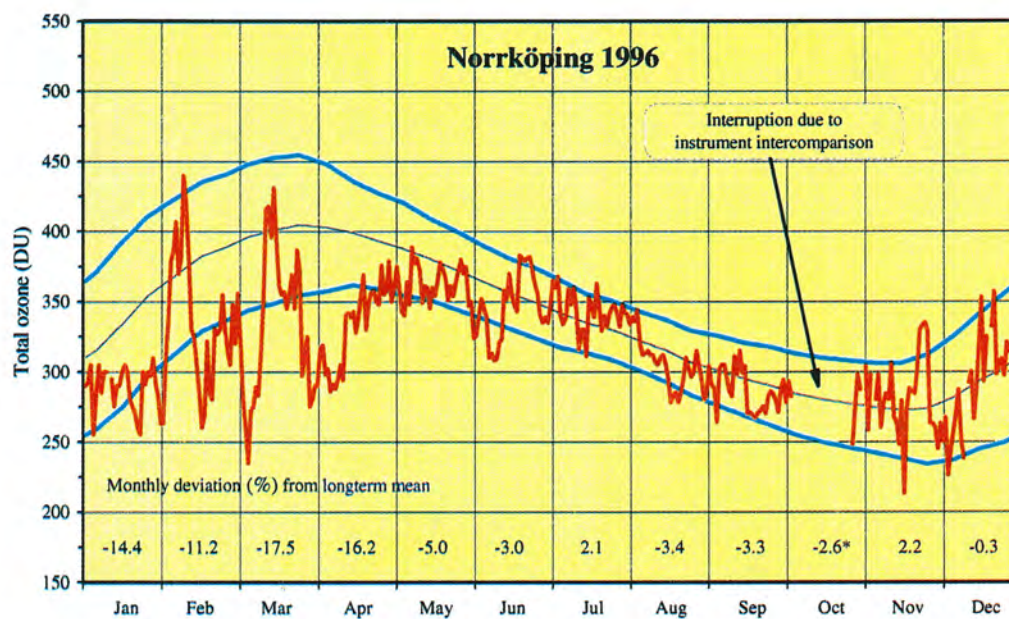




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SUMMARY

This report summarises the quality control, quality assurance and measurements of total ozone at Norrköping and Vindeln during the period 1994-1996. To ensure the quality and link the observations closely to the other ozone data participation in intercomparisons and international campaigns are noted. The Dobson #30 instrument was at Arosa in 1995 and showed good agreement with the reference Dobson instrument. The Brewer #006 was compared to the travelling reference Brewer #017 in 1996. Major changes in the measurements and instruments are discussed. In particular the introduction of the new instrument Brewer #128, which was compared to Brewer #017 twice in 1996. The first intercomparison pointed on the need of a change of the calibration whilst the second one was in agreement with the previous one. The new instrument seem to be more sensitive to the environment than the old one is. During the campaign at Izaña it was noted that the photomultiplier of this instrument went saturated measuring in the UV-A. Fortunately, this will not affect the measurements of the total ozone.

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1 INTRODUCTION

The main goal of the project is to perform regular observations (monitoring) of total ozone, i.e. the content of ozone in a vertical column throughout the atmosphere. The Swedish Environmental Protection Agency (NV) has been funding this project since 1987. In 1988 regular measurements started in Norrköping at SMHI and in 1991 at Vindeln Experimental Forest Station. The measurements are reported by Josefsson (1989, 1990, 1991, 1992a, 1994, 1995 and 1996). These measurements will be used for studies of the variations and possible trends of the amount of total ozone as well as for studies of modelled and measured ultraviolet solar radiation. Daily data are available on request from SMHI or by internet <http://www.smhi.se>. Data are also delivered to the World Ozone Data Centre (WO₃DC) and the stations are included in the Global Ozone Observing System (GO₃OS). In the winter and spring data from Norrköping are sent to WMO GO₃OS ozone mapping centre at Thessaloniki in Greece where daily maps are produced. These near real-time maps are very valuable and may be compared with TOVS (TIROS Operational Vertical Sounder) and TOMS (Total Ozone Mapping Spectrometer). Although the network is sparse in some areas the maps give a good overview of the ozone situation in the northern hemisphere.

Table 2.1 The locations of the measurements of total ozone in Sweden.

STATION	LATITUDE	LONGITUDE	HEIGHT (a.s.l.)	INSTRUMENT	PERIOD
UPPSALA	59.87°N	17.63°E	15 m	Dobson #030	1951-66
NORRKÖPING	58.58°N	16.15°E	43 m	Brewer #006 Brewer #128	1983-96 1996-
VINDELN	64.24°N	19.77°E	225 m	Dobson #030	1991- 1996-

Some technical events of importance have occurred during this long period. At the end of July and early August of 1995 the Dobson #030 participated in the tenth WMO international intercomparison of Dobson spectrophotometers at Arosa. The result was very good. The highest difference against the standard, Dobson #065, was 0.3% in total ozone for a μ -range of 1.15 to 3.2, WMO (1996).

A new instrument, Brewer #128, was purchased to increase the frequency of observations at Vindeln and also to make it possible to measure UV-spectra in the range 288-363 nm. It was delivered to Norrköping in late December of 1995. After preliminary tests it was operated in parallel to Brewer #006 during spring of 1996. A difference in the total ozone as measured by the two instruments was detected. The new instrument also seems to be effected by the temperature to a greater extent than the older one. Another disappointing effect is that it was less sensitive at shorter wavelengths than the older instrument. This affects the ability to take accurate measurements at low solar elevations. In late May 1996 the Brewers were calibrated versus the travelling standard Brewer #017 in Norrköping. No significant discrepancy, >1%, in the Brewer #006 total ozone was detected. But the calibration of Brewer #128 had to be altered. The change was in accordance with the results of the parallel operation between the two Brewers during spring.

Due to the better temperature and solar elevation characteristics of Brewer #006 it was decided to install that instrument at Vindeln. From July 1996 it has been monitoring in parallel with the Dobson #030. The staff at Vindeln had made good preparations which made the installation

easy. A solid platform had been built and a telephone line had been installed. Now, the instrument can be operated from Norrköping via tele-modem and data are available at once.

In October 1996 the Brewer #128 participated in the Nordic Ozone and UV-groups Intercomparison at Izaña (NOGIC96). There was a concurrent ozone calibration done versus Brewer #017 that confirmed the calibration in May. However, a problem with saturation of the photomultiplier was detected. This did not affect the measurements of total ozone only the spectral measurements at high levels of irradiance. There was no saturation noted for wavelengths shorter than 325 nm. This problem has been solved in late winter of 1997.

2 TESTS AND MAINTENANCE

2.1 Brewer #006

Several tests are performed regularly each day to ensure that a Brewer instrument is in good condition. To simplify the testing two lamps are available inside the case of the instrument. The observations of total ozone are intermittently changed to mercury lamp tests to control the wavelength setting. There is a slow variation of the temperature of the instrument that may affect the wavelength setting. A mercury spectral line is scanned and compared with a corresponding tabulated one. In this way the wavelength setting is checked and if needed adjusted several times a day. The accuracy of the wavelength setting is approximately 0.01 nm and the precision is better than 0.005 nm.

A halogen lamp, in this context also called standard lamp, is used as a reference of the relative sensitivity. Two values from this test, corresponding to the values of ozone (R6) and sulphur dioxide (R5), are recorded daily and compared with the same values from previous tests. The plot in Figure 2.1.1 summarise the variation of these values for the period. These values should be within ± 30 units of the long-term averages. Large changes may occur when the lamp is exchanged, moved, the lamp house is opened or when the optics are cleaned. Unexplained changes should imply that a real change of the sensitivity has occurred and a need of a new calibration. Normally, the values scatter some 10 units, which is within the level of tolerance. Probable causes of this variation are dependence on temperature, instability of the lamp, ageing of the lamp and of course a true change of the relative sensitivity of the instrument. The observed sudden jumps in the R5 and R6 values during this period are connected with certain events and can thus be explained. It should also be noted that these jumps are within the level of tolerance. In particular, the stability of the R6-value is important. Because this number is related to the measurement of total ozone.

For Brewer #006 there are two sudden jumps in this period. The one in early 1995 is probably connected with the exchange of the desiccant inside the instrument which was opened and exposed to cold air. The other one in early 1996 was expected, because at this moment the fore optics as well as the lamp house was removed. Also some of the optical parts, lenses and filters, were cleaned.

The uncertainty of the sulphur dioxide measurements (± 5 DU) is roughly of the same magnitude as the atmospheric column amount at our measuring sites, (0-5 DU). However, at special occasions with enhanced levels, >5 DU, the increase is detectable. This may occur after major volcanic eruptions or when severely polluted air is advected into our region.

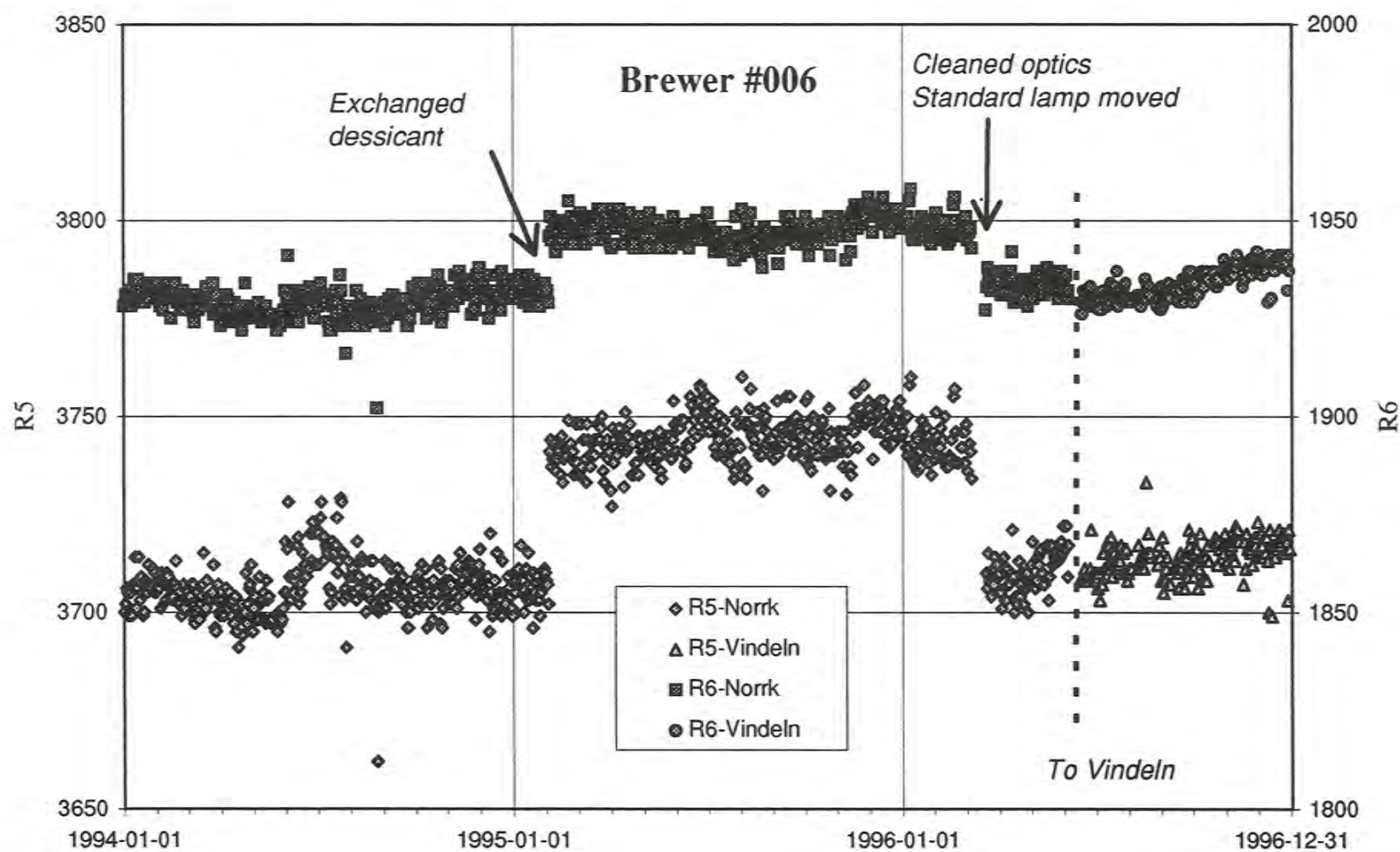


Figure 2.1 Daily standard lamp test values, for Brewer#006 and the period 1994, 1995 and 1996. They are used as indicators of the stability of the instrument. The level of tolerance is ± 30 units. The R5-value corresponds to the sulphur dioxide and the R6-value to the total ozone.

