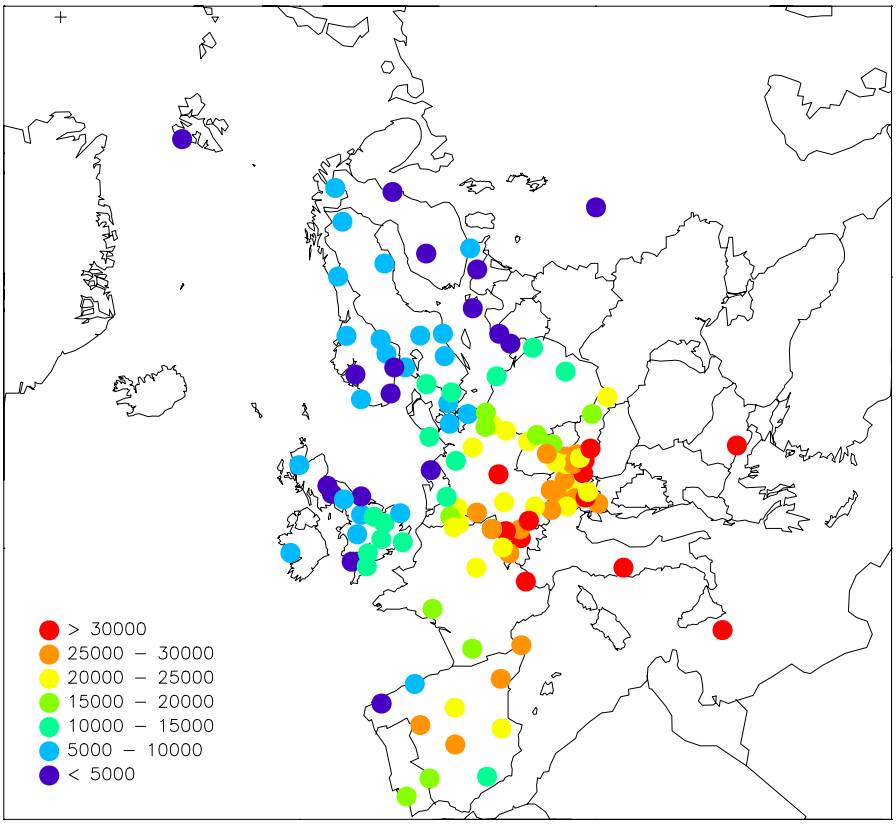
EMEP/CCC-Report 4/2005

EMEP Co-operative Programme for Monitoring and Evaluation of the Long-Range Transmission of Air Pollutants in Europe

Ozone measurements 2003

Anne-Gunn Hjellbrekke and Sverre Solberg



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1. Introduction

Ozone is a natural constituent of the atmosphere and plays a vital role in many atmospheric processes. However, man made emissions of volatile organic compounds and nitrogen oxides have increased the photochemical formation of ozone in the troposphere. Until the end of the 1960s the problem was basically believed to be one of the big cities and their immediate surroundings. In the 1970s, however, it was found that the problem of photochemical oxidant formation is much more widespread. The ongoing monitoring of ozone at rural sites throughout Europe shows that episodes of high concentrations of ground-level ozone occur over most parts of the continent every summer. During these episodes the ozone concentrations can reach values above ambient air quality standards over large regions and lead to adverse effects for human health and vegetation. Historical records of ozone measurements in Europe and North America indicate that in the last part of the nineteenth century the values were only about half of the average surface ozone concentrations measured in the same regions during the last 10-15 years (Bojkov, 1986; Volz and Kley, 1988).

The formation of ozone is due to a large number of photochemical reactions taking place in the atmosphere and depends on the temperature, humidity and solar radiation as well as the primary emissions of nitrogen oxides and volatile organic compounds. Together with the non-linear relationships between the primary emissions and the ozone formation, these effects complicates the abatement strategies for ground-level ozone and makes photochemical models crucial in addition to the monitoring data.

The 1999 Gothenburg Protocol is designed for a joint abatement of acidification, eutrophication and ground-level ozone. It has been estimated that once the Protocol is implemented, the number of days with excessive ozone levels will be halved and that the exposure of vegetation to excessive ozone levels will be 44% down on 1990.

2. Critical levels

Ozone concentrations vary widely from region to region, with the time of year, and with time of day. Typically, high concentrations of ozone are observed in periods with anticyclonic conditions. Such episodes may lead to adverse environmental effects such as impact on human health, agricultural crops, forests and materials. National authorities and international organisations have therefore formulated critical levels for ozone.

The critical levels defined by ECE for protection of vegetation are 150 $\mu g/m^3$ for hourly mean, 60 $\mu g/m^3$ for eight-hour mean and 50 $\mu g/m^3$ for seven-hour mean (9 a.m.–4 p.m.) averaged over the growing season (April–September). In EU the ozone directive (Directive 2002/3/EC) has defined a number of target values and long-term objectives for the protection of vegetation and human health. The target value for human health for 2010 is that 120 $\mu g/m^3$ (8h mean) is not to be exceeded

on more than 25 days per year averaged over 3 years. For protection of vegetation AOT40 (May-July) should not exceed 18,000 µg/m^{3}h averaged over five years. In addition information should be given to the population when hourly means exceed 180 µg/m^3 and an alert warning should be issued if hourly means exceed 240 µg/m^3.

The critical level formulated by WHO for protection of health is 120 µg/m^3 for eight-hour mean.

In defining the harmful effects of ozone exposure to plants, attention must be given to the physiological response to ozone. Ozone is generally taken up through the stomata, and reacts with a number of enzymes and antioxidants. Several studies have shown that plants respond by reduced carbon dioxide uptake, and other symptoms of damage to the respiration system, for ozone exposure above a certain threshold (e.g. Forberg et al., 1987). This concentration threshold varies between plant species, cultivars, and phenological development.

Previously recommended critical levels for ozone based on seven-hour mean concentrations in the growing season do not take into account the existence of such a threshold, and have been criticised because the effects on vegetation of a generally high concentration level of ozone may be less harmful than the exposure to short-term and episodic high concentrations, which may cause permanent damage to the cell tissue.

Within the framework of the UN-ECE Convention on long-range transboundary air pollution, workshops held at Egham, UK (Ashmore and Wilson, 1992) and at Bern, Switzerland (Führer and Achermann, 1994) have recommended that critical levels for ozone exposure should be based on the accumulated exposure in ppb hours over a concentration threshold during the growing season (AOT). The Egham workshop was not able to decide conclusively on the threshold concentration or the accumulated dose corresponding to the critical loads, but the Bern workshop made specific recommendations to use a threshold of 40 ppb. The critical levels were revised at a UN-ECE workshop in Kuopio, Finland (Kärenlampi and Skärby, 1996) with minor changes to the Bern recommendations and are defined as:

- Critical level for agricultural crops: The AOT40 for crops is calculated as an accumulated ozone exposure above a threshold of 40 ppb for a period of three months during daylight hours, defined as those hours the mean global radiation is 50 W/m^2 or greater. The AOT40 value for comparison with the critical level should be calculated as the highest running three months sum during the period when crops are grown. If a fixed period is required for modelling assessment the period May to July should be used. Data from open-top chamber experiments indicate that an AOT40 of 3000 ppbh corresponds to a 5% yield loss for wheat. This value is only applicable when soil moisture is not limiting because of sufficient precipitation or irrigation.
  Short term critical level for crops: The critical levels are defined as:
  – 500 ppbh over five days for high (water) vapour pressure deficit conditions
  – 200 ppbh over five days for low (water) vapour pressure deficit conditions.

As for the long term critical level, the short term critical levels refer to daylight hours only and should not be applied when soil moisture is limiting.

- For natural vegetation, since the sensitivity of the most sensitive species is considered to be similar to that of the most sensitive crops, the same long term critical level as for agricultural crops is used.

- Critical level for forests: AOT40 of 10 000 ppbh, calculated for daylight hours only, defined as for crops, during a six months period from April to September.

Although these critical loads are based on relatively strong experimental evidence, changes in the formulations may be expected when more information is available on the response of different plants to ozone exposure. The vegetation periods above are defined as being typical of climatic conditions in Northern Europe whereas other vegetation periods may be more appropriate for other areas, such as Southern Europe and Northern Scandinavia.

The critical levels are considered to be suitable for exceedance mapping and integrated assessment modelling, but should not be used for economic assessment of crop or biomass losses. For these purposes, it is needed to take into account different species and modifying factors such as (water) vapour pressure deficit, soil moisture content, nutritional status, altitude, other pollutants etc.

Work is currently in progress to revise the critical levels for ozone (level II) and was the focus of a UNECE Workshop in Gothenburg, November 2002. Although substantial progress was made, no final recommendations have yet been defined.

3. Measurement network

Surface ozone measurements have been a part of the EMEP extended (voluntary) measurement activities since the third phase (1 January 1984–31 December 1986). Due to the lack of funds, the systematic collection and checking of data within EMEP, did not start until 1 January 1987. The measurement of ozone data within the EMEP region was a continuation of the OECD's oxidant data collection programme OXIDATE. Ozone data from the OXIDATE project have been reported in three reports (Grennfelt and Schjoldager, 1984; Grennfelt et al., 1988 and 1989).

This report presents surface ozone data measured at rural and background EMEP sites during 2003 with emphasis on statistical summaries and geographical distributions. Earlier reports are listed in Annex 5.

Table 1 and Figure 1 show the location of the monitoring stations reporting data from whole or part of 2003. In total 131 stations in 27 different countries reported data. One of these sites (Ispra) is operated by the Commission of the European Communities in Italy.

Table 1: List of EMEP ozone monitoring stations in operation 2003.

