, from the average.

It turned out that most of the "outliers" represented a laminae cases and were not flagged because they do not represent a quality problem but an atmospheric signal. Only handful of soundings could be flagged as “reject” by this method. There was more “warning flags” though as can be seen in “OSDOCQC.xls”

Table “OSDOCQC.xls”

This table contains a detailed QC report. We flagged altogether 122 soundings from which by “reject flag” only 25. However, there were more than 25 useless soundings for OSDOC but we did not want to remove short soundings only because of their shortness. Someone may want to use our data some day in tropospheric ozone analysis. If the sounding reached 500 K we did not flag it at all.

The same apply with the soundings with deficient O3 data in higher layers. We flagged it with comments unless the data deficiency was above 800 K level.(I think everyone knows to be careful with the highest levels anyway.)

The Table “OSDOCQC.xls” is also self-explanatory but a few comments may be due.

1. In some cases “too low O3 above 450 K (from PV/Theta anal.)” leads to rejection but in most cases only to warnings. For the rejected soundings the deficiency is so large that it puts the whole sounding in “suspicious” category. Generally I would hesitate to use “warning category” soundings either but since the data at lower levels is not in contradiction with the rest of the network we do not want to remove them from the data base.

2. We gave general warning about often low TOZ in Uccle and De Bild profiles (often C > 1.1). Also, a profile integration gives higher TOZ than in average in Camborne, Gardermoen, Reykjavik, and perhaps also in Resolute and Yakutsk. This maybe nothing dangerous but worth knowing anyway.