The standard lamp is also used for some other tests. One is the Run and Stop test. It is done to check the performance of the slit mask. In normal operation the slit mask is moving (Run) and exposes the exit slits one by one. One cycle of measurement is done in about one second. The movement of the slit mask has to be co-ordinated with the reading of the photomultiplier. Otherwise the slit will not be fully exposed when the measurement at a specific wavelength is taken. This co-ordination is controlled by an appropriate delay of the slit mask positioned in front of the exit slits. Most sensitive to changes in the shutter performance is the dark position, where the dark count of the photomultiplier is measured. The measured dark count is normally of the order of a few pulses if the temperature of the instrument is below +20°C. Above +30°C it increases quite rapidly with temperature. The program corrects for this effect and compared to measured number of counts it is normally almost negligible. But as an indicator of the slit mask performance it can be regarded as very sensitive, since even a small change in the dark count changes the ratio. The last time the Run and Stop test indicated a problem for Brewer #006 was in late 1991.

Another test checks and monitors the dead time of the photomultiplier. It is a measure of the time it takes for the photomultiplier to respond to a signal. A pre-set value of the dead time is used to correct the measured counts. Also this test has shown no indication of problem during this period. Once a day after sunset the Run and Stop test and the Dead Time test are done. The instrument can also be tested by varying the delay time of the slit mask to check the setting of this parameter. It is done about once a year to confirm that the used value does not have to be altered. At the calibration in late May 1996 it was noted that the low voltage setting of the instrument was slightly low. Therefore it was adjusted up to 5 V.

The desiccants of the instrument have to be checked and replaced now and then. An indicator of the state of the desiccant is possible to view through an inspection window. Anyhow, to avoid problems from humidity in the instrument, the desiccant is regularly exchanged once a month, if the weather permits.

2.2 Brewer #128

The principles of testing the performance of a Brewer is mentioned in the previous section and will not be repeated here. Although, the calibration of total ozone was off-set for Brewer#128, most test values indicates a good performance during 1996.

The R5 and R6 values for Brewer #128 is roughly one third in magnitude compared to the corresponding values of #006. The graphs have the same resolution on the y-axis whilst the time period only covers one year. The sudden jumps for this instrument are smaller. The first two ones in February and late May are caused by changing the constants of the instrument. The third one is more delicate to relate to a specific event. It seems to have started in September prior to the Izaña intercomparison. The instrument was calibrated, shipped and used for special measurements a number of times during this period. Probably there has been a number of small changes that have added up. The overall spectral responsivity has decreased about 4% as measured by using irradiance calibrated lamps. This is indicating that there may be attenuating deposits on the optics or a decrease in the sensitivity of the photomultiplier.

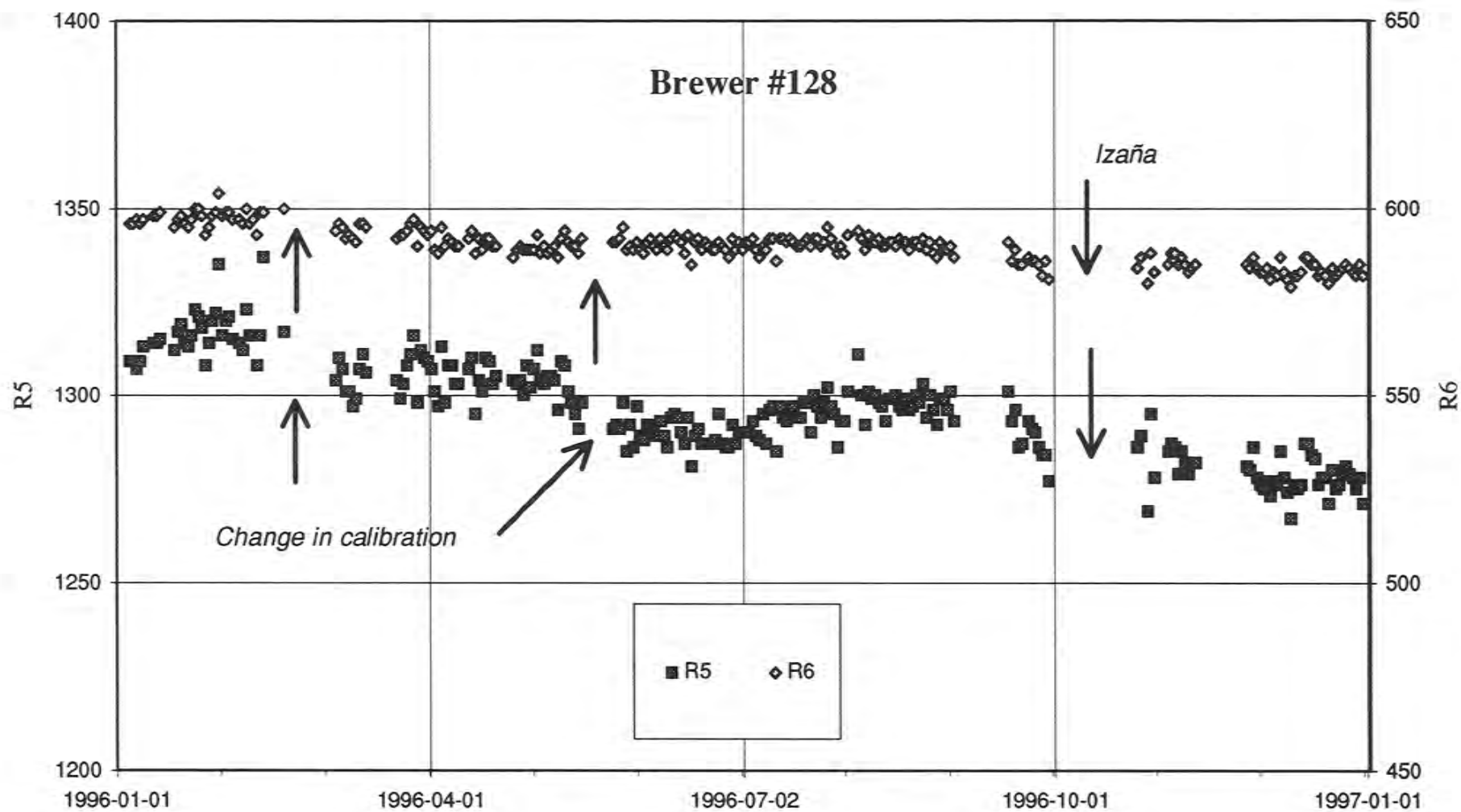


Figure 2.2 Daily standard lamp test values, for Brewer#128 during 1996. They are used as an indicator of the stability of the instrument. The level of tolerance is ± 30 units. The R5-values corresponds to the sulphur dioxide and the R6-values to the total ozone.

2.3 Dobson #030

The Dobson instrument has now been in routine operation at Vindeln since 1991. The low sun during winter time prevents accurate measurements. Once a month measurements using the full-moon may be taken. However, cloudy weather often prevents these occasions. Starting in February focused sun-measurements are done using the CD-wavelength pair. The fundamental AD-wavelength pair is used as soon as possible and most of the observations are recorded using this type of observation. In 1996 there were a total of 255 measurements; 89 AD Direct sun and about 80 AD Zenith blue sky and almost as many AD zenith cloudy sky.

As for the Brewer the performance of the Dobson spectrophotometer is checked with lamps. A mercury lamp is used to check the wavelength setting and a set of standard lamps to check the stability. Due to the manual procedure these tests are only performed once a month. Compilations of the calibrations are shown in Table 2.3.1 and Figure 2.3.1. Dobson ozone observations are made on wavelength pairs by rotating two levers, called Q1 and Q2, of the instrument. The settings of the levers varies with temperature and air pressure. Therefore correcting tables, Q-tables, are established.

The lamp-test values have been within an acceptable range of variation. The tests are performed on a regular basis and the instrument has been working well without any notable problems. The results of the lamp tests have shown that the correction for the C'-wavelength varies slightly more than for the other ones. This is in accordance with the results of previous years. As this wavelength pair is not used for the observations with this instrument the result is only logged. The calibration lamp 30Q1 is used once a month. Lamp 30Q2 has been used once in 1996. In Table 2.3.1 the lamp calibrations are summarised.

Table 2.3 Lamp tests of Dobson #030 using lamp 30Q1. Noted corrections for each wavelength-pair. Also included are the discrepancies for the Hg-lamp.

Date	A	C	C'	D	Hg
96-01-26	-0.3	-0.3	0.7	-0.2	0.21
96-02-28	-0.1	-0.1	1.0	-0.1	0.05
96-04-01	-0.3	-0.4	0.5	-0.3	-0.14
96-04-29	-0.3	-0.5	0.5	-0.4	-0.05
96-06-03	0.6	0.5	0.8	0.6	0.19
96-06-28	-0.2	-0.3	0.8	-0.3	0.14
96-08-03	-0.4	-0.4	0.5	-0.3	0.08
96-08-30	-0.8	-0.7	0.5	-0.6	0.26
96-09-28	-0.5	-0.5	1.0	-0.4	0.10
96-11-02	0.1	0.2	-0.1	0.2	-0.18
96-11-27	0.1	0.2	-0.1	0.2	0.00
96-12-25	0.1	0.2	0.0	0.2	0.04

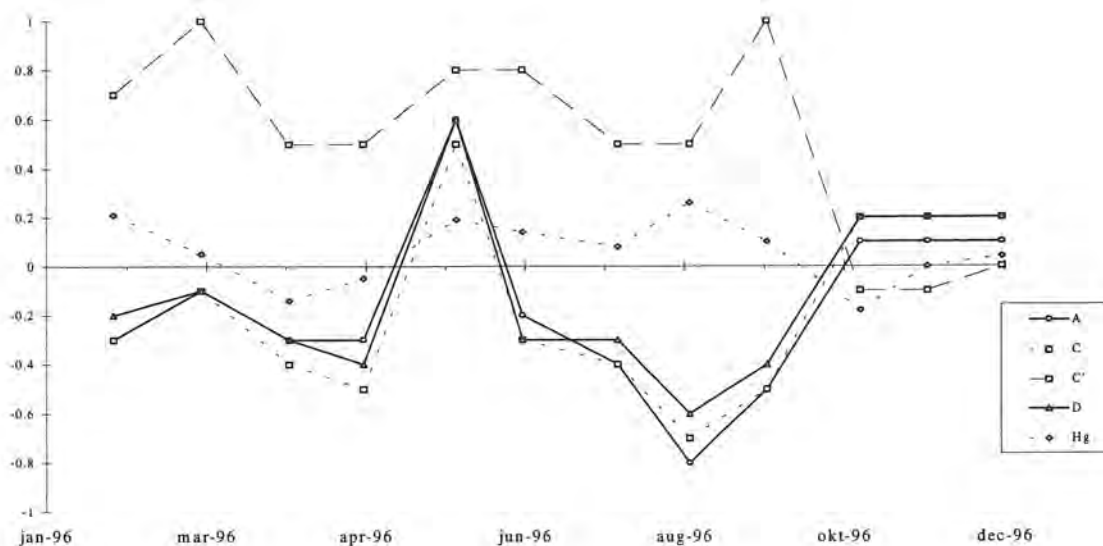


Figure 2.3 Lamp tests of Dobson #030 using lamp 30Q1 for each wavelength-pair. Also included are the discrepancies for the Hg-lamp.