Code	Station	Country	Latitude	Longitude	Altitude (m)
AT0002R	Illmitz	Austria	47 46 00 N	16 46 00 E	117
AT0004R	St. Koloman	Austria	47 39 00 N	13 12 00 E	851
AT0005R	Vorhegg	Austria	46 40 40 N	12 58 20 E	1020
AT0030R	Pillersdorf bei Retz	Austria	48 43 16 N	15 56 32 E	315
AT0032R	Sulzberg	Austria	47 31 45 N	09 55 36 E	1020
AT0033R	Stolzalpe bei Murau	Austria	47 07 45 N	14 12 14 E	1302
AT0034G	Sonnblick	Austria	47 03 16 N	12 57 30 E	3106
AT0037R	Zillertaler Alpen	Austria	47 08 13 N	11 52 12 E	1970
AT0038R	Gerlitzen	Austria	46 41 37 N	13 54 54 E	1895
AT0040R	Masenberg	Austria	47 20 53 N	15 52 56 E	1170
AT0041R	Haunsberg	Austria	47 58 23 N	13 00 58 E	730
AT0042R	Heidenreichstein	Austria	48 52 43 N	15 02 48 E	570
AT0043R	Forsthof	Austria	48 06 22 N	15 55 10 E	581
AT0044R	Graz Platte	Austria	47 06 47 N	15 28 14 E	651
AT0045R	Dunkelsteinerwald	Austria	48 22 16 N	15 32 48 E	320
AT0046R	Gänserndorf	Austria	48 20 05 N	16 43 50 E	161
AT0047R	Stixneusiedl	Austria	48 03 03 N	16 40 36 E	240
AT0048R	Zoebelboden	Austria	47 50 19 N	14 26 29 E	899
BE0001R	Offagne	Belgium	49 52 40 N	05 12 13 E	430
BE0032R	Eupen	Belgium	50 37 46 N	06 00 10 E	295
BE0035R	Vezin	Belgium	50 30 12 N	04 59 22 E	160
BG0053R	Rojen Peak	Bulgaria	41 41 45 N	24 44 19 E	1750
CH0002R	Payerne	Switzerland	46 49 00 N	06 57 00 E	500
CH0003R	Tänikon	Switzerland	47 29 00 N	08 54 00 E	540
CH0004R	Chaumont	Switzerland	47 03 04 N	06 58 50 E	1130
CH0005R	Rigi	Switzerland	47 04 10 N	08 27 56 E	1028
CZ0001R	Svratouch	Czech Republic	49 44 00 N	16 02 00 E	737
CZ0003R	Kosetice	Czech Republic	49 35 00 N	15 05 00 E	534
DE0001R	Westerland	Germany	54 55 32 N	08 18 35 E	12
DE0002R	Langenbrügge	Germany	52 48 08 N	10 45 34 E	74
DE0003R	Schauinsland	Germany	47 54 53 N	07 54 31 E	1205
DE0004R	Deuselbach	Germany	49 45 53 N	07 03 07 E	480
DE0005R	Brotjacklriegel	Germany	48 49 10 N	13 13 09 E	1016
DE0007R	Neuglobsow	Germany	53 10 00 N	13 02 00 E	65
DE0008R	Schmücke	Germany	50 39 00 N	10 46 00 E	937
DE0009R	Zingst	Germany	54 26 00 N	12 44 00 E	1
DE0012R	Bassum	Germany	52 51 00 N	08 42 00 E	52
DE0026R	Ueckermünde	Germany	53 27 00 N	14 24 00 E	1
DE0035R	Lückendorf	Germany	50 50 00 N	14 46 00 E	490
DE0039R	Aukrug	Germany	54 02 24 N	09 28 48 E	15
DE0042R	Öhringen	Germany	49 14 32 N	09 26 50 E	283
DE0045R	Schorfheide	Germany	52 58 00 N	13 39 00 E	70
DE0046R	Raisting	Germany	47 54 00 N	11 06 00 E	552
DE0047R	Falkenberg	Germany	52 10 00 N	14 07 00 E	73
DK0005R	Keldsnor	Denmark	54 44 00 N	10 44 00 E	10
DK0031R	Ulborg	Denmark	56 17 00 N	08 26 00 E	10
DK0041R	Lille Valby	Denmark	55 41 13 N	12 07 34 E	10
EE0009R	Lahemaa	Estonia	59 30 00 N	25 54 00 E	32
EE0011R	Vilsandy	Estonia	58 23 00 N	21 49 00 E	6
ES0007R	Víznar	Spain	37 14 18 N	03 28 28 W	1230
ES0008R	Niembro	Spain	43 26 32 N	04 51 01 W	134
ES0009R	Campisabalos	Spain	41 16 52 N	03 08 34 W	1360
ES0010R	Cabo de Creus	Spain	42 19 10 N	03 19 01 E	23
ES0011R	Barcarrola	Spain	38 28 33 N	06 55 22 W	393
ES0012R	Zarra	Spain	39 05 10 N	01 06 07 W	885
ES0013R	Penausende	Spain	41 17 00 N	05 52 00 W	985
ES0014R	Els Torms	Spain	41 24 00 N	00 43 00 E	470
ES0015R	Risco Llamo	Spain	39 31 00 N	04 21 00 W	1241
ES0016R	O Saviñao	Spain	43 13 52 N	07 41 59 W	506

Table 1, cont.

Code	Station	Country	Latitude	Longitude	Altitude (m)
FI0009R	Utö	Finland	59 46 45 N	21 22 38 E	7
FI0017R	Virolahti II	Finland	60 31 36 N	27 41 10 E	8
FI0022R	Oulanka	Finland	66 19 13 N	29 24 06 E	310
FI0037R	Ahtari II	Finland	62 35 00 N	24 11 00 E	180
FR0008R	Donon	France	48 30 00 N	07 08 00 E	775
FR0009R	Revin	France	49 54 00 N	04 38 00 E	390
FR0010R	Morvan	France	47 16 00 N	04 05 00 E	620
FR0012R	Iraty	France	43 02 00 N	01 05 00 W	1300
FR0013R	Peyrusse Vieille	France	43 22 29 N	00 06 16 E	236
FR0014R	Montandon	France	47 18 00 N	06 49 00 E	746
FR0015R	La Tardière	France	49 37 00 N	01 50 00 E	
FR0016R	Le Casset	France	45 39 00 N	06 31 00 E	
GB0002R	Eskdalemuir	United Kingdom	55 18 47 N	03 12 15 W	269
GB0006R	Lough Navar	United Kingdom	54 26 35 N	07 52 12 W	130
GB0013R	Yarner Wood	United Kingdom	50 35 47 N	03 42 47 W	119
GB0014R	High Muffles	United Kingdom	54 20 04 N	00 48 27 W	267
GB0015R	Strath Vaich Dam	United Kingdom	57 44 04 N	04 46 28 W	270
GB0031R	Aston Hill	United Kingdom	52 30 14 N	03 01 59 W	370
GB0032R	Bottesford	United Kingdom	52 55 46 N	00 48 55 W	32
GB0033R	Bush	United Kingdom	55 51 31 N	03 12 18 W	180
GB0034R	Glazebury	United Kingdom	53 27 31 N	02 27 59 W	21
GB0035R	Great Dun Fell	United Kingdom	54 41 00 N	02 27 00 W	847
GB0036R	Harwell	United Kingdom	51 34 23 N	01 19 00 W	137
GB0037R	Ladybower Res.	United Kingdom	53 23 56 N	01 45 12 W	420
GB0038R	Lullington Heath	United Kingdom	50 47 34 N	00 10 46 E	120
GB0039R	Sibton	United Kingdom	52 17 38 N	01 27 47 E	46
GB0043R	Narberth	United Kingdom	51 46 53 N	04 41 34 W	160
GB0044R	Somerton	United Kingdom	51 13 52 N	03 02 53 W	55
GB0045R	Wicken Fen	United Kingdom	52 17 54 N	00 17 34 W	5
GR0001R	Aliartos	Greece	38 22 00 N	23 05 00 E	110
GR0002R	Finokalia	Greece	35 19 00 N	25 40 00 E	0
HU0002R	K-puszta	Hungary	46 58 00 N	19 35 00 E	125
IE0031R	Mace Head	Ireland	53 10 00 N	09 30 00 W	15
IT0001R	Montelibretti	Italy	42 06 00 N	12 38 00 E	48
LT0015R	Preila	Lithuania	55 21 00 N	21 04 00 E	5
LV0010R	Rucava	Latvia	56 13 00 N	21 13 00 E	5
MT0001R	Giordan lighthouse	Malta	36 06 00 N	14 12 00 E	160
NL0009R	Kollumerwaard	Netherlands	53 20 02 N	06 16 38 E	1
NL0010R	Vredepeel	Netherlands	51 32 28 N	05 51 13 E	28
NO0001R	Birkenes	Norway	58 23 00 N	08 15 00 E	190
NO0015R	Tustervatn	Norway	65 50 00 N	13 55 00 E	439
NO0039R	Kårvatn	Norway	62 47 00 N	08 53 00 E	210
NO0041R	Osen	Norway	61 15 00 N	11 47 00 E	440
NO0042G	Spitsbergen, Zeppelinfjell	Norway	78 54 00 N	11 53 00 E	474
NO0043R	Prestebakke	Norway	59 00 00 N	11 32 00 E	160
NO0045R	Jeløya	Norway	59 26 00 N	10 36 00 E	3
NO0048R	Voss	Norway	60 36 00 N	06 32 00 E	500
NO0052R	Sandve	Norway	58 05 00 N	07 51 00 E	15
NO0055R	Karasjok	Norway	69 28 00 N	25 13 00 E	333
NO0056R	Hurdal	Norway	60 22 00 N	11 04 00 E	300
PL0002R	Jarczew	Poland	51 49 00 N	21 59 00 E	180
PL0003R	Sniezka	Poland	50 44 00 N	15 44 00 E	1603
PL0004R	Leba	Poland	54 45 00 N	17 32 00 E	2
PL0005R	Diabla Gora	Poland	54 09 00 N	22 04 00 E	157
PT0004R	Monte Velho	Portugal	38 05 00 N	08 48 00 W	43

Table 1, cont.

Code	Station	Country	Latitude	Longitude	Altitude (m)
RU0016R	Shepeljovo	Russia	59 58 00 N	29 07 00 E	4
RU0018R	Danki	Russia	54 54 00 N	37 48 00 E	150
SE0011R	Vavihill	Sweden	56 01 00 N	13 09 00 E	175
SE0012R	Aspvreten	Sweden	58 48 00 N	17 23 00 E	20
SE0013R	Esrange	Sweden	67 53 00 N	21 04 00 E	475
SE0014R	Råö	Sweden	57 23 38 N	11 54 50 E	5
SE0032R	Norra-Kvill	Sweden	57 49 00 N	15 34 00 E	261
SE0035R	Vindeln	Sweden	64 15 00 N	19 46 00 E	225
SE0039R	Grimsö	Sweden	59 43 40 N	15 28 19 E	132
SI0008R	Iskrba	Slovenia	45 34 00 N	14 52 00 E	520
SI0031R	Zarodnje	Slovenia	46 25 43 N	15 00 12 E	770
SI0032R	Krvavec	Slovenia	46 17 58 N	14 32 19 E	1740
SI0033R	Kovk	Slovenia	46 07 43 N	15 06 50 E	600
SK0002R	Chopok	Slovakia	48 56 00 N	19 35 00 E	2008
Sk0004R	Stará Lesná	Slovakia	49 09 00 N	20 17 00 E	808
SK0006R	Starina	Slovakia	49 03 00 N	22 16 00 E	345
SK0007R	Topolniky	Slovakia	47 57 36 N	17 51 38 E	113

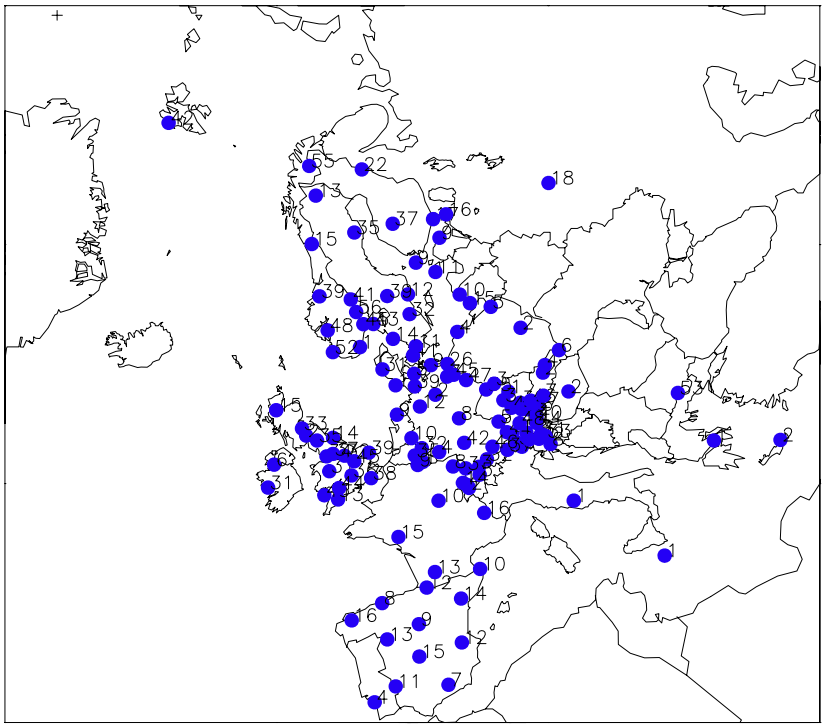

Figure 1: Location of the monitoring stations.

At Donon (FR08) the measurements are taken at four different heights above the ground:

FR08A: 8.6 m, ground level
FR08B: 17.6 m, half height of the trees
FR08C: 31.2 m, canopy of the trees
FR08D: 45.2 m, approximately 15 m above the trees

The ozone sites are situated mainly in Central, Western and Northern Europe and the network density is insufficient in the Eastern and Mediterranean parts of Europe.

The monitoring stations have been selected by the countries and only a small number of them are regular EMEP sites. Information about the ozone data quality, calibration and maintenance procedures have during 2000 been collected from the participants (Aas et al., 2000).

The UV-absorption method was the only measurement method in use in 2003.

All data presented in this report are given in µg/m^3. The conversion factor used to calculate from ppb to µg/m^3 is given in Table 2. Most countries use a conversion factor of 2.0, which corresponds to 20°C and 1013 hPa. Switzerland uses the mean annual conditions at the stations (9°C and 950 mbar at Payerne, Tänikon, Rigi, Chaumont and Sion). A number of countries report ozone data in ppb, and in this case the data are converted to µg/m^3 by multiplying by 2.0 at the CCC.

Table 2: Conversion factor ppb – µg/m^3.

Country	Conversion factor
Austria	2.0
Belgium	unknown
Czech Republic	2.0
Denmark	2.0
Estonia	2.14
Finland	2.0
France	2.0
Germany	2.0
Greece (Aliartos)	1.96
Greece (Finokalia)	reported in ppb
Hungary	2.0
Ireland (Mace Head)	reported in ppb
Italy (Ispra)	2.0
Italy (Montelibretti)	reported in ppb
Latvia	2.0
Lithuania	2.0
Netherlands	2.0
Norway	2.0
Poland	2.0
Portugal	1.96
Russia	2.0
Slovakia	reported in ppb
Slovenia	2.0
Spain	2.0
Sweden	2.0
Switzerland	1.96
United Kingdom	reported in ppb

4. Data completeness

The annual data capture (number of valid measurements in per cent of the total number of measurements) for each station is given in Table 3. The capture was in general good, and in 2003 more than 100 stations had a capture above 90%. Excluding two Norwegian sites which was closed down during 2003, eight sites was below 75%.

Table 3: Data capture in per cent, 2003.

Code	Station	Data capture 2003
AT0002R	Illmitz	94.3
AT0004R	St. Koloman	94.1
AT0005R	Vorhegg	95.6
AT0030R	Pillersdorf bei Retz	95.5
AT0032R	Sulzberg	96.5
AT0033R	Stolzalpe bei Murau	90.8
AT0034G	Sonnblick	94.3
AT0037R	Zillertaler Alpen	94.4
AT0038R	Gerlitzen	94.2
AT0040R	Masenberg	95.0
AT0041R	Haunsberg	96.8
AT0042R	Heidenreichstein	95.6
AT0043R	Forsthof	95.4
AT0044R	Graz Platte	91.6
AT0045R	Dunkelsteinerwald	95.1
AT0046R	Gänserndorf	95.8
AT0047R	Stixneusiedl	87.5
AT0048R	Zoebelboden	95.3
BE0001R	Offagne	89.4
BE0032R	Eupen	90.5
BE0035R	Vezin	92.3
BG0053R	Rojen peak	98.6
CH0002R	Payerne	95.4
CH0003R	Tänikon	95.4
CH0004R	Chaumont	95.1
CH0005R	Rigi	94.6
CZ0001R	Svratouch	81.1
CZ0003R	Košetice	83.2
DE0001R	Westerland	93.1
DE0002R	Langenbrügge	95.6
DE0003R	Schauinsland	94.2
DE0004R	Deuselbach	95.9
DE0005R	Brotjacklriegel	73.4
DE0007R	Neuglobsow	90.4
DE0008R	Schmücke	93.6
DE0009R	Zingst	95.7
DE0012R	Bassum	91.9
DE0026R	Ueckermünde	95.2
DE0035R	Lückendorf	91.1
DE0039R	Aukrug	91.0
DE0042R	Öhringen	95.7
DE0045R	Schorfheide	91.2

Table 3, cont.

Code	Station	Data capture 2003
DE0046R	Raisting	95.3
DE0047R	Falkenberg	93.5
DK0005R	Keldsnor	99.9
DK0031R	Ulborg	57.8
DK0041R	Lille Valby	96.5
EE0009R	Lahemaa	97.4
EE0011R	Vilsandy	93.0
ES0007R	Víznar	97.0
ES0008R	Niembro	92.2
ES0009R	Campisabalos	95.4
ES0010R	Cabo de Creus	95.1
ES0011R	Barcarrola	97.3
ES0012R	Zarra	97.0
ES0013R	Penausende	95.9
ES0014R	Els Torms	97.0
ES0015R	Risco Llamo	96.9
ES0016R	O Saviñao	92.4
FI0009R	Utö	92.3
FI0017R	Virolahti II	97.8
FI0022R	Oulanka	97.1
FI0037R	Ahtari II	92.4
FR0008R	Donon A	97.4
FR0008R	Donon B	96.2
FR0008R	Donon D	98.8
FR0008R	Donon C	98.7
FR0009R	Revin	99.0
FR0010R	Morvan	97.9
FR0012R	Iraty	86.6
FR0013R	Peyrusse Vieille	96.5
FR0014R	Montandon	95.5
FR0015R	La Tardière	97.1
FR0016R	Le Casset	97.3
GB0002R	Eskdalemuir	96.4
GB0006R	Lough Navar	72.9
GB0013R	Yarner Wood	98.8
GB0014R	High Muffles	98.7
GB0015R	Strath Vaich Dam	86.8
GB0031R	Aston Hill	99.1
GB0032R	Bottesford	98.9
GB0033R	Bush	98.6
GB0034R	Glazebury	88.7
GB0035R	Great Dun Fell	99.0
GB0036R	Harwell	96.1
GB0037R	Ladybower Res.	98.1
GB0038R	Lullington Heath	95.5
GB0039R	Sibton	91.8
GB0043R	Narberth	88.6
GB0044R	Somerton	97.3
GB0045R	Wicken Fen	98.6
GR0001R	Aliartos	71.6
GR0002R	Finokalia	60.4
HU0002R	K-puszta	83.6

Table 3, cont.