3 RESULTS

3.1 Measurements

The instruments and the methods of measurement are described in earlier yearly reports, e.g. Josefsson (1994). The preferable method of measuring total ozone is to use the sun as light source and to perform a direct sun observation, ds. This type of observation is also used when comparing (calibrating) a specific instrument versus a reference. Other types of observations are focused sun and focused moon observations. During cloudy conditions the radiance of the zenith sky is observed, which is called zenith sky observation, zs. Normally, this is a less accurate method and therefore these observations are only used for days when no other types of observations are available. In this case total ozone is derived from empirical relationships between long-term quasi-simultaneous observations of direct sun and zenith sky. Such a relationship has to be established for each station. The method is dependent of solar elevation, amount of total ozone, amount of aerosol as well as the cloud optical depth and the height distributions of these variables.

Data of total ozone in this report refers to the so called Bass and Paur Scale. Before the 1st of January 1992 total ozone values were referring to the so called Vigroux scale that were adopted in conjunction with the IGY (International Geophysical Year) 1st of July 1957. Pre IGY data refer to older absorption coefficients. Changing from Vigroux to Bass-Paur there was a change of a few percent in the total ozone, WODC (1996).

All types of data recorded by the Brewer instrument are primarily stored on the hard disk of the computer. Copies are done regularly. The data are sent to a Brewer ozone data bank at the Atmospheric Environment Service (AES) in Canada. The Finnish Meteorological Institute operates a data base since early 1994 as a co-operation effort within the Nordic Ozone Group (NOG). The data base is supposed to be updated once a month with the possibility of each contributor to have access to the whole data-set.

Daily values of total ozone are stored on the main-frame computer of SMHI. These values are manually checked and corrected. They are selected to represent the amount of total ozone at noon, i.e. at 11 UTC. If it was impossible to find a value measured close to that time the most accurate value of that day was selected and the nearest full hour is given, in UTC. A cloudy day may for instance be represented by a focused moon observation taken in the night. This data base is plotted in Figure 3.1.3 and it is also given in Appendix 1.

Total ozone values recorded by the Dobson instrument at Vindeln are sent to SMHI after the end of each month. The direct sun, focused sun and zenith blue observations are filled into a standard form and then sent to WODC (World Ozone Data Centre) in Canada. The zenith cloud observations are stored until a better empirical relation is available. The raw data as well as processed data are stored at Vindeln and daily values of total ozone are stored in the main-frame computer of SMHI and they are also submitted to the NOG data base. Since July 1996 the Brewer #006 is operated along with the Dobson #030. The parallel record will be used to ensure that no significant inhomogeneities will occur due to the shift in instrument.

When selecting a value that is representative of a day the priority for the Brewer observations is normally:

- Direct sun $\mu < 3$, no clouds interfering
- Direct sun $3 < \mu < 4$ or disturbing clouds
- Focused sun
- Focused moon
- Zenith sky $\mu < 4$

where μ is the relative optical path length through the layer of ozone. As solar radiation traverses the atmosphere it is attenuated by its constituents, e.g. molecules and aerosols. The μ -value represents the relative abundance of ozone along the path of radiation compared to that of a vertical column with the same cross section.

Observational results from Uppsala, (Rindert, 1976) are also found in Figures 3.1.3 to 3.1.6. The average mean values for 'ten-day' periods for the period, May 1951 - July 1966 are connected by a solid line representing the average yearly variation. For each 'ten-day' period a smoothed value of the standard deviation for daily values have been estimated. These values have been connected with thin lines to represent the typical range of variation of daily values.

Daily total ozone Norrköping 1994 and normal range Uppsala 1951-1966

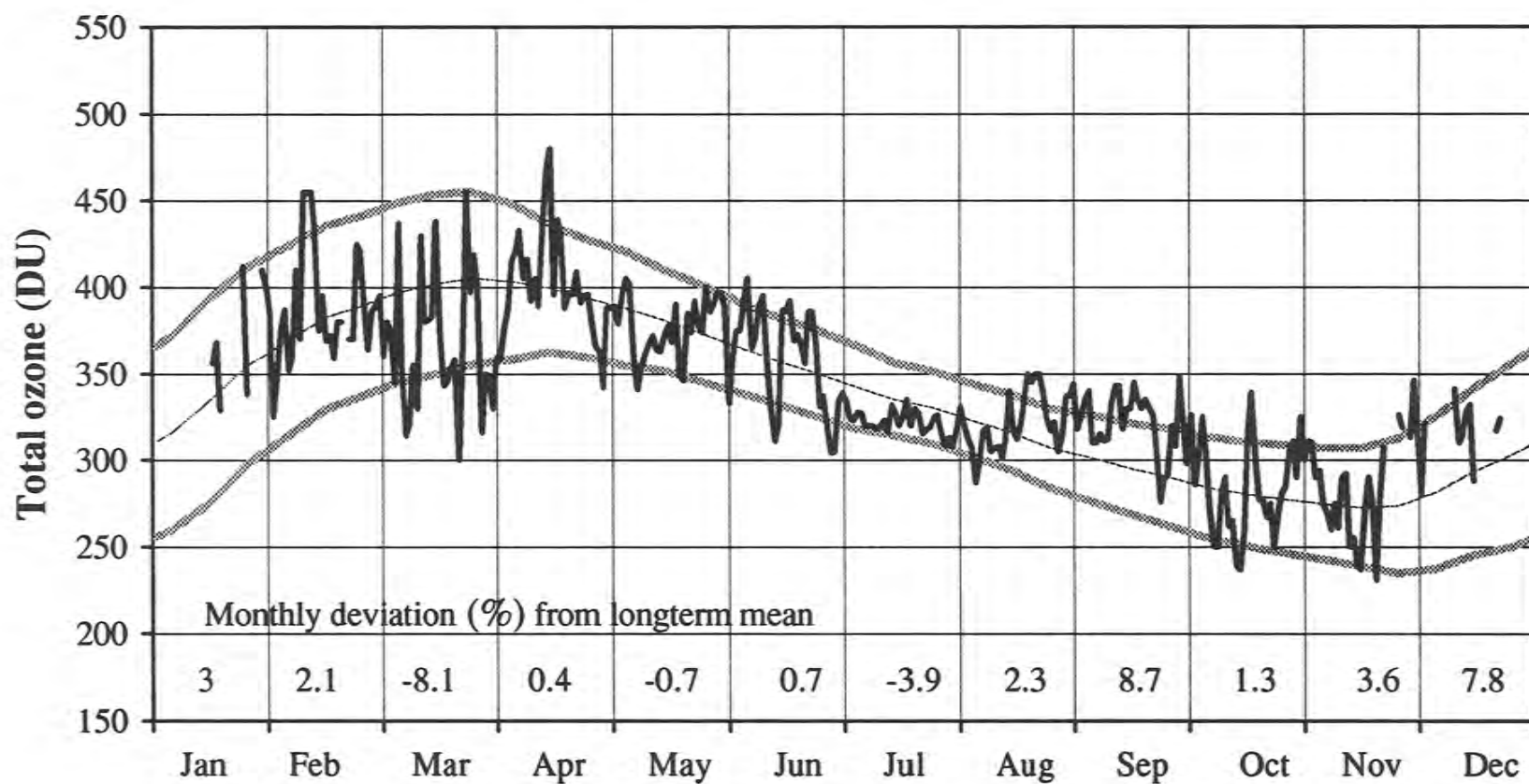


Figure 3.1.1 Daily 'noon' values of total ozone recorded by Brewer #006 at Norrköping in 1994. Long-term mean, standard deviations and extremes are from Uppsala 1951-1966. The values at the bottom are the monthly deviations (percent) from the long-term monthly means if there are more than five observations. All data refer to the Bass-Paur Scale.

Daily total ozone Norrköping 1995 and normal range Uppsala 1951-1966

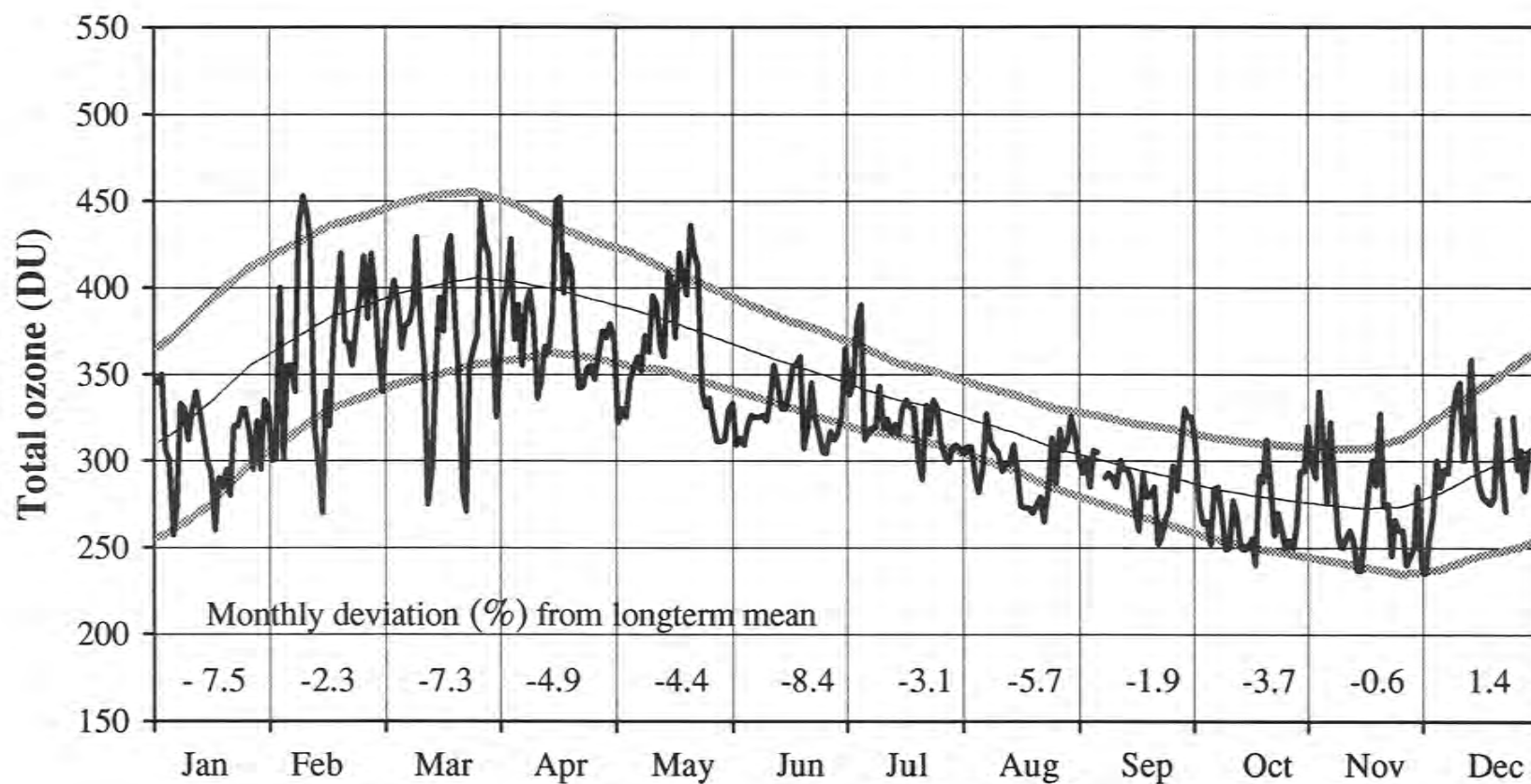


Figure 3.1.2 Daily 'noon' values of total ozone recorded by Brewer #006 at Norrköping in 1995. Long-term mean, standard deviations and extremes are from Uppsala 1951-1966. The values at the bottom are the monthly deviations (percent) from the long-term monthly means if there are more than five observations. All data refer to the Bass-Paur Scale.