Code	Station	Data capture 2003
IE0031R	Mace Head	97.1
IT0001R	Montelibretti	98.1
LT0015R	Preila	95.1
LV0010R	Rucava	93.3
MT0001R	Giordan lighthouse	80.3
NL0009R	Kollumerwaard	98.7
NL0010R	Vredepeel	98.5
NO0001R	Birkenes	98.9
NO0015R	Tustervatn	90.4
NO0039R	Kårvatn	99.8
NO0041R	Osen	97.4
NO0042G	Spitsbergen, Zeppelinfjell	98.0
NO0043R	Prestebakke	99.0
NO0045R	Jeløya	32.9
NO0048R	Voss	32.8
NO0052R	Sandve	99.8
NO0055R	Karasjok	99.8
NO0056R	Hurdal	99.3
PL0002R	Jarczew	99.9
PL0003R	Sniezka	100.0
PL0004R	Leba	100.0
PL0005R	Diabla Gora	98.1
PT0004R	Monte Velho	89.0
RU0016R	Shepeljovo	49.5
RU0018R	Danki	97.6
SE0011R	Vavihill	98.3
SE0012R	Aspvreten	96.1
SE0013R	Esrange	99.9
SE0014R	Råö	98.9
SE0032R	Norra-Kvill	99.6
SE0035R	Vindeln	98.4
SE0039R	Grimsö	99.7
SI0008R	Iskrba	91.5
SI0031R	Zarodnje	94.0
SI0032R	Krvavec	96.6
SI0033R	Kovk	89.0
SK0002R	Chopok	58.7
SK0004R	Stará Lesná	96.3
SK0006R	Starina	98.8
SK0007R	Topolniky	99.2

Missing data in the measurement series may be critical, especially in summer when the highest ozone concentrations occur. In particular calculations of AOT40 values may be strongly affected by missing data, and a correction is necessary in order to obtain comparable calculations. In the mapping of AOT40, a 85% data capture has been required and an adjustment proportional to the number of missing data has been applied, i.e. exposure index divided by the fraction of data available. This correction will give a good approximation when the missing data

are randomly scattered throughout the dataset, but a better correction is needed for larger gaps in the dataset. Calculations of percentiles are less sensitive to missing data, and a data capture of 75% has been regarded as sufficient for the mapping.

5. Concentration summaries and episodes

The summer 2003 was an extremely warm and dry summer in Europe, leading to a health crisis in several countries as well as considerable impacts on crops and vegetation. The warm and sunny weather contributed to higher ozone levels than usual during the summer, with numerous ozone episodes during July and August.

Table 1.1 in Annex 1 shows the extreme concentrations for 2003. The number of hours and days the ozone concentrations exceed 120, 150, 180 and 200 µg/m^3 and the maxima are given. The highest hourly mean values were found at Eupen, Belgium (296 µg/m^3, 8th August), Montelibretti, Italy (287 µg/m^3, 6th June) and Donon, France (259 µg/m^3, 11th August).

Values above 200 µg/m^3 were during 2003 measured at 44 sites in Central Europe, compared to 7 sites in 2002 and 14 sites in 2001. The lowest maximum values were observed at Zeppelinfjellet, Spitsbergen (109 µg/m^3, 17th April).

The one hour critical level for ozone formulated by the ECE for protection of vegetation, 150 µg/m^3, was in 2003 exceeded at all sites in Central and Southern Europe (Figure 1.3). At several sites in Austria, Switzerland, Germany and Slovenia the limit was exceeded more than 40 days.

Figure 1.4 shows the number of exceedances of the threshold value of 180 µg/m^3 formulated by the EU for informing the public. At Montelibretti, the threshold value was exceeded 30 days, while 13 additional sites measured above 180 µg/m^3 for at least 10 days. In total values above 180 µg/m^3 were measured at 75 sites.

Table 1.2 shows the 25-, 50-, 75-, 90-, 95-, 98- and 99-percentiles for the period April–September. Graphical distributions of the 99-percentile and 95-percentile are shown in Figure 1.1 and Figure 1.2. The lowest values are found in the Baltics, Ireland, Scotland and Scandinavia, where the 99-percentile is below 140 µg/m^3. The concentrations are higher in Central Europe, where the 99-percentile generally ranges from 160-200 µg/m^3. The concentration levels on the Iberian Peninsula are variable, possibly due to local influence and topographical differences.

6. Calculation of AOT40

According to the workshop on critical levels for ozone in Europe, held in Kuopio, 1996, the AOT40 values for forest and agricultural crops are accumulated during daylight hours only, defined as hours with mean global radiation exceeding 50 W/m^2. Since the CCC has no access to measurements of global radiation, a simple approach have been used for the calculations in this report, defining daylight as solar zenith angle less that 80°.

AOT40 and AOT60 for forests and agricultural crops for 2003 are shown in Tables 2.1 and 2.2 in Annex 2, and the corresponding geographical distributions of AOT40 and AOT60 in Figures 2.1-2.4. The maps of AOT40 show a general increasing gradient from west to east. The lowest values are found in Scandinavia, in the Baltic region and in the northern parts of Ireland and the United Kingdom, while the highest values are found in Austria, Hungary, Slovenia and on Malta.

The maps show that the exceedances of the critical levels are considerable. The critical level for forests (10 000 ppbh) is exceeded in larger parts of Central and Eastern Europe. Several stations in Central Europe had AOT40 values above 30 000 ppbh. The critical level for agricultural crops, 3000 ppbh, was in 2003 exceeded at most stations in Central Europe.

7. Seasonal variation

Monthly mean concentrations for 2003 are given in Table 3.1 in Annex 3 and monthly data capture in Table 3.2. The concentrations show a clear pattern with maximum values during spring or early summer and a minimum in winter. As mentioned in Chapter 5, the summer in 2003 was very special giving very high maximum values in July and August. The seasonal variations is the net result of a number of processes such as dry deposition, photochemical loss (titration with NO_x) and formation, and varying influx from the stratosphere as well as varying background ozone concentrations.

Plots of the seasonal variations 1990–2003 are given in Figure 3.1.

The seasonal variation of ozone shows characteristics, which seem to be bound by the geographical location of the station (Roemer et al., 1996). In Central and Alpine Europe the variation is characterised by a broad summer maximum with high monthly means from May to August. A springtime maximum in April and May followed by a gradual decline to a minimum in November-December is found for sites in England, the Netherlands and the southern parts of Scandinavia and Finland. A springtime maximum followed by a minimum in the summer is generally found in Ireland, Scotland and the northern parts of Scandinavia and Finland.

8. Diurnal variation

In addition to the seasonal variation, ozone concentrations show a variation on a shorter time scale. The diurnal variation is a result of the variation in vertical mixing, surface dry deposition and photochemistry. Thus, coastal and mountain sites away from NO_x sources generally show the least diurnal cycles, whereas diurnal cycles will be most pronounced at inland sites in spring and summer.

The average diurnal variation of surface ozone for summer (April–September) 2003 is shown in Annex 4. In general the lowest concentrations are found in early morning and the highest in the afternoon.

The most pronounced diurnal variation is found at the rural sites in Central Europe e.g. sites in Switzerland, most of the German sites and Ispra in Italy. Typical for those sites is a more marked peak in the diurnal cycle with a characteristic maximum around mid-afternoon. The pronounced diurnal peak during the summer months is due to photochemical generation of ozone during daytime as a result of higher temperature and insolation during this time of the day. However, during the night, more stable atmospheric conditions and nocturnal inversions prevent the vertical mixing and the transport of ozone from the free troposphere into the boundary layer.

A weaker diurnal variation is observed at the coastal and island stations and at the remote sites in Norway and Sweden. Mace Head, situated on the west coast of Ireland, has roughly the same average concentrations as the rural sites in Central Europe but almost no diurnal variation due to remoteness from source areas and prevailing westerly winds. Zeppelinfjellet at Spitsbergen shows no diurnal variation.

Elevated sites like Schauinsland, Chaumont and Krvavec show a weaker diurnal cycle and the average concentration level is also high, due to influence of air from the free troposphere.

9. Update

The data compiled in this report represent the quality assured and quality controlled data at present. If errors are detected in the future, the data will be corrected in the database. It is important that users make certain they have access to the most recent version of the data. For the data presented here, the latest alteration was 14 July, 2005.

Complete data sets are available upon request to the CCC (e-mail: anne-gunn.hjellbrekke@nilu.no). Information about the EMEP network and measurement data is also available on the web at http://www.emep.int and http://www.nilu.no/projects/ccc/index.html.

10. References

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11. List of participating institutions

Austria	Umweltbundesamt Provincial Government of Tyrol Provincial Government of Carinthia Environment Institute Vorarlberg Provincial Government Styria Provincial Government Salzburg Provincial Government Lower Austria
Belgium	CELINE – IRCEL
Bulgaria	Executive Environment Agency
Commission of the European Communities	Joint Research Center. Ispra Establishment
Czech Republic	Czech Hydrometeorological Institute
Denmark	National Environmental Research Institute
Finland	Finnish Meteorological Institute
France	l' Ecole des Mines de Douai Laboratories Wolff
Germany	Umweltbundesamt
Greece	Environmental Chemical Processes Laboratory, University of Crete Ministry of Environmental Physical Planning and Public Works
Hungary	Institute for Atmospheric Physics, Dep. for Air Chemistry
Italy	C.N.R. Istituto Inquinamento Atmosferico
Latvia	Latvian Hydrometeorological Agency
Lithuania	Institute of Physics
Netherlands	National Institute for Public Health and Environmental Protection (RIVM)
Norway	Norwegian Institute for Air Research (NILU)
Poland	Institute of Meteorology and Water Management Institute of Environmental Protection
Portugal	Ministério do ambiente e recursos naturais
Russian Federation	Institute of Global Climate and Ecology
Slovakia	Slovak Hydrometeorological Institute
Slovenia	Hydrometeorological Institute of Slovenia
Spain	Dirección General de Calidad y Evaluacíon Ambiental
Sweden	Swedish Environmental Research Institute (IVL)
Switzerland	Swiss Federal Laboratory of Testing Materials and Research (EMPA)
United Kingdom	AEA Technology

Annex 1

Concentration summaries and episodes, tables and figures

Table 1.1: Number of hours (h) and days (d) exceeding 120, 150, 180 and 200 μg/m^3 and maximum concentrations in 2003.

Code	Station	Total		>120		>150		>180		>200		Max concentrations	
		hours	days	hours	days	hours	days	hours	days	hours	days	μg/m^3	day(s)
AT0002R	Illmitz	8258	361	962	129	187	42	26	9	5	2	227	01.07.2003
AT0004R	St. Koloman	8246	362	1348	109	307	30	51	8	0	0	198	14.08.2003
AT0005R	Vorhegg	8372	365	751	97	155	25	20	7	3	2	205	10.06.2003
AT0030R	Pillersdorf bei Retz	8366	365	781	106	120	29	10	5	0	0	194	14.08.2003
AT0032R	Sulzberg	8456	358	1599	119	415	43	68	11	9	2	209	12.08.2003
AT0033R	Stolzalpe bei Murau	7958	350	557	76	61	9	2	1	0	0	183	10.08.2003
AT0034G	Sonnblick	8261	365	2109	171	188	27	33	4	1	1	202	08.08.2003
AT0037R	Zillertaler Alpen	8272	361	1641	137	182	16	14	4	0	0	188	08.08.2003
AT0038R	Gerlitzen	8255	363	1407	123	168	31	1	1	0	0	181	11.06.2003
AT0040R	Masenberg	8320	365	1946	136	344	50	7	1	0	0	186	13.08.2003
AT0041R	Haunsberg	8484	363	1177	111	308	43	33	9	0	0	200	13.08.2003
AT0042R	Heidenreichstein	8372	365	771	110	117	27	6	2	0	0	194	13.08.2003
AT0043R	Forsthof	8360	365	1222	119	261	43	24	8	6	2	214	13.08.2003
AT0044R	Graz Platte	8022	355	1694	137	320	49	5	3	1	1	208	13.08.2003
AT0045R	Dunkelsteinerwald	8331	365	697	107	177	41	25	10	0	0	200	16.07.2003, 24.07.2003, 13.08.2003, 18.08.2003
AT0046R	Gänserndorf	8394	365	891	125	223	47	24	7	8	3	225	14.08.2003
AT0047R	Stixneusiedl	7662	334	808	109	144	33	18	6	3	2	213	11.06.2003
AT0048R	Zoebelboden	8348	365	1114	105	218	29	10	2	0	0	192	13.08.2003
BE0001R	Offagne	7835	349	561	72	201	25	58	11	11	6	222	15.07.2003
BE0032R	Eupen	7928	352	579	74	180	30	60	13	26	7	296	08.08.2003
BE0035R	Vezin	8085	357	381	65	141	27	46	11	19	6	239	08.08.2003
BG0053R	Rojen peak	8633	363	2240	168	203	38	9	4	0	0	184.7	15.08.2003
CH0002R	Payerne	8353	365	790	108	223	44	26	8	6	2	218.6	13.08.2003
CH0003R	Tänikon	8357	365	742	110	208	46	30	9	7	2	215.6	12.08.2003
CH0004R	Chaumont	8331	365	1811	126	549	60	93	14	31	5	225.9	12.08.2003
CH0005R	Rigi	8284	363	1778	133	468	62	65	13	14	4	214.9	12.08.2003
CZ0001R	Svratouch	6386	272	680	70	40	10	0	0	0	0	176.3	04.08.2003
CZ0003R	Košetice	7286	304	795	104	88	18	7	2	0	0	197	13.08.2003

Table 1.1, cont.

Code	Station	Total		>120		>150		>180		>200		Max concentrations	
		hours	days	hours	days	hours	days	hours	days	hours	days	μg/m^3	day(s)
DE0001R	Westerland	8153	364	261	55	13	7	0	0	0	0	163	18.09.2003
DE0002R	Langenbrügge	8372	365	573	76	124	29	18	5	4	2	216	12.08.2003
DE0003R	Schauinsland	8256	363	1569	114	399	47	108	15	39	9	233	07.08.2003
DE0004R	Deuselbach	8405	365	833	88	251	29	57	11	22	5	224	12.08.2003
DE0005R	Brotjacklriegel	6432	279	1044	77	245	33	16	4	3	1	222	13.08.2003
DE0007R	Neuglobsow	7916	365	328	57	40	16	7	2	2	1	205	13.08.2003
DE0008R	Schmücke	8203	365	1510	113	525	49	118	12	34	5	243	12.08.2003
DE0009R	Zingst	8382	365	127	23	9	3	0	0	0	0	170	22.09.2003
DE0012R	Bassum	8047	365	308	55	66	16	9	3	5	1	238	12.08.2003
DE0026R	Ueckermünde	8337	364	245	45	35	7	2	1	0	0	186	04.06.2003
DE0035R	Lückendorf	7976	363	842	99	131	29	16	5	7	1	215	13.08.2003
DE0039R	Aukrug	7973	355	208	40	27	11	0	0	0	0	169	12.08.2003
DE0042R	Öhringen	8385	365	732	95	199	34	33	10	5	3	215	10.08.2003, 13.08.2003
DE0045R	Schorfheide	7989	363	519	80	105	22	18	5	6	1	211	13.08.2003
DE0046R	Raisting	8348	365	603	95	130	28	20	5	0	0	193	11.08.2003
DE0047R	Falkenberg	8190	365	520	79	110	22	20	4	7	2	222	13.08.2003
DK0005R	Keldsnor	8751	365	64	14	6	3	0	0	0	0	170	22.09.2003
DK0031R	Ulborg	5067	212	125	23	0	0	0	0	0	0	147	21.04.2003
DK0041R	Lille Valby	8457	360	80	16	5	2	0	0	0	0	167	18.09.2003
EE0009R	Lahemaa	8533	362	48	12	4	1	0	0	0	0	171	22.04.2003
EE0011R	Vilsandy	8148	345	82	17	0	0	0	0	0	0	141	27.07.2003
ES0007R	Víznar	8498	365	170	40	1	1	0	0	0	0	155	14.08.2003
ES0008R	Niembro	8079	350	104	22	0	0	0	0	0	0	149	03.08.2003
ES0009R	Campisabalos	8356	362	450	64	37	11	1	1	0	0	184	28.06.2003
ES0010R	Cabo de Creus	8328	361	1067	110	162	30	10	6	3	2	212	21.06.2003
ES0011R	Barcarrola	8526	365	264	39	26	6	0	0	0	0	180	11.08.2003
ES0012R	Zarra	8495	363	677	88	18	10	0	0	0	0	165	14.08.2003
ES0013R	Penausende	8403	357	774	86	167	24	4	2	0	0	196	11.07.2003
ES0014R	Els Torms	8501	365	789	106	52	23	1	1	0	0	182	15.08.2003
ES0015R	Risco Llamo	8492	365	1087	103	93	17	0	0	0	0	179	14.08.2003
ES0016R	O Saviñao	8090	357	122	26	0	0	0	0	0	0	150	19.03.2003, 20.03.2003, 22.03.2003

Table 1.1, cont.

Code	Station	Total		>120		>150		>180		>200		Max concentrations	
		hours	days	hours	days	hours	days	hours	days	hours	days	μg/m^3	day(s)
FI0009R	Utö	8088	343	39	9	0	0	0	0	0	0	142	31.07.2003
FI0017R	Virolahti II	8567	364	27	8	2	2	0	0	0	0	157	31.07.2003
FI0022R	Oulanka	8505	360	21	5	3	1	0	0	0	0	153	21.04.2003
FI0037R	Ahtari II	8093	348	26	4	0	0	0	0	0	0	135	16.04.2003
FR0008R	Donon A	8533	365	1158	96	395	40	71	13	15	6	254	11.08.2003
FR0008R	Donon B	8428	362	1245	100	431	40	82	13	21	6	259	11.08.2003
FR0008R	Donon D	8657	365	1332	105	466	42	88	14	25	7	253	11.08.2003
FR0008R	Donon C	8649	365	1256	99	428	40	80	13	20	6	255	11.08.2003
FR0009R	Revin	8673	365	589	61	201	22	57	8	22	7	239	08.08.2003
FR0010R	Morvan	8576	361	683	79	95	22	7	4	0	0	195	07.08.2003
FR0012R	Iraty	7583	334	1079	101	167	33	3	1	0	0	192	08.08.2003
FR0013R	Peyrusse Vieille	8456	356	472	57	72	16	4	1	0	0	192	08.08.2003
FR0014R	Montandon	8369	358	583	72	176	26	36	6	2	1	204	12.08.2003
FR0015R	La Tardière	8505	356	453	62	111	20	16	4	1	1	203	08.08.2003
FR0016R	Le Casset	8526	362	1533	119	121	20	0	0	0	0	169	20.09.2003
GB0002R	Eskdalemuir	8444	357	58	13	0	0	0	0	0	0	146	09.08.2003
GB0006R	Lough Navar	6384	272	14	3	1	1	0	0	0	0	154	08.08.2003
GB0013R	Yarner Wood	8659	365	256	36	73	16	11	4	0	0	200	05.08.2003
GB0014R	High Muffles	8643	365	34	8	0	0	0	0	0	0	144	04.08.2003
GB0015R	Strath Vaich Dam	7604	324	118	22	4	2	0	0	0	0	154	17.04.2003
GB0031R	Aston Hill	8682	364	151	20	32	6	6	1	0	0	188	15.07.2003
GB0032R	Bottesford	8668	365	188	32	50	12	14	5	4	2	204	06.08.2003, 09.08.2003
GB0033R	Bush	8636	365	52	12	0	0	0	0	0	0	144	24.03.2003
GB0034R	Glazebury	7774	328	72	12	22	6	0	0	0	0	174	09.08.2003
GB0035R	Great Dun Fell	8675	363	185	16	34	6	1	1	0	0	182	09.08.2003
GB0036R	Harwell	8417	361	289	43	124	23	40	10	11	4	246	15.07.2003
GB0037R	Ladybower Res.	8593	364	137	26	27	9	1	1	0	0	182	04.08.2003
GB0038R	Lullington Heath	8369	360	401	46	160	25	43	7	18	4	236	11.08.2003
GB0039R	Sibton	8038	340	108	22	14	4	3	1	0	0	188	06.08.2003
GB0043R	Narberth	7757	340	110	14	15	4	0	0	0	0	170	16.04.2003
GB0044R	Somerton	8521	364	218	35	68	15	3	1	0	0	192	15.07.2003
GB0045R	Wicken Fen	8634	365	183	30	45	9	8	2	4	1	230	06.08.2003

Table 1.1, cont.