Daily total ozone Norrköping 1996 and normal range Uppsala 1951-1966

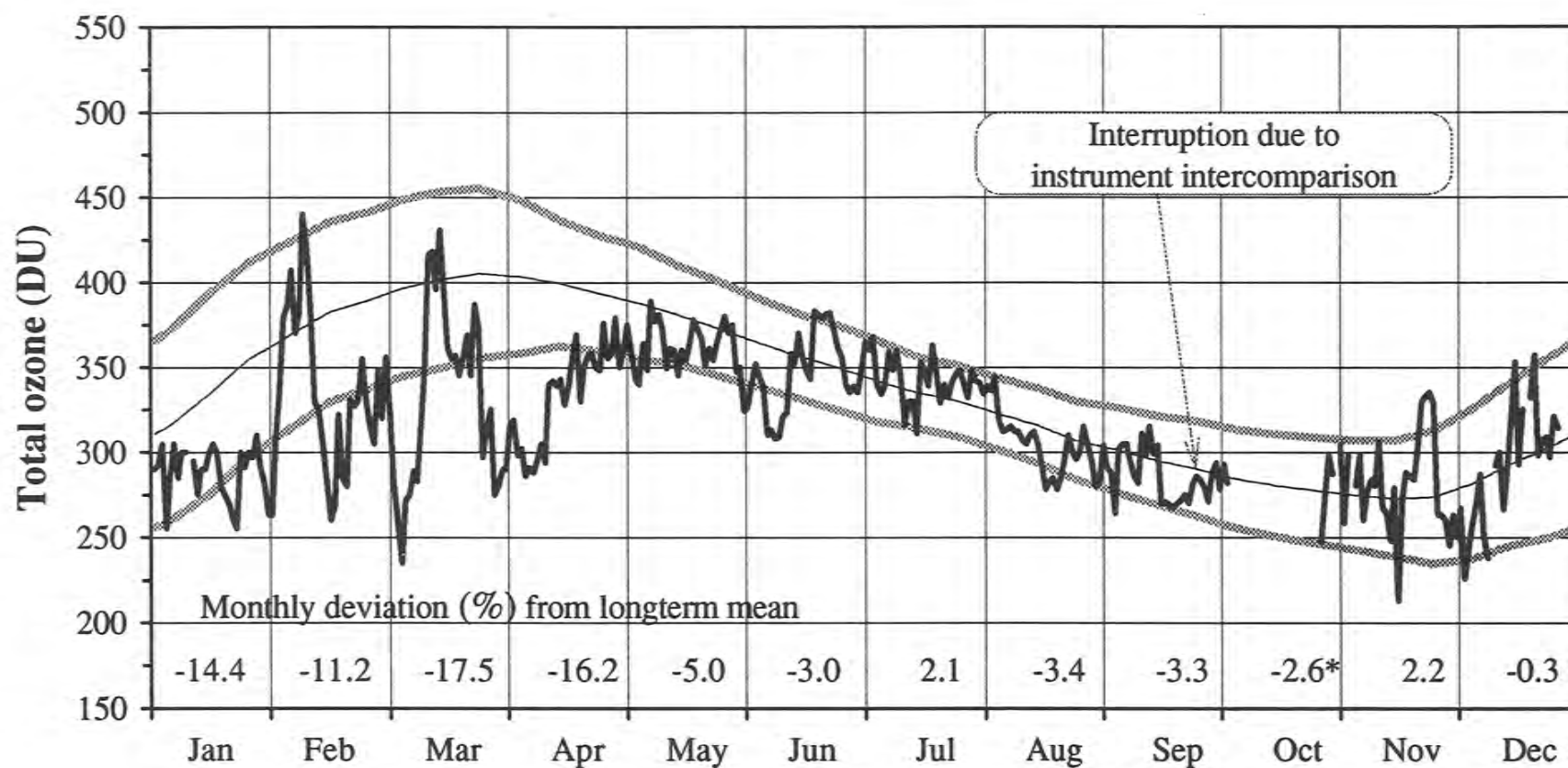


Figure 3.1.3 Daily 'noon' values of total ozone recorded by Brewer #006 and Brewer #128 at Norrköping in 1996. Long-term mean, standard deviations and extremes are from Uppsala 1951-1966. The values at the bottom are the monthly deviations (percent) from the long-term monthly means if there are more than five observations. All data refer to the Bass-Paur Scale.

Daily total ozone Vindeln 1994
Dobson #30
normal range Uppsala 1951-1966

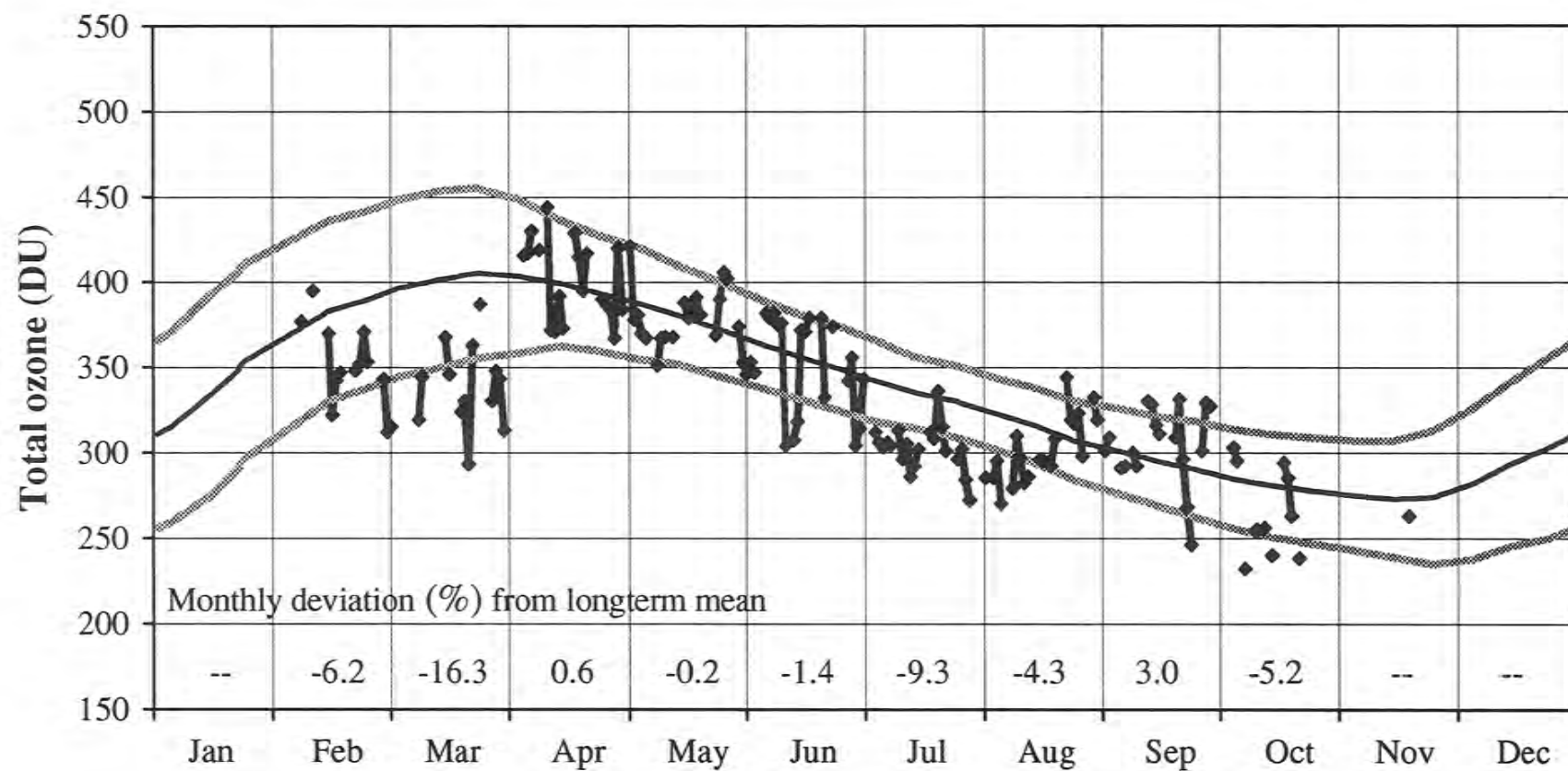


Figure 3.1.4 Daily values of total ozone recorded by Dobson #030 at Vindeln in 1994. Long-term mean, standard deviations and extremes are from Uppsala 1951-1966. The values at the bottom are the monthly deviations (percent) from the long-term monthly means if there are more than five observations. All data refer to the Bass-Paur Scale.

Daily total ozone Vindeln 1995
Dobson #30
normal range Uppsala 1951-1966

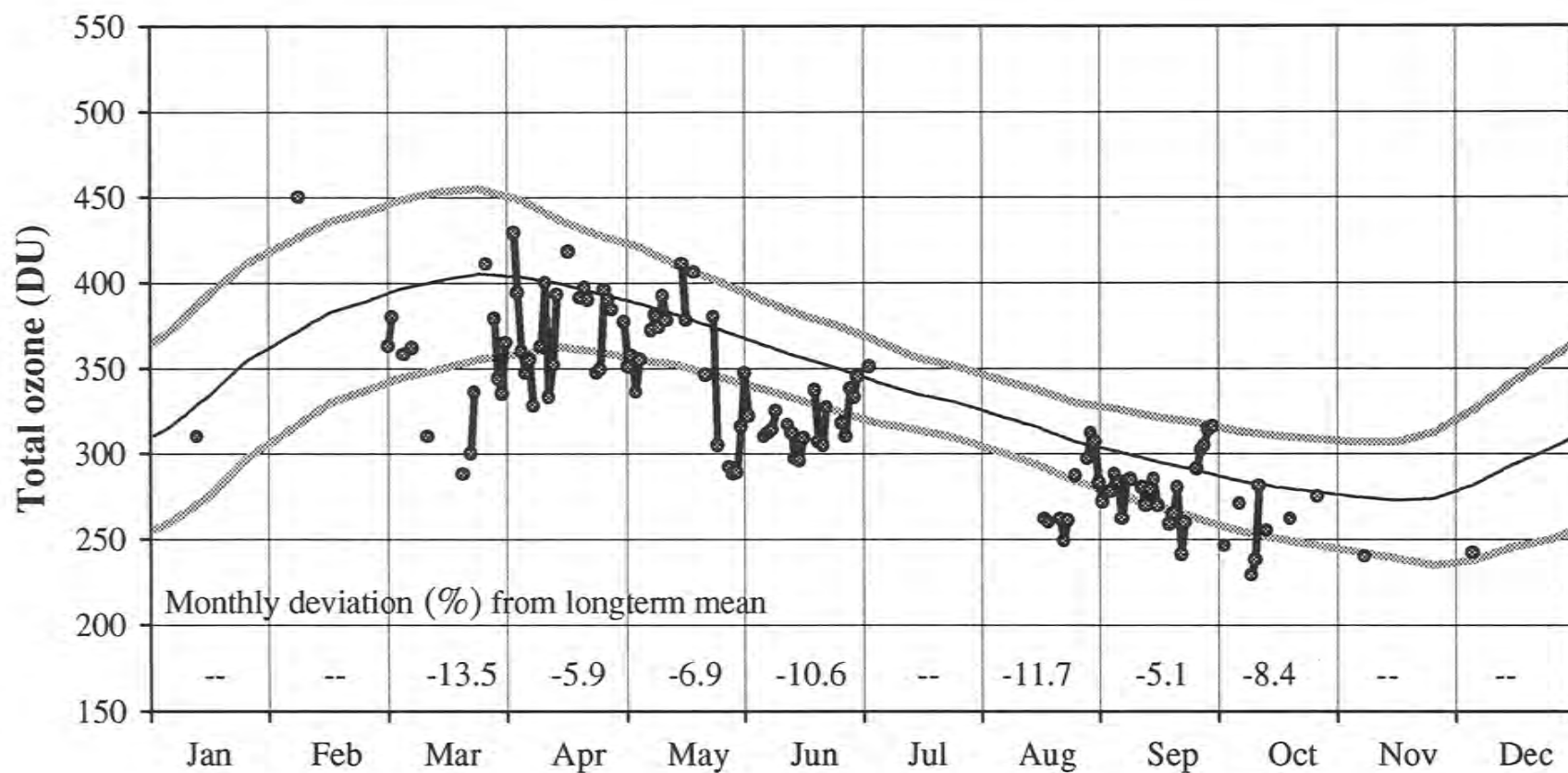


Figure 3.1.5 Daily values of total ozone recorded by Dobson #030 at Vindeln in 1995. Long-term mean, standard deviations and extremes are from Uppsala 1951-1966. The values at the bottom are the monthly deviations (percent) from the long-term monthly means if there are more than five observations. All data refer to the Bass-Paur Scale.