Code	Station	Total		>120		>150		>180		>200		Max concentrations	
		hours	days	hours	days	hours	days	hours	days	hours	days	μg/m^3	day(s)
GR0001R	Aliartos	6271	265	0	0	0	0	0	0	0	0	117	25.03.2003
GR0002R	Finokalia	5294	232	1298	97	101	15	0	0	0	0	166.9	11.05.2003
HU0002R	K-puszta	7320	310	690	102	161	34	9	3	0	0	186	11.06.2003
IE0031R	Mace Head	8504	360	78	12	2	1	0	0	0	0	156	17.04.2003
IT0001R	Montelibretti	8595	362	832	141	261	73	59	30	19	12	287	13.06.2003
LT0015R	Preila	8330	354	59	12	1	1	0	0	0	0	154	19.09.2003
LV0010R	Rucava	8172	346	22	6	0	0	0	0	0	0	144	05.06.2003
MT0001R	Giordan lighthouse	7033	304	2142	161	208	49	6	3	0	0	195	14.08.2003
NL0009R	Kollumerwaard	8645	364	36	9	5	4	0	0	0	0	157	09.08.2003
NL0010R	Vredepeel	8630	365	230	44	89	19	24	7	11	4	244	07.08.2003
NO0001R	Birkenes	8667	365	9	6	0	0	0	0	0	0	126.9	21.04.2003
NO0015R	Tustervatn	7919	333	83	7	0	0	0	0	0	0	145.2	18.04.2003
NO0039R	Kårvatn	8741	365	72	10	15	2	0	0	0	0	162.2	17.04.2003
NO0041R	Osen	8529	359	51	9	5	2	0	0	0	0	162	18.04.2003
NO0042G	Spitsbergen, Zeppelinfjell	8586	362	0	0	0	0	0	0	0	0	109.4	17.04.2003
NO0043R	Prestebakke	8669	364	56	11	0	0	0	0	0	0	138.8	18.09.2003
NO0045R	Jeløya	2879	120	9	3	0	0	0	0	0	0	129.6	21.04.2003
NO0048R	Voss	2877	120	67	12	0	0	0	0	0	0	141.2	19.04.2003
NO0052R	Sandve	8742	365	58	13	0	0	0	0	0	0	143.3	15.04.2003
NO0055R	Karasjok	8743	365	48	4	5	2	0	0	0	0	156.4	18.04.2003
NO0056R	Hurdal	8702	365	33	7	0	0	0	0	0	0	142.7	17.04.2003
PL0002R	Jarczew	8755	365	206	41	15	5	0	0	0	0	162	27.07.2003, 23.09.2003
PL0003R	Sniezka	8757	365	787	89	60	13	8	2	2	1	202	13.08.2003
PL0004R	Leba	8758	365	133	29	8	3	1	1	0	0	182	19.09.2003
PL0005R	Diabla Gora	8596	363	155	33	9	4	0	0	0	0	161.6	26.02.2003
PT0004R	Monte Velho	7798	350	345	64	90	21	18	8	2	2	204	19.06.2003, 31.07.2003
RU0016R	Shepeljovo	4336	183	6	3	0	0	0	0	0	0	137.3	24.07.2003
RU0018R	Danki	8549	365	21	11	10	7	2	2	0	0	197	11.01.2003

Table 1.1, cont.

Code	Station	Total		>120		>150		>180		>200		Max concentrations	
		hours	days	hours	days	hours	days	hours	days	hours	days	$\mu g/m^3$	day(s)
SE0011R	Vavihill	8607	362	290	39	11	4	0	0	0	0	160	21.04.2003
SE0012R	Aspvreten	8419	357	133	25	6	2	0	0	0	0	158	18.09.2003
SE0013R	Esrange	8750	365	68	4	14	3	0	0	0	0	171	20.04.2003
SE0014R	Råö	8665	363	148	31	11	5	0	0	0	0	162	04.06.2003
SE0032R	Norra-Kvill	8725	365	207	23	13	2	5	1	0	0	190	18.09.2003
SE0035R	Vindeln	8619	363	44	7	1	1	0	0	0	0	155	16.04.2003
SE0039R	Grimsö	8731	365	41	11	0	0	0	0	0	0	142	04.06.2003
SI0008R	Iskrba	8019	360	850	116	139	29	11	3	3	2	210	14.08.2003
SI0031R	Zarodnje	8235	364	783	99	46	12	0	0	0	0	173	21.07.2003, 28.08.2003
SI0032R	Krvavec	8458	364	2337	159	441	56	8	5	0	0	187	13.06.2003
SI0033R	Kovk	7796	359	1161	118	216	36	6	3	0	0	185	13.08.2003
SK0002R	Chopok	5140	218	1545	118	94	24	2	1	0	0	184	13.08.2003
SK0004R	Stará Lesná	8438	356	381	60	28	10	0	0	0	0	166	23.08.2003
SK0006R	Starina	8653	364	596	95	49	15	0	0	0	0	177	14.08.2003
SK0007R	Topolniky	8691	365	881	132	161	39	16	8	2	1	232	13.08.2003

Table 1.2: Percentiles of hourly ozone values April–September 2003.

Code	Station	25%	50%	75%	90%	95%	98%	99%	Data capture
AT0002R	Illmitz	67.0	89.0	116.0	140.0	149.0	164.0	175.2	95.1
AT0004R	St. Koloman	90.0	107.0	125.0	144.0	160.0	174.0	183.0	94.5
AT0005R	Vorhegg	73.0	91.0	109.0	129.0	143.0	161.0	171.0	95.5
AT0030R	Pillersdorf bei Retz	73.0	92.0	112.0	132.0	143.0	156.0	163.0	95.3
AT0032R	Sulzberg	90.0	109.0	128.0	149.0	162.0	176.8	185.0	99.2
AT0033R	Stolzalpe bei Murau	70.0	90.0	108.0	124.0	132.0	142.0	158.0	91.5
AT0034G	Sonnblick	108.0	119.0	131.0	141.0	148.0	164.0	178.0	92.9
AT0037R	Zillertaler Alpen	98.0	113.0	127.0	140.0	148.0	165.2	175.0	95.4
AT0038R	Gerlitzen	98.0	112.0	124.0	137.0	147.0	160.0	164.0	93.6
AT0040R	Masenberg	99.0	115.0	132.0	145.0	154.0	164.0	170.5	94.5
AT0041R	Haunsberg	81.0	99.0	122.0	143.0	156.0	170.0	177.0	95.6
AT0042R	Heidenreichstein	63.0	86.0	111.0	132.0	142.0	156.0	161.0	95.1
AT0043R	Forsthof	83.0	103.0	122.0	143.0	153.0	167.3	174.0	95.3
AT0044R	Graz Platte	92.0	111.0	131.0	146.0	155.0	165.0	169.0	91.5
AT0045R	Dunkelsteinerwald	58.0	80.0	108.0	133.0	147.0	162.0	174.0	94.8
AT0046R	Gänserndorf	64.0	87.0	114.0	140.0	152.0	164.0	173.2	95.2
AT0047R	Stixneusiedl	65.0	87.0	112.0	134.0	144.0	156.2	167.0	95.4
AT0048R	Zoebelboden	86.0	103.0	120.0	137.0	150.0	163.0	169.0	95.5
BE0001R	Offagne	60.0	81.0	105.0	129.0	153.0	175.8	185.4	90.1
BE0032R	Eupen	49.0	74.0	102.0	129.0	148.0	172.0	188.4	94.7
BE0035R	Vezin	28.0	62.0	89.0	118.0	140.0	168.0	182.0	95.4
BG0053R	Rojen peak	103.3	117.6	129.5	139.0	145.5	153.5	160.1	99.3
CH0002R	Payerne	55.2	81.4	109.5	138.2	150.7	163.6	175.8	94.9
CH0003R	Tänikon	55.8	78.8	105.6	136.0	149.7	166.5	177.7	94.9
CH0004R	Chaumont	92.5	111.8	134.5	154.7	165.5	182.7	197.5	94.4
CH0005R	Rigi	93.3	111.3	132.9	151.8	163.4	177.3	185.7	93.4
CZ0001R	Svratouch	73.6	92.4	112.7	128.5	136.0	143.6	150.4	96.5
CZ0003R	Košetice	68.0	89.0	111.0	130.0	140.0	150.8	159.0	99.2
DE0001R	Westerland	77.0	87.0	101.0	113.0	123.3	135.0	142.0	92.8
DE0002R	Langenbrügge	55.0	78.0	102.0	127.0	144.0	155.0	167.0	95.0
DE0003R	Schauinsland	89.0	107.0	131.0	150.0	167.0	187.0	200.0	92.8
DE0004R	Deuselbach	68.0	88.0	113.0	137.7	155.0	174.0	187.1	95.4
DE0005R	Brotjacklriegel	89.0	110.0	131.0	148.0	158.0	166.8	174.0	66.2
DE0007R	Neuglobsow	52.0	74.0	95.0	116.0	129.0	145.0	150.9	91.3
DE0008R	Schmücke	81.0	105.0	132.0	156.0	168.0	188.0	197.0	94.4
DE0009R	Zingst	63.0	75.0	89.0	104.0	114.0	125.0	134.0	95.1
DE0012R	Bassum	45.0	66.0	86.0	112.0	130.0	146.0	158.0	91.3
DE0026R	Ueckermünde	58.0	77.0	96.0	114.0	123.0	136.0	148.0	94.0
DE0035R	Lückendorf	76.0	95.0	115.0	134.0	145.0	156.6	165.0	89.3
DE0039R	Aukrug	45.0	66.0	86.0	107.0	121.0	139.6	148.0	85.8
DE0042R	Öhringen	55.0	78.0	106.0	134.0	150.0	166.4	177.0	95.1
DE0045R	Schorfheide	54.0	80.0	104.0	125.0	140.0	155.0	170.0	90.3
DE0046R	Raisting	37.0	69.0	100.0	128.0	142.0	159.0	172.2	95.2
DE0047R	Falkenberg	57.0	77.0	101.0	126.0	139.0	157.0	168.3	92.6
DK0005R	Keldsnor	63.0	73.0	84.0	98.0	106.0	118.0	126.0	99.4
DK0031R	Ulborg	65.0	78.0	91.0	104.0	118.0	133.0	139.0	65.9
DK0041R	Lille Valby	54.0	71.0	85.0	99.0	107.0	120.0	127.7	93.9
EE0009R	Lahemaa	42.0	64.0	81.0	96.0	104.0	113.0	120.0	97.1
EE0011R	Vilsandy	68.0	80.0	92.0	103.0	111.0	120.0	126.0	98.3
ES0007R	Víznar	72.5	85.9	99.3	111.0	118.0	128.0	133.0	97.8
ES0008R	Niembro	59.1	74.2	88.1	102.0	111.0	121.0	127.8	87.0
ES0009R	Campisabalos	71.9	88.1	105.0	122.0	133.0	142.0	149.0	94.9
ES0010R	Cabo de Creus	89.7	102.0	119.0	134.1	145.0	158.0	165.3	94.9
ES0011R	Barcarrola	59.2	78.3	96.6	114.0	123.0	134.0	144.0	97.8
ES0012R	Zarra	83.3	96.1	111.8	126.0	133.0	141.0	147.0	96.9
ES0013R	Penausende	78.8	96.2	114.0	132.0	147.0	162.0	170.0	97.7
ES0014R	Els Torms	81.1	97.9	114.0	129.0	138.0	147.6	153.0	97.2
ES0015R	Risco Llamo	91.8	107.0	120.0	133.0	142.0	151.8	157.0	97.0
ES0016R	O Saviñao	44.1	59.8	77.7	92.2	101.0	112.0	120.0	90.5
FI0009R	Utö	63.0	74.0	86.0	97.0	104.0	112.0	121.0	87.1
FI0017R	Virolahti II	41.0	61.0	79.0	93.0	101.0	109.0	116.0	96.6
FI0022R	Oulanka	52.0	67.0	82.0	93.0	101.0	110.0	114.0	94.9
FI0037R	Ahtari II	48.0	65.0	81.0	95.0	102.0	111.2	118.0	91.9
FR0008R	Donon A	77.0	95.0	120.0	147.0	161.3	178.0	191.0	96.4
FR0008R	Donon B	79.0	97.0	122.0	150.0	163.0	180.0	193.7	96.4
FR0008R	Donon D	81.0	98.0	124.0	151.0	164.0	181.0	193.0	97.9
FR0008R	Donon C	80.0	97.5	122.0	150.0	163.0	180.0	192.0	97.8
FR0009R	Revin	59.0	78.0	103.0	129.0	149.0	172.0	189.0	98.5

Table 1.2, cont.

Code	Station	25%	50%	75%	90%	95%	98%	99%	Data capture
FR0010R	Morvan	67.0	87.0	108.0	128.0	139.0	151.9	162.5	96.8
FR0012R	Iraty	88.0	104.0	122.0	138.0	149.0	157.8	164.0	85.6
FR0013R	Peyrusse Vieille	68.0	84.0	103.0	123.0	136.0	149.0	156.6	96.5
FR0014R	Montandon	58.0	77.0	100.0	128.0	147.0	166.0	179.0	97.0
FR0015R	La Tardière	61.0	78.0	99.0	123.0	137.6	156.0	168.0	94.0
FR0016R	Le Casset	99.0	112.0	126.0	138.0	146.0	153.0	156.0	95.7
GB0002R	Eskdalemuir	42.0	58.0	72.0	86.0	96.0	116.0	126.0	92.6
GB0006R	Lough Navar	32.0	54.0	66.0	78.0	88.0	98.7	115.4	55.4
GB0013R	Yarner Wood	54.0	70.0	86.0	106.0	124.8	148.0	162.0	98.2
GB0014R	High Muffles	44.0	56.0	68.0	82.0	92.0	106.0	116.0	98.2
GB0015R	Strath Vaich Dam	62.0	72.0	88.0	100.0	110.0	124.0	134.0	90.8
GB0031R	Aston Hill	56.0	68.0	80.0	98.0	112.0	134.0	146.0	99.1
GB0032R	Bottesford	44.0	64.0	84.0	102.0	118.0	140.0	154.0	97.8
GB0033R	Bush	50.0	62.0	74.0	86.0	94.0	108.0	118.0	97.7
GB0034R	Glazebury	18.0	42.0	64.0	82.0	96.0	122.0	140.8	78.8
GB0035R	Great Dun Fell	58.0	68.0	80.0	100.0	116.0	134.0	146.0	99.2
GB0036R	Harwell	52.0	70.0	88.0	108.0	130.0	162.0	180.0	96.9
GB0037R	Ladybower Res.	50.0	62.0	76.0	92.0	108.0	132.0	146.8	96.9
GB0038R	Lullington Heath	56.0	74.0	92.0	120.0	144.0	168.0	184.0	93.1
GB0039R	Sibton	46.0	64.0	80.0	96.0	110.0	126.0	140.0	98.5
GB0043R	Narberth	40.0	52.0	72.0	94.0	106.0	126.0	133.1	94.4
GB0044R	Somerton	52.0	70.0	86.0	104.0	122.0	146.0	158.0	96.7
GB0045R	Wicken Fen	36.0	58.0	80.0	98.0	116.0	140.0	152.0	98.0
GR0001R	Aliartos	7.0	23.0	52.0	70.0	76.0	80.0	82.9	57.2
GR0002R	Finokalia	100.3	113.7	127.0	137.6	144.2	154.6	157.7	76.2
HU0002R	K-puszta	55.0	81.0	110.0	134.0	147.0	163.0	169.0	87.7
IE0031R	Mace Head	66.0	76.0	90.0	102.0	108.0	120.0	126.0	94.9
IT0001R	Montelibretti	33.0	68.0	111.0	140.0	156.0	175.0	186.8	96.0
LT0015R	Preila	53.0	67.0	81.0	93.5	102.0	109.7	121.9	98.2
LV0010R	Rucava	33.0	55.0	70.0	82.2	92.0	103.0	114.0	98.3
MT0001R	Giordan lighthouse	108.0	120.0	131.0	143.0	150.0	158.0	162.0	90.2
NL0009R	Kollumerwaard	44.0	62.0	77.0	90.0	101.0	112.0	118.8	98.4
NL0010R	Vredepeel	26.0	51.0	75.0	102.0	122.0	151.0	166.2	97.5
NO0001R	Birkenes	45.1	62.6	76.7	88.5	95.2	104.8	111.7	98.5
NO0015R	Tustervatn	59.7	72.8	87.2	97.0	106.2	119.4	128.8	97.4
NO0039R	Kårvatn	34.4	59.0	81.2	96.8	105.6	118.6	130.8	99.2
NO0041R	Osen	39.2	61.0	82.2	93.6	101.8	111.4	121.7	95.0
NO0042G	Spitsbergen, Zeppelinfj	57.0	65.8	75.2	86.9	95.4	101.2	103.9	98.8
NO0043R	Prestebakke	56.0	70.0	84.0	98.0	108.0	116.0	124.0	97.8
NO0045R	Jeløya	65.8	77.8	88.0	99.7	106.8	118.2	123.4	15.8
NO0048R	Voss	86.0	96.2	108.6	118.9	125.6	131.2	135.4	15.8
NO0052R	Sandve	63.4	74.9	86.8	97.3	106.3	115.7	123.7	99.2
NO0055R	Karasjok	60.0	71.8	86.6	96.0	102.2	111.2	122.1	99.3
NO0056R	Hurdal	48.4	64.0	80.4	93.6	101.7	111.0	116.8	98.9
PL0002R	Jarczew	46.0	68.0	90.0	110.0	119.0	132.0	140.0	99.4
PL0003R	Sniezka	75.0	93.0	112.0	128.0	136.0	147.0	155.0	99.4
PL0004R	Leba	63.0	79.0	93.0	106.0	113.0	125.0	132.0	99.5
PL0005R	Diabla Gora	52.7	71.9	87.7	104.7	113.6	124.0	134.0	97.7
PT0004R	Monte Velho	55.0	77.0	98.0	116.0	129.0	155.0	171.0	90.8
RU0016R	Shepeljovo	22.4	49.3	71.5	86.1	93.6	102.3	106.9	65.9
RU0018R	Danki	32.2	48.0	63.0	75.6	83.2	90.0	95.0	96.3
SE0011R	Vavihill	57.0	74.0	92.0	109.0	123.0	137.0	144.0	96.2
SE0012R	Aspvreten	56.0	74.0	91.0	104.0	113.0	128.0	136.0	96.9
SE0013R	Esrange	60.0	71.0	86.0	96.0	102.0	115.0	138.0	99.4
SE0014R	Råö	62.0	77.0	91.0	105.0	115.0	128.0	137.0	99.2
SE0032R	Norra-Kvill	63.0	75.0	90.0	106.0	118.0	131.0	137.0	99.2
SE0035R	Vindeln	47.0	67.0	84.0	96.0	103.0	111.0	121.9	98.2
SE0039R	Grimsö	44.5	62.0	80.0	93.0	102.0	113.0	119.0	99.3
SI0008R	Iskrba	19.0	73.0	114.0	133.0	143.0	157.0	165.8	91.6
SI0031R	Zarodnje	82.0	99.0	115.0	128.0	138.0	145.0	150.3	92.8
SI0032R	Krvavec	106.0	121.0	135.0	150.0	157.0	166.0	171.0	96.2
SI0033R	Kovk	83.0	104.0	124.0	140.0	153.0	163.0	170.0	87.0
SK0002R	Chopok	102.0	115.0	128.0	139.0	146.0	152.0	156.0	86.2
SK0004R	Stará Lesná	51.0	77.0	100.0	117.0	127.0	136.0	141.2	92.8
SK0006R	Starina	61.0	81.0	105.0	122.0	134.0	145.0	152.0	97.6
SK0007R	Topolniky	59.0	81.0	110.0	134.0	144.0	155.0	166.0	99.4