Daily total ozone Vindeln 1996
Dobson #30 and Brewer #006
normal range Uppsala 1951-1966

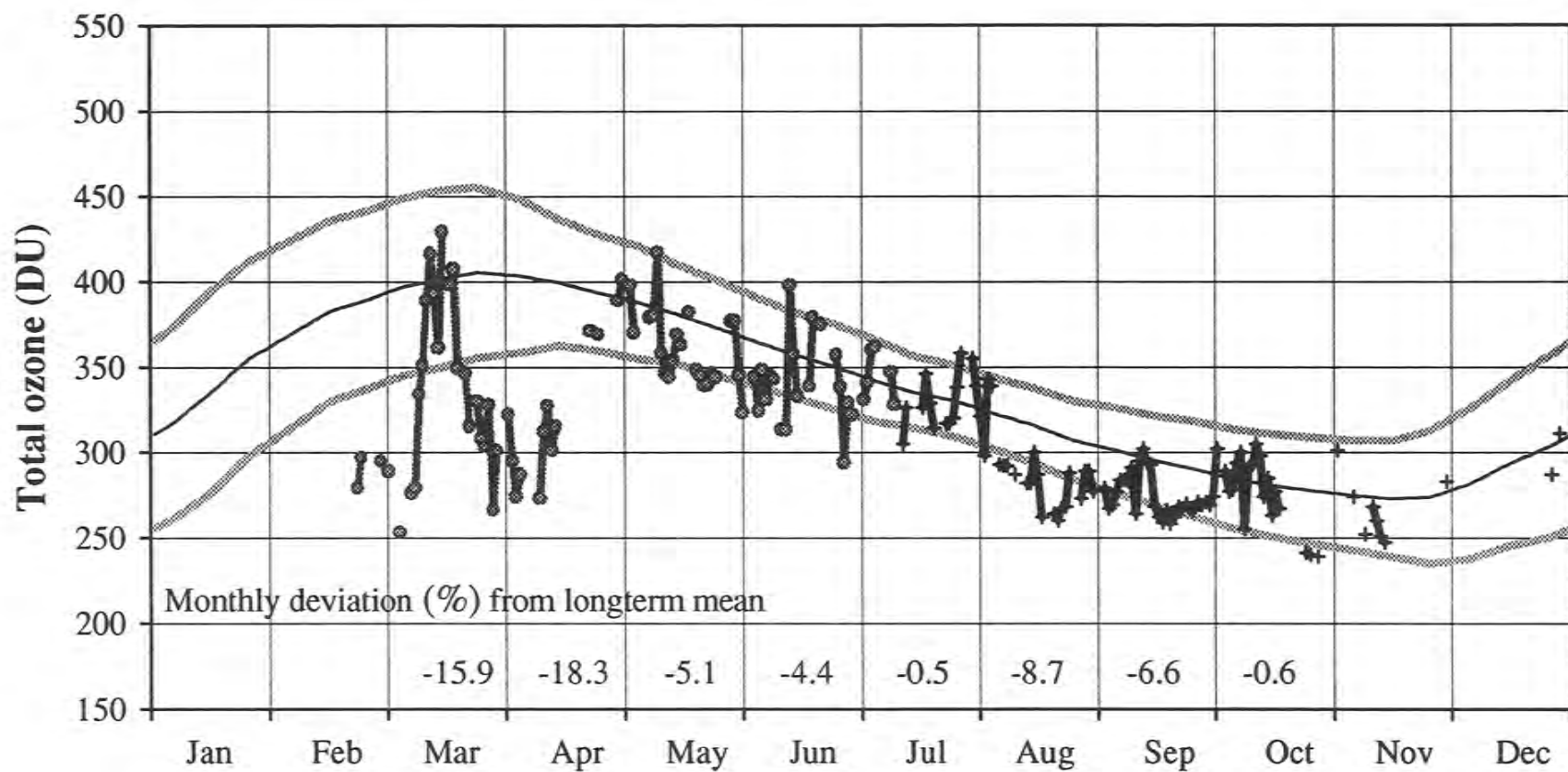


Figure 3.1.6 Daily values of total ozone recorded by Dobson #030 and Brewer #006 at Vindeln in 1996. Long-term mean, standard deviations and extremes are from Uppsala 1951-1966. The values at the bottom are the monthly deviations (percent) from the long-term monthly means if there are more than five observations. All data refer to the Bass-Paur Scale.

3.2 Data availability

An important aspect of an environmental monitoring project is to present and transfer data to those interested. Doing so one must consider the quality and the accuracy of the data. If there will be future changes confusion may arise if there are different versions of the data available. In respect of the total ozone monitoring there are several control tools helping the observer to detect if data are in error more or less on a real-time basis. Small drifts or changes (<3%) can not be detected immediately.

The public interest of the depletion of the ozone layer issue has shown that almost real time data should be available. For this purpose small eventual errors are of minor importance. However, for trend studies even small errors must be removed. It has been decided to take this risk of distributing eventually erroneous data because of the large interest. The experience so far is that there has been no need to do any major revisions afterwards. Only a few occasions with typing errors have been detected.

Data and graphs are available on-line using the internet. The exact address may change but it can be found starting at the main home page of SMHI, which is <http://www.smhi.se>.

3.3 Long-term variations and trends

In this section long-term refers to the whole period of observations, i.e. decades. The observed variations may be due to natural and anthropogenic factors as well as uncertainties in the measurements. Therefore, an observed variation or deviation from some reference or mean value can not easily be attributed to some specific factor unless a thorough analysis is done. A brief background to various factors affecting the long-term variation on different time-scales can be found in Josefsson (1994).

Monthly mean values of total ozone at Norrköping and at Vindeln are given in Tables 3.3.1 and 3.3.2. The corresponding values from Uppsala can be found in Josefsson (1994). The seasonal values are plotted in Figure 3.3.1. In general the trend is negative. It is largest in spring-time and negligible in the autumn. The largest relative deficits of total ozone are observed during winter and spring. But, the average seasonal values during these seasons are larger than the corresponding autumn values. This is of course due to the large yearly variation in the total ozone.

Looking at the plots of daily individual amounts of total ozone, e.g. Figures 3.1.1-3.1.6, there is a lower frequency of high amounts of total ozone during later years compared to earlier periods. Values higher than 450 DU are rare and the latest observation of total ozone higher than 500 DU in Norrköping occurred in February 1990. There is no observation at all above 500 DU at Vindeln. At Uppsala 1951-1966 more than every second year values above 500 DU were observed.

Table 3.3.1 Monthly, yearly, seasonal and half yearly values of total ozone (DU) for Norrköping 1982 - 1997. Notes: Bass-Paur Scale, * Indicates interpolated value, winter season includes Dec previous year, Jan and Feb actual year, winter half year value includes Oct, Nov and Dec previous year, Jan, Feb and Mar actual year. If only one monthly value is missing (i.e, -1) the yearly value is computed using mean value of the missing month. In each column the **maximum** and **minimum** value is denoted by bold and bold italic type respectively.

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR	WIN	SPR	SUM	AUT	SUM HY	WIN HY
1982					371,9	353,2	337,2	-1	-1	274,1	279,0	-1	-1	-1	-1	-1	-1	-1	-1
1983	-1	333,1	364,1	400,9	359,4	341,7	-1	-1	-1	318,2	-1	-1	-1	-1	374,8	-1	-1	-1	-1
1984	-1	-1	402,6	387,4	389,6	358,6	331,4	303,8	309,7	306,3	285,3	-1	-1	-1	393,2	331,2	300,5	346,8	-1
1985	-1	-1	410,9	397,3	351,4	350,6	339,0	299,6	305,2	262,7	-1	-1	-1	-1	386,5	329,7	-1	340,6	-1
1986	-1	-1	-1	406,1	351,5	-1	-1	-1	304,8	280,2	-1	-1	-1	-1	-1	-1	-1	-1	-1
1987	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1988	-1	383,8	419,5	393,4	366,8	344,6	336,2	319,4	286,6	275,3	287,9	332,2	340,1	-1	393,2	333,4	283,2	341,2	-1
1989	321,3	397,7	386,0	383,8	371,0	347,3	336,6	321,1	291,7	278,7	288,8	310,4	336,2	350,4	380,2	335,0	286,4	341,9	333,3
1990	328,8	350,7	384,5	384,0	355,0	345,8	332,3	314,5	298,7	282,1	306,6	324,7	333,9	329,9	374,5	330,8	295,8	338,4	323,6
1991	363,8	386,0	377,1	400,1	394,4	378,8	333,3	320,7	300,1	287,5	300,9	296,6	344,9	358,2	390,5	344,2	296,2	354,6	340,1
1992	271,7	339,8	362,9	390,8	351,2	337,2	327,9	304,6	282,1	296,3	290,1	298,0	321,1	302,7	368,3	323,2	289,5	332,3	309,9
1993	319,4	297,4	343,8	336,3	341,1	343,4	328,6	316,5	285,1	275*	290*	290*	313,9*	304,9	340,4	329,5	283,4*	325,2	307,5
1994	346*	387,9	368,6	400,2	377,7	359,3	322,5	322,2	321,2	284,4	283,7	315,8	340,8	341,3*	382,2	334,7	296,4	350,5	326,3*
1995	310,4	371,3	371,9	379,2	363,5	326,8	325,3	296,9	289,8	270,4	272,3	297,0	322,9	332,5	371,5	316,3	277,5	330,3	322,9
1996	287,0	337,4	330,9	334,0	361,5	346,2	342,8	304,2	285,7	283,9	279,9	292,1	315,5	307,1	342,1	347,2	283,2	329,1	299,2
1997	319,0	366,0	364,7	363,4	366,2									325,7	364,8				317,6

Table 3.3.2 Monthly, yearly, seasonal and half yearly values of total ozone (DU, Bass-Paur scale) for Vindeln 1991 - 1997, The winter season includes Dec previous year, Jan and Feb actual year. Winter half year value includes Oct, Nov and Dec previous year, Jan, Feb and Mar actual year, Months with less than five days with reliable observations are indicated by -1, Zenith cloud observations are not yet included, The missing data in summer of 1995 is due to calibration of the instrument in Arosa. In each column the **maximum** and **minimum** value is denoted by bold and bold italic type respectively.

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR	WIN	SPR	SUM	AUT	SUM HY	WIN HY
1991	-1	-1	352,5	403,7	388,7	364,9	319,1	309,5	308,8	285,5	-1	-1	-1	-1	381,6	331,2	-1	349,1	-1
1992	-1	-1	374,0	393,0	350,3	331,0	328,1	299,2	266,0	271,8	-1	-1	-1	-1	372,4	319,4	-1	327,9	-1
1993	-1	-1	340,8	323,6	325,1	347,4	305,2	302,7	277,3	253,2	-1	-1	-1	-1	329,8	318,4	-1	313,6	-1
1994	-1	-1	335,7	401,2	379,5	352,0	304,5	301,2	304,3	266,1	-1	-1	-1	-1	372,1	319,2	-1	340,5	-1
1995	-1	-1	347,2	375,3	354,2	319,0	-1	-1	280,4	257,1	-1	-1	-1	-1	358,9	-1	-1	-1	-1
1996	-1	-1	337,3	325,8	361,1	341,2	334,0	287,5	275,9	277,2	258,7	-1	-1	-1	341,4	320,9	-1	320,9	-1
1997	-1	-1	380,0	355,3	376,9	336,3	317,9								370,7				

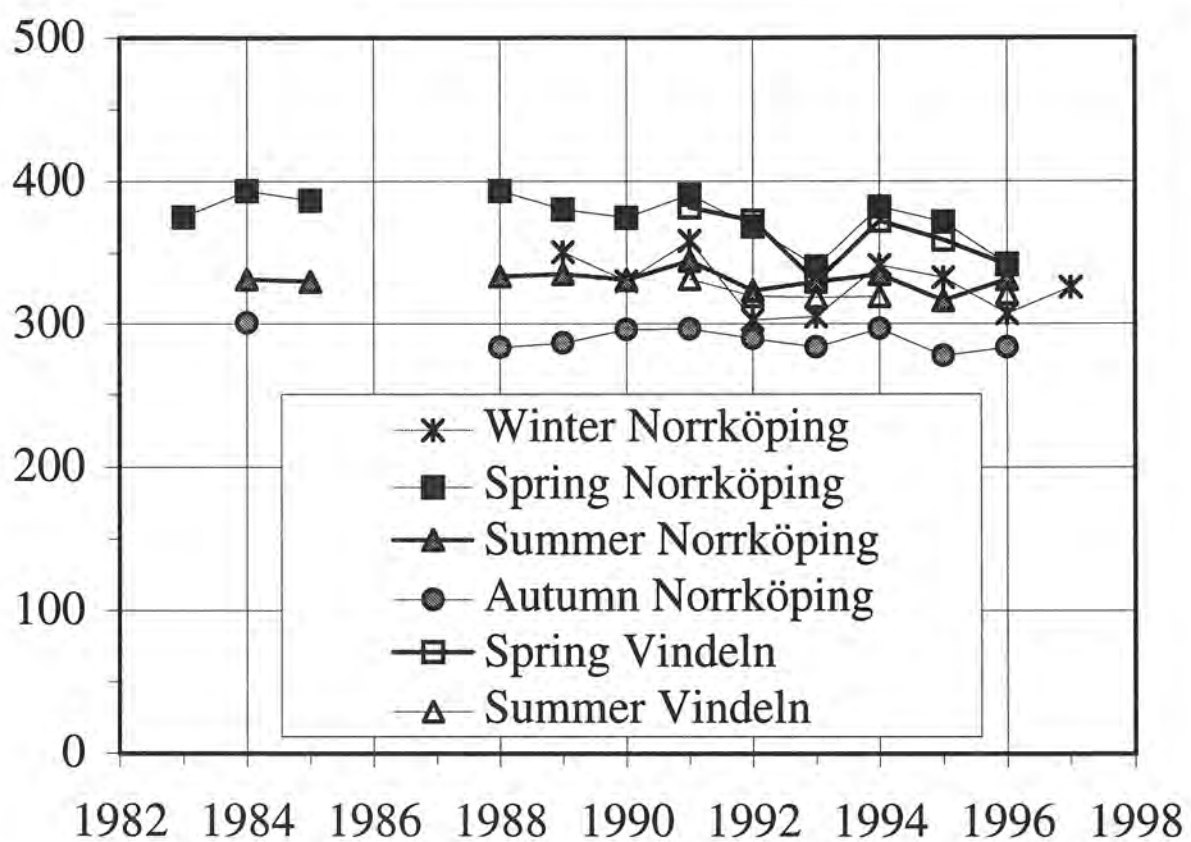


Figure 3.3.1 Seasonal average values of total ozone (DU) for Norrköping and Vindeln, cf. Tables 3.3.1 and 3.3.2.

4 CONCLUSIONS

The main objective to accurately and regularly observe the total ozone has been fulfilled at both sites during the period 1994 to 1996. Unexpected gaps in the data records are few and short at Norrköping. The automatic sun/moon tracking system of the Brewer instrument at Norrköping has produced data even during holidays and most importantly, it has also given a high frequency of the direct sun and focused sun observations, which are the most accurate methods of measurement. The measurements at Vindeln and Norrköping have shown good correlation with other nearby observations in the Nordic countries during the Winter-Spring campaigns. Vindeln has proved to fill a gap in the total ozone network and with the Brewer #006 in operation more frequent data will be available and also more up to date access. Another feature is the possibility to measure UV-B spectra.

The measurements from Uppsala are still of great importance. This historical high quality series will continue to serve as a valuable reference. Present and future variations in the amount of total ozone will be compared with it.

The present goals of the project are:

- proceed with regular observations at Norrköping and Vindeln
- ensure high quality of data by participating in international intercomparisons and by performing regular checks of instruments
- participate in the European ozone layer winter campaigns by contributing total ozone data
- having data and simple plots available for potential users and for public information on WWW and on request

5 ACKNOWLEDGEMENTS

The financial support of the Swedish Environmental Protection Agency (NV) to this project is gratefully acknowledged. The authors are also very grateful for the efforts of the staff at Vindeln Experimental Forest Station. They have thoroughly made the measurements with the Dobson and they took actively part in the installation of the Brewer instrument.

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APPENDIX 1

TOTAL OZONE RECORDED IN NORRKÖPING

Latitude: 58.58°N Longitude: 16.15°E Height: 45m

Period: 1994-01-01 -- 1996-12-31

Data from 1988 up to 1993 are published in Josefsson (1988, 1990, 1991, 1992, 1994 and 1996). One value is given for each day normally it is recorded close to noon-time. The amount of total ozone is presented in Dobson units, Bass-Paur Scale.

The second column of each month indicates the type of observation that has been used to determine the total ozone. It is briefly explained below. Type=1 corresponds to the most accurate method using the direct sun at favourable conditions. If the air mass is higher than 4 or if the direct sun observation is affected by e.g. clouds type-value is set to 2. Zenith sky observations, i.e. type=5, have the lowest priority. They are only included if more accurate observations are not available. However, in order to get a more complete data-set total ozone values have been manually evaluated from the zenith sky observations. Missing values are indicated by -9, -99 or -999.

TOTAL OZONE : The thickness of a layer of pure ozone at standard pressure and temperature (STP; 0°C, 101325 Pa). The number of molecules in that layer equals the number in a vertical column above the point of observation. The total ozone varies during the day, the year and in space. Typical extremes for Norrköping/Uppsala is about 200 and 550 DU.

A common unit for total ozone is the Dobson Unit (D.U.).

1 DU	= 10^{-5} m ozone at STP
	= 10^{-3} atm cm
	= $268.7 \cdot 10^{18}$ molecules m^{-2}
	= 21415 $\mu\text{g m}^{-2}$

TOTAL OZONE (DU, Bass-Paur Scale) NORRKÖPING-SMHI 1994

DATE	JAN		FEB		MAR		APR		MAY		JUN		JUL		AUG		SEP		OCT		NOV		DEC	
1	-999	-9	325	2	395	2	359	2	388	1	333	1	339	1	331	2	318	1	326	1	311	2	280	3
2	-999	-9	350	5	360	5	358	2	389	1	359	2	334	1	321	1	325	5	286	1	310	1	321	3
3	-999	-9	376	3	380	5	377	1	379	1	375	5	324	1	312	1	335	5	300	5	290	2	-999	5
4	-999	-9	387	2	375	5	388	1	396	1	375	5	323	1	307	1	340	5	325	1	294	1	-999	5
5	-999	-9	352	2	345	2	415	2	405	1	390	1	328	1	287	1	310	5	304	1	275	1	-999	5
6	-999	-9	360	2	437	2	421	1	402	1	405	1	327	1	299	2	310	5	272	2	270	5	318	3
7	-999	-9	410	5	350	5	433	1	360	1	365	2	320	1	317	1	315	5	250	5	260	5	-999	5
8	-999	-9	370	5	314	2	405	1	341	1	371	1	320	1	319	2	311	1	250	5	275	5	346	3
9	-999	-9	455	5	321	1	416	1	354	1	389	2	320	1	305	1	312	2	281	1	261	1	-999	5
10	-999	-9	455	5	355	2	392	1	362	1	395	2	318	1	307	1	333	2	290	5	290	5	341	3
11	366	3	455	5	330	5	405	1	367	1	360	1	320	1	308	1	343	1	262	1	292	1	310	3
12	-999	-9	433	1	430	5	389	1	372	1	332	1	323	1	301	1	343	1	265	1	250	5	314	3
13	-999	-9	375	5	380	2	426	1	364	1	311	1	316	1	312	1	318	1	239	1	255	2	328	3
14	364	3	395	1	381	1	465	5	363	1	321	1	332	1	340	5	330	1	237	2	240	5	332	3
15	-999	-9	369	1	383	1	480	5	373	1	387	1	328	1	318	2	330	5	260	3	237	2	288	3
16	356	3	372	1	438	1	396	1	378	2	386	1	320	5	312	1	345	2	316	1	269	2	-999	-9
17	368	3	359	1	371	2	439	1	368	2	392	1	325	5	321	2	335	5	339	1	290	5	310	4
18	329	3	380	5	343	1	431	1	390	5	369	1	335	5	335	5	330	5	301	1	277	3	-999	-9
19	-999	-9	380	5	345	5	388	2	350	1	373	1	320	5	350	5	335	5	277	1	231	2	310	4
20	366	3	-999	-9	354	1	397	1	346	1	367	1	330	5	345	5	330	5	277	1	275	5	-999	-9
21	-999	-9	370	5	358	1	396	2	385	1	356	2	327	1	350	5	326	2	267	1	307	2	317	3
22	350	3	370	5	300	5	409	1	374	1	386	2	315	5	350	5	306	1	275	5	-999	-9	324	3
23	-999	-9	425	5	365	5	391	1	392	1	386	1	318	2	339	1	276	1	250	5	-999	-9	-999	-9
24	412	2	421	1	455	5	395	1	378	1	366	1	319	1	324	1	289	1	270	5	-999	-9	-999	-9
25	338	3	389	1	397	1	396	1	374	1	331	1	325	1	317	1	291	2	281	1	326	2	-999	-9
26	-999	-9	364	1	419	2	380	2	400	5	337	1	326	1	322	1	320	5	285	5	319	2	-999	-9
27	419	2	386	1	402	1	366	1	386	1	319	1	316	2	305	2	308	3	306	1	-999	-9	-999	-9
28	-999	-9	390	5	316	1	363	2	390	1	304	1	308	1	315	5	348	1	311	1	313	3	298	3
29	410	5			350	5	342	1	397	1	305	1	313	1	337	2	325	1	290	5	346	3	-999	-9
30	400	5			349	2	388	2	397	2	334	1	308	1	337	1	298	1	325	5	312	3	-999	-9
31	385	5			330	2			389	2			319	1	344	1			300	5			-999	-9