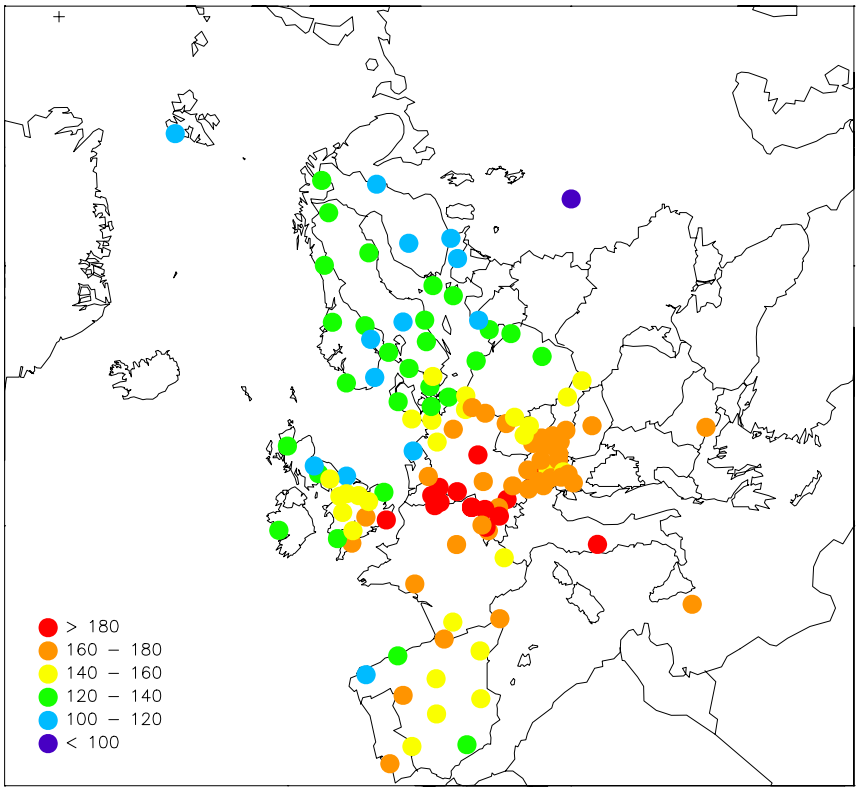


Figure 1.1: Ozone April–September 2003. 99-percentiles ($\mu g/m^3$).

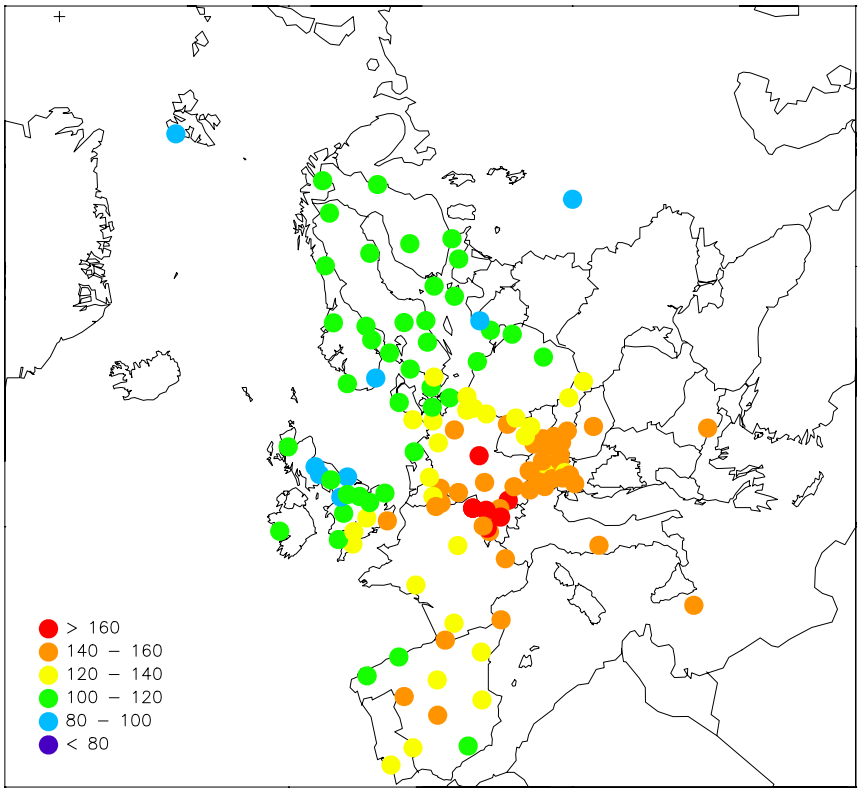


Figure 1.2: Ozone April–September 2003. 95-percentiles ($\mu g/m^3$).

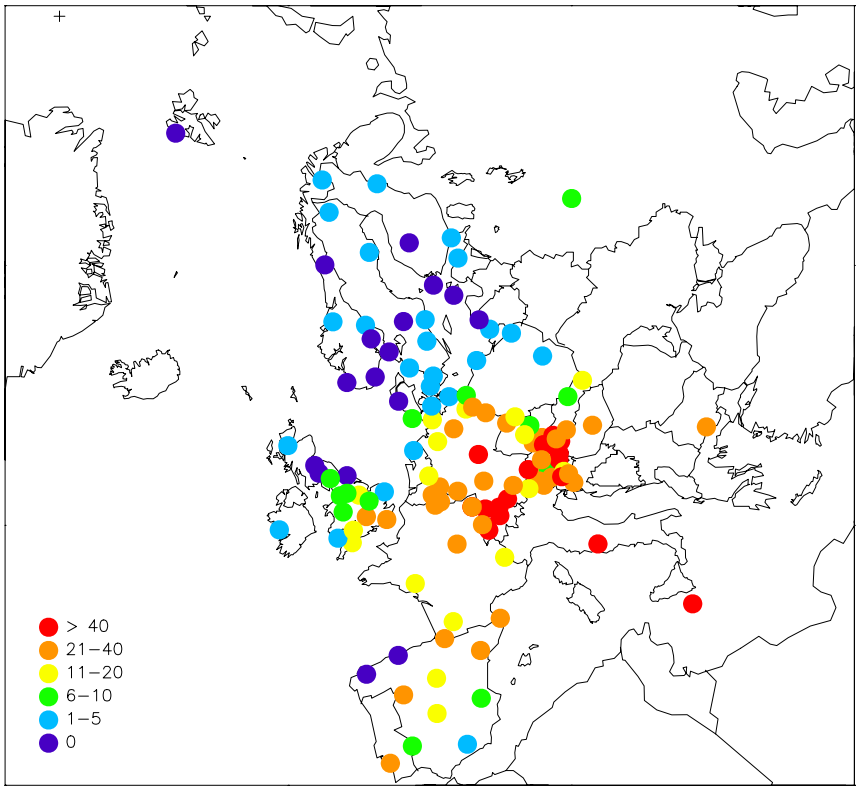


Figure 1.3: Number of exceedances of the threshold value of 150 μg/m^3. (Unit: number of days).

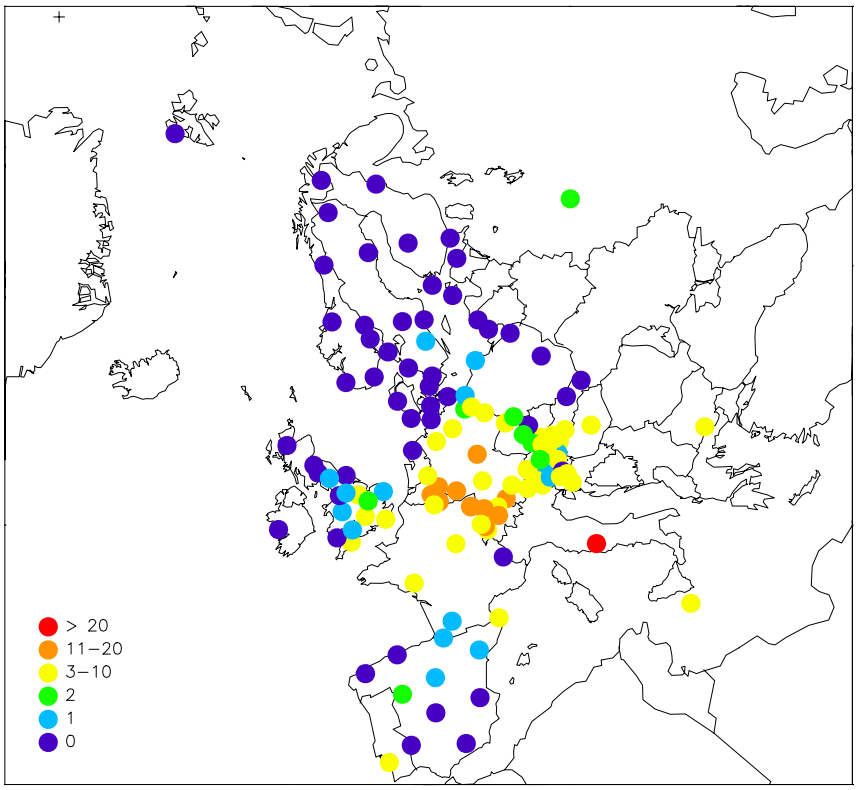


Figure 1.4: Number of exceedances of the threshold value of 180 μg/m^3. (Unit: number of days).

Annex 2

AOT40 and AOT60, figures and tables