TOTAL OZONE (DU, Bass-Paur Scale) NORRKÖPING-SMHI 1995

DATE	JAN		FEB		MAR		APR		MAY		JUN		JUL		AUG		SEP		OCT		NOV		DEC	
1	345	9	301	2	340	5	352	1	369	1	333	1	365	1	304	1	293	2	308	1	298	1	235	5
2	350	9	400	5	385	1	388	2	322	2	309	1	338	1	308	1	301	1	275	5	290	5	255	5
3	306	2	301	3	393	2	402	1	330	1	313	2	344	1	308	1	285	5	264	1	340	5	270	5
4	301	2	355	2	404	1	428	2	325	1	309	2	379	2	291	1	306	2	265	5	311	1	300	5
5	257	3	355	1	391	2	370	1	346	2	320	1	390	1	282	1	305	5	252	2	276	1	285	4
6	274	3	340	5	365	5	390	5	353	1	326	1	312	2	296	1	-99	-9	284	1	322	4	295	5
7	333	3	436	1	378	1	355	5	360	5	325	5	316	1	327	1	290	5	285	5	285	2	293	3
8	330	9	453	2	380	1	391	2	352	1	325	2	319	1	311	1	293	1	270	1	255	4	325	10
9	312	3	445	1	390	5	398	1	372	1	326	1	319	1	307	1	290	5	249	1	250	4	340	4
10	330	9	428	1	429	2	383	1	363	1	323	1	343	1	305	1	285	5	250	5	255	5	345	4
11	340	9	319	1	380	5	336	2	395	5	335	1	319	1	294	1	300	5	277	1	260	5	300	3
12	330	9	300	5	355	5	346	1	390	5	355	5	324	1	298	1	295	5	269	2	254	2	315	10
13	314	3	270	5	275	5	366	1	366	1	345	5	316	2	298	1	295	5	250	1	237	2	358	3
14	300	5	340	5	296	2	363	1	360	5	330	5	321	2	309	1	288	2	249	1	237	2	302	3
15	294	3	320	5	350	5	384	2	409	2	330	1	315	2	295	1	270	5	250	5	260	9	286	3
16	260	3	376	1	394	2	450	5	403	1	340	5	330	5	274	2	260	5	255	2	285	5	279	3
17	290	3	395	5	375	2	452	1	371	1	354	2	335	5	273	1	292	1	240	2	300	5	277	3
18	285	2	420	5	422	1	397	2	420	5	356	1	331	2	273	1	279	1	291	1	286	2	275	3
19	295	5	369	2	430	2	419	1	406	1	360	5	330	1	270	5	280	5	288	2	327	2	279	3
20	280	5	368	1	385	2	410	5	396	2	307	1	300	5	275	5	285	5	312	1	274	2	324	3
21	320	5	355	5	353	2	371	1	436	2	320	2	289	1	279	1	252	1	286	1	275	5	295	3
22	320	5	378	1	283	2	342	2	420	5	345	5	332	1	265	1	256	1	257	1	245	3	271	3
23	330	9	395	2	271	1	343	1	413	2	325	1	315	1	283	1	267	1	270	1	266	3	-99	-9
24	330	9	418	2	355	1	353	1	340	2	315	1	335	5	313	1	272	2	260	2	260	5	325	3
25	317	2	382	2	365	2	355	5	331	1	305	1	330	5	287	2	297	1	250	1	260	5	295	3
26	295	3	420	1	373	1	347	2	336	1	304	1	310	5	318	1	283	1	254	2	240	5	306	3
27	323	2	399	1	450	5	360	5	321	1	317	1	303	1	306	1	305	1	250	5	245	5	283	3
28	295	5	357	1	426	1	375	5	311	1	312	1	299	1	311	2	330	5	263	2	250	5	305	3
29	335	5			420	1	371	2	311	1	315	1	308	1	325	1	325	5	294	1	285	5	-99	-9
30	331	1			392	1	379	1	312	1	326	1	309	1	317	1	325	5	294	1	240	5	314	3
31	300	2			325	5			329	1			307	1	301	1			320	5			282	4

TOTAL OZONE (DU, Bass-Paur Scale) NORRKÖPING-SMHI 1996

DATE	JAN		FEB		MAR		APR		MAY		JUN		JUL		AUG		SEP		OCT		NOV		DEC	
1	290	4	310	5	323	1	316	1	375	1	326	1	365	5	339	5	291	1	293	5	258	5	267	5
2	293	3	335	5	282	2	319	1	359	1	340	1	360	1	336	1	288	1	282	1	298	5	226	5
3	305	3	379	4	259	1	298	1	343	5	352	1	368	1	344	1	264	1	-999	-9	-999	-9	244	5
4	255	4	387	1	235	5	302	1	340	5	345	1	340	5	319	1	302	1	-999	-9	280	5	257	5
5	285	10	407	1	272	1	286	1	364	5	339	1	334	1	312	1	305	1	-999	-9	298	1	270	3
6	305	10	370	2	275	5	291	1	348	5	310	2	339	2	313	1	305	1	-999	-9	260	5	287	5
7	285	10	382	1	289	1	288	1	389	1	313	1	359	1	315	1	295	5	-999	-9	277	1	251	5
8	300	10	440	5	283	1	295	1	377	1	308	1	348	1	312	1	286	1	-999	-9	284	1	238	5
9	300	10	420	5	315	1	305	1	381	1	309	1	360	5	312	1	282	1	-999	-9	280	5	-999	-9
10	-99	-9	380	5	352	1	294	1	372	5	321	1	345	5	307	1	311	1	-999	-9	306	1	292	5
11	295	10	330	5	416	1	340	5	349	1	323	1	316	1	305	1	298	1	-999	-9	267	5	300	5
12	275	10	325	5	418	1	342	1	361	1	358	1	330	5	310	1	315	5	-999	-9	264	5	266	5
13	290	10	304	2	396	1	339	1	360	1	352	1	330	1	312	1	299	1	-999	-9	248	5	287	5
14	290	10	284	1	431	1	343	1	345	1	353	1	311	1	305	1	304	1	-999	-9	279	3	320	3
15	300	10	260	5	394	2	328	1	360	1	355	1	353	1	294	1	270	1	-999	-9	213	5	353	3
16	305	10	269	1	362	1	339	1	354	1	348	1	347	5	278	1	271	1	-999	-9	273	5	293	3
17	300	10	322	1	355	1	355	1	365	5	343	1	339	1	283	1	269	1	-999	-9	288	5	325	3
18	280	5	285	1	357	5	369	1	378	1	383	1	363	5	285	1	267	1	-999	-9	286	5	-999	-9
19	275	5	280	5	345	1	330	5	373	1	381	1	346	1	278	1	270	1	-999	-9	284	5	332	3
20	270	5	331	1	356	1	350	5	367	5	379	1	329	1	285	1	272	1	-999	-9	302	5	357	3
21	260	5	327	1	369	1	357	1	351	1	381	1	340	1	295	1	275	1	-999	-9	330	5	298	4
22	255	5	330	1	345	5	358	1	361	1	382	1	332	1	310	1	270	5	-999	-9	333	3	307	3
23	300	5	355	1	387	2	350	5	354	1	372	1	341	1	302	1	282	1	-999	-9	335	1	309	3
24	291	3	330	10	373	1	348	1	364	1	362	1	346	1	296	2	286	1	-999	-9	329	3	297	3
25	300	5	315	10	297	1	376	1	372	1	356	1	348	1	300	5	284	1	-999	-9	263	5	321	3
26	297	3	305	5	313	1	355	5	380	1	340	1	341	1	315	5	279	1	248	1	263	5	314	4
27	310	5	348	2	325	1	358	1	370	1	335	5	332	1	305	1	271	1	276	1	260	5	-999	-9
28	292	3	320	5	275	5	379	1	375	1	339	5	348	1	295	1	288	1	295	5	245	5	-999	-9
29	282	2	356	1	280	5	350	5	347	1	335	5	342	1	280	5	294	5	289	1	263	5	-999	-9
30	263	2			290	5	360	5	350	1	347	1	341	1	283	1	278	1	-999	-9	250	5	-999	-9
31	263	1			290	5			324	1			334	1	304	1			304	1			-999	-9

APPENDIX 2

TOTAL OZONE RECORDED AT VINDELN

Latitude: 64.24°N Longitude: 19.77°E Height: 225m

Period: 1994 January -- 1996 December

One value is given for each day normally it is recorded close to noon-time. Data are published along with those for Norrköping. There are very few observations during the winter due to the low sun. The amount of total ozone is presented in Dobson units, Bass-Paur Scale.

Depending on the type of instrument that has been used the second column indicates different things. Using the Dobson, as in 1995, the column can be deduced as: A zero (=0) indicates that the fundamental direct sun observation and the AD-pair of wavelengths has been used to determine the total ozone. Zenith sky observations, i.e. TYPE=2-7, have the lower priority. They are only included if more accurate observations are not available. However, in order to get a more complete data-set total ozone values have been evaluated from the zenith cloudy sky observations. These are less accurate and the indicator reads -9. Missing values are indicated by -9, -99 or -999.

TOTAL OZONE : The thickness of a layer of pure ozone at standard pressure and temperature (STP; 0°C, 101325 Pa). The number of molecules in that layer equals the number in a vertical column above the point of observation. The total ozone varies during the day, the year and in space. Typical extremes for Vindeln/Uppsala is probably about 200 and 550 DU.

A common unit for total ozone is the Dobson Unit (D.U.).

1 DU	= 10^{-5} m ozone at STP
	= 10^{-3} atm cm
	= $268.7 \cdot 10^{18}$ molecules m^{-2}
	= 21415 $\mu\text{g m}^{-2}$

TOTAL OZONE (DU, Bass-Paur Scale) VINDELN 1994

DATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	-99 -9	-99 -9	312 60	-99 -9	-99 -9	346 0	343 0	285 0	301 0	-99 -9	-99 -9	-99 -9
2	-99 -9	-99 -9	315 60	-99 -9	421 0	353 -9	-99 -9	-99 -9	309 0	-99 -9	-99 -9	-99 -9
3	-99 -9	-99 -9	-99 -9	-99 -9	378 -9	347 0	-99 -9	285 0	-99 -9	-99 -9	-99 -9	-99 -9
4	-99 -9	-99 -9	-99 -9	-99 -9	381 0	-99 -9	312 0	295 -9	-99 -9	303 0	-99 -9	-99 -9
5	-99 -9	-99 -9	-99 -9	416 -9	370 0	-99 -9	306 0	270 0	291 -9	295 0	-99 -9	-99 -9
6	-99 -9	-99 -9	-99 -9	417 0	367 0	382 -9	303 0	-99 -9	292 -9	-99 -9	-99 -9	-99 -9
7	-99 -9	377 -9	-99 -9	430 -9	-99 -9	379 -9	306 0	-99 -9	-99 -9	232 0	-99 -9	-99 -9
8	-99 -9	-99 -9	-99 -9	-99 -9	-99 -9	382 -9	304 0	279 0	300 -9	-99 -9	-99 -9	-99 -9
9	-99 -9	-99 -9	319 0	419 0	351 0	375 -9	-99 -9	310 -9	292 -9	-99 -9	-99 -9	-99 -9
10	-99 -9	395 60	344 0	-99 -9	367 -9	376 0	313 -9	297 0	-99 -9	255 0	-99 -9	-99 -9
11	-99 -9	-99 -9	-99 -9	444 0	368 0	304 -9	296 0	282 0	-99 -9	-99 -9	-99 -9	-99 -9
12	-99 -9	-99 -9	-99 -9	372 0	-99 -9	-99 -9	305 -9	286 0	330 0	256 2	-99 -9	-99 -9
13	-99 -9	-99 -9	-99 -9	371 0	368 -9	307 -9	286 0	-99 -9	328 -9	-99 -9	-99 -9	-99 -9
14	-99 -9	370 60	-99 -9	392 -9	-99 -9	318 0	292 0	-99 -9	316 0	240 2	-99 -9	-99 -9
15	-99 -9	322 60	-99 -9	373 0	-99 -9	372 0	302 0	296 0	311 0	-99 -9	-99 -9	-99 -9
16	-99 -9	342 60	368 -9	-99 -9	388 -9	371 0	-99 -9	295 0	-99 -9	-99 -9	-99 -9	-99 -9
17	-99 -9	347 60	346 -9	-99 -9	379 0	379 0	-99 -9	294 0	-99 -9	294 2	-99 -9	-99 -9
18	-99 -9	-99 -9	-99 -9	429 -9	386 -9	-99 -9	312 0	292 0	-99 -9	285 2	263 41	-99 -9
19	-99 -9	-99 -9	-99 -9	415 0	391 -9	-99 -9	308 0	308 0	309 0	263 60	-99 -9	-99 -9
20	-99 -9	-99 -9	324 0	395 0	381 -9	379 -9	336 -9	-99 -9	331 0	-99 -9	-99 -9	-99 -9
21	-99 -9	348 60	330 0	417 0	-99 -9	332 0	315 0	-99 -9	296 0	238 60	-99 -9	-99 -9
22	-99 -9	352 60	293 0	-99 -9	-99 -9	-99 -9	301 0	344 -9	268 -9	-99 -9	-99 -9	-99 -9
23	-99 -9	371 60	363 -9	-99 -9	-99 -9	374 -9	-99 -9	319 0	246 0	-99 -9	-99 -9	-99 -9
24	-99 -9	353 60	-99 -9	-99 -9	369 0	-99 -9	-99 -9	317 -9	-99 -9	-99 -9	-99 -9	-99 -9
25	-99 -9	-99 -9	387 -9	390 0	390 0	-99 -9	296 0	323 0	-99 -9	-99 -9	-99 -9	-99 -9
26	-99 -9	-99 -9	-99 -9	387 -9	406 0	-99 -9	302 0	298 0	301 0	-99 -9	-99 -9	-99 -9
27	-99 -9	-99 -9	-99 -9	384 0	402 0	342 -9	284 0	-99 -9	329 -9	-99 -9	-99 -9	-99 -9
28	-99 -9	343 60	330 0	367 0	-99 -9	356 -9	272 0	-99 -9	327 0	-99 -9	-99 -9	-99 -9
29	-99 -9		348 -9	420 0	-99 -9	304 0	-99 -9	332 -9	-99 -9	-99 -9	-99 -9	-99 -9
30	-99 -9		343 0	384 0	374 -9	314 -9	-99 -9	319 0	-99 -9	-99 -9	-99 -9	-99 -9
31	-99 -9		313 0		353 -9		-99 -9	-99 -9		-99 -9		-99 -9

TOTAL OZONE (DU, Bass-Paur Scale) VINDELN 1995

DATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	-99 -9	-99 -9	-99 -9	365 0	377 0	347 -9	-99 -9	-99 -9	272 0	-99 -9	-99 -9	-99 -9
2	-99 -9	-99 -9	363 2	-99 -9	351 -9	322 0	-99 -9	-99 -9	-99 -9	246 0	-99 -9	-99 -9
3	-99 -9	-99 -9	380 2	429 0	357 -9	-99 -9	351 -9	-99 -9	278 -9	-99 -9	-99 -9	-99 -9
4	-99 -9	-99 -9	-99 -9	394 0	336 0	-99 -9	-99 -9	-99 -9	288 -9	-99 -9	-99 -9	-99 -9
5	-99 -9	-99 -9	-99 -9	360 -9	355 -9	-99 -9	-99 -9	-99 -9	283 -9	-99 -9	-99 -9	242 -9
6	-99 -9	-99 -9	358 2	347 0	-99 -9	310 -9	-99 -9	-99 -9	262 0	271 0	-99 -9	-99 -9
7	-99 -9	450 60	-99 -9	355 -9	-99 -9	312 0	-99 -9	-99 -9	284 -9	-99 -9	240 -9	-99 -9
8	-99 -9	-99 -9	362 2	328 0	372 -9	314 0	-99 -9	-99 -9	285 -9	-99 -9	-99 -9	-99 -9
9	-99 -9	-99 -9	-99 -9	-99 -9	381 0	325 0	-99 -9	-99 -9	-99 -9	229 0	-99 -9	-99 -9
10	-99 -9	-99 -9	-99 -9	363 0	374 0	-99 -9	-99 -9	-99 -9	-99 -9	238 0	-99 -9	-99 -9
11	-99 -9	-99 -9	-99 -9	400 -9	392 -9	-99 -9	-99 -9	-99 -9	280 -9	281 -9	-99 -9	-99 -9
12	310 41	-99 -9	310 41	333 0	378 0	317 0	-99 -9	-99 -9	270 -9	-99 -9	-99 -9	-99 -9
13	-99 -9	-99 -9	-99 -9	352 0	-99 -9	312 0	-99 -9	-99 -9	279 -9	255 -9	-99 -9	-99 -9
14	-99 -9	-99 -9	-99 -9	393 -9	-99 -9	297 0	-99 -9	-99 -9	285 -9	-99 -9	-99 -9	-99 -9
15	-99 -9	-99 -9	-99 -9	-99 -9	-99 -9	296 0	-99 -9	-99 -9	270 -9	-99 -9	-99 -9	-99 -9
16	-99 -9	-99 -9	-99 -9	-99 -9	411 -9	309 0	-99 -9	-99 -9	-99 -9	-99 -9	-99 -9	-99 -9
17	-99 -9	-99 -9	-99 -9	418 -9	378 0	-99 -9	-99 -9	262 0	-99 -9	-99 -9	-99 -9	-99 -9
18	-99 -9	-99 -9	-99 -9	-99 -9	-99 -9	-99 -9	-99 -9	260 0	259 -9	-99 -9	-99 -9	-99 -9
19	-99 -9	-99 -9	-99 -9	-99 -9	406 -9	337 -9	-99 -9	-99 -9	265 0	262 -9	-99 -9	-99 -9
20	-99 -9	-99 -9	-99 -9	391 0	-99 -9	307 0	-99 -9	-99 -9	280 -9	-99 -9	-99 -9	-99 -9
21	-99 -9	-99 -9	288 -9	397 -9	-99 -9	305 -9	-99 -9	262 0	241 0	-99 -9	-99 -9	-99 -9
22	-99 -9	-99 -9	-99 -9	390 0	346 0	327 -9	-99 -9	249 0	260 -9	-99 -9	-99 -9	-99 -9
23	-99 -9	-99 -9	300 2	-99 -9	-99 -9	-99 -9	-99 -9	261 0	-99 -9	-99 -9	-99 -9	-99 -9
24	-99 -9	-99 -9	336 -9	347 0	380 -9	-99 -9	-99 -9	-99 -9	-99 -9	-99 -9	-99 -9	-99 -9
25	-99 -9	-99 -9	-99 -9	349 0	305 0	-99 -9	-99 -9	287 0	291 0	-99 -9	-99 -9	-99 -9
26	-99 -9	-99 -9	-99 -9	396 -9	-99 -9	318 0	-99 -9	-99 -9	302 0	275 -9	-99 -9	-99 -9
27	-99 -9	-99 -9	411 0	390 -9	-99 -9	310 0	-99 -9	-99 -9	305 0	-99 -9	-99 -9	-99 -9
28	-99 -9	-99 -9	-99 -9	384 -9	292 0	338 -9	-99 -9	297 0	314 0	-99 -9	-99 -9	-99 -9
29	-99 -9	-99 -9	379 0	-99 -9	288 0	333 -9	-99 -9	312 0	316 0	-99 -9	-99 -9	-99 -9
30	-99 -9	-99 -9	344 0	-99 -9	289 0	345 -9	-99 -9	307 0	-99 -9	-99 -9	-99 -9	-99 -9
31	-99 -9	-99 -9	335 -9	-99 -9	316 -9	-99 -9	-99 -9	283 0	-99 -9	-99 -9	-99 -9	-99 -9

TOTAL OZONE (DU, Bass-Paur Scale) VINDELN 1996

DATE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	-99 -9	-99 -9	289 2	322 -9	-99 -9	-99 -9	331 -9	298 0	279 -9	-99 -9	-99 -9	-99 -9
2	-99 -9	-99 -9	-99 -9	295 0	398 -9	-99 -9	341 -9	343 -9	267 -9	289 -9	-99 -9	-99 -9
3	-99 -9	-99 -9	-99 -9	274 0	370 -9	344 0	360 -9	339 -9	269 -9	277 -9	-99 -9	-99 -9
4	-99 -9	-99 -9	253 2	287 0	-99 -9	324 0	362 -9	-99 -9	277 -9	278 -9	274 -9	-99 -9
5	-99 -9	-99 -9	-99 -9	-99 -9	-99 -9	348 0	-99 -9	293 0	284 -9	294 -9	-99 -9	-99 -9
6	-99 -9	-99 -9	-99 -9	-99 -9	-99 -9	331 0	-99 -9	292 0	284 -9	300 -9	-99 -9	-99 -9
7	-99 -9	-99 -9	276 -9	-99 -9	379 -9	345 0	-99 -9	292 0	283 -9	255 -9	252 -9	-99 -9
8	-99 -9	-99 -9	279 2	-99 -9	380 0	343 -9	347 -9	292 0	291 -9	291 -9	-99 -9	-99 -9
9	-99 -9	-99 -9	334 2	273 0	417 -9	-99 -9	328 0	287 0	264 -9	293 -9	268 -9	-99 -9
10	-99 -9	-99 -9	351 2	312 0	358 0	313 -9	-99 -9	-99 -9	295 -9	305 -9	260 -9	-99 -9
11	-99 -9	-99 -9	389 -9	327 0	346 0	313 -9	305 0	-99 -9	302 -9	298 -9	251 -9	-99 -9
12	-99 -9	-99 -9	416 2	301 0	344 0	398 -9	326 -9	282 0	294 -9	274 -9	247 -9	-99 -9
13	-99 -9	-99 -9	393 2	315 0	354 -9	357 -9	-99 -9	282 0	293 -9	285 -9	-99 -9	-99 -9
14	-99 -9	-99 -9	361 0	-99 -9	369 -9	333 -9	-99 -9	300 -9	268 -9	263 -9	-99 -9	-99 -9
15	-99 -9	-99 -9	429 0	-99 -9	363 0	-99 -9	-99 -9	287 -9	262 -9	277 -9	-99 -9	-99 -9
16	-99 -9	-99 -9	-99 -9	-99 -9	-99 -9	-99 -9	326 -9	262 0	259 -9	267 -9	-99 -9	-99 -9
17	-99 -9	-99 -9	398 0	-99 -9	382 0	339 -9	346 -9	-99 -9	266 -9	-99 -9	-99 -9	-99 -9
18	-99 -9	-99 -9	407 2	-99 -9	-99 -9	379 -9	329 0	-99 -9	258 -9	-99 -9	-99 -9	-99 -9
19	-99 -9	-99 -9	349 0	-99 -9	348 0	-99 -9	314 0	264 0	262 -9	-99 -9	-99 -9	-99 -9
20	-99 -9	-99 -9	-99 -9	-99 -9	345 0	375 -9	-99 -9	260 0	268 -9	-99 -9	-99 -9	-99 -9
21	-99 -9	-99 -9	346 0	-99 -9	339 0	-99 -9	-99 -9	267 0	267 -9	-99 -9	-99 -9	-99 -9
22	-99 -9	279 60	315 0	371 0	340 0	-99 -9	317 0	268 0	270 -9	-99 -9	-99 -9	-99 -9
23	-99 -9	297 2	-99 -9	-99 -9	346 0	-99 -9	317 0	288 -9	267 -9	241 -9	-99 -9	-99 -9
24	-99 -9	-99 -9	330 0	369 0	344 0	357 -9	320 0	-99 -9	266 -9	240 -9	-99 -9	-99 -9
25	-99 -9	-99 -9	308 -9	-99 -9	-99 -9	338 0	338 -9	-99 -9	271 -9	-99 -9	-99 -9	287 -9
26	-99 -9	-99 -9	303 0	-99 -9	-99 -9	294 0	358 -9	273 0	296 -9	239 -9	-99 -9	-99 -9
27	-99 -9	-99 -9	328 -9	-99 -9	-99 -9	329 -9	-99 -9	289 -9	271 -9	-99 -9	-99 -9	311 -9
28	-99 -9	295 60	266 0	-99 -9	377 0	322 0	-99 -9	289 0	269 -9	-99 -9	283 -9	-99 -9
29	-99 -9	-99 -9	301 0	389 0	377 -9	-99 -9	355 -9	277 0	274 -9	-99 -9	-99 -9	-99 -9
30	-99 -9		-99 -9	401 0	345 -9	-99 -9	339 0	-99 -9	302 -9	-99 -9	-99 -9	-99 -9
31	-99 -9		-99 -9		323 0		321 0	-99 -9		301 -9		-99 -9

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Swedish Meteorological and Hydrological Institute
SE-601 76 Norrköping, Sweden. Tel. +4611158000. Telex 644 00 smhi s.

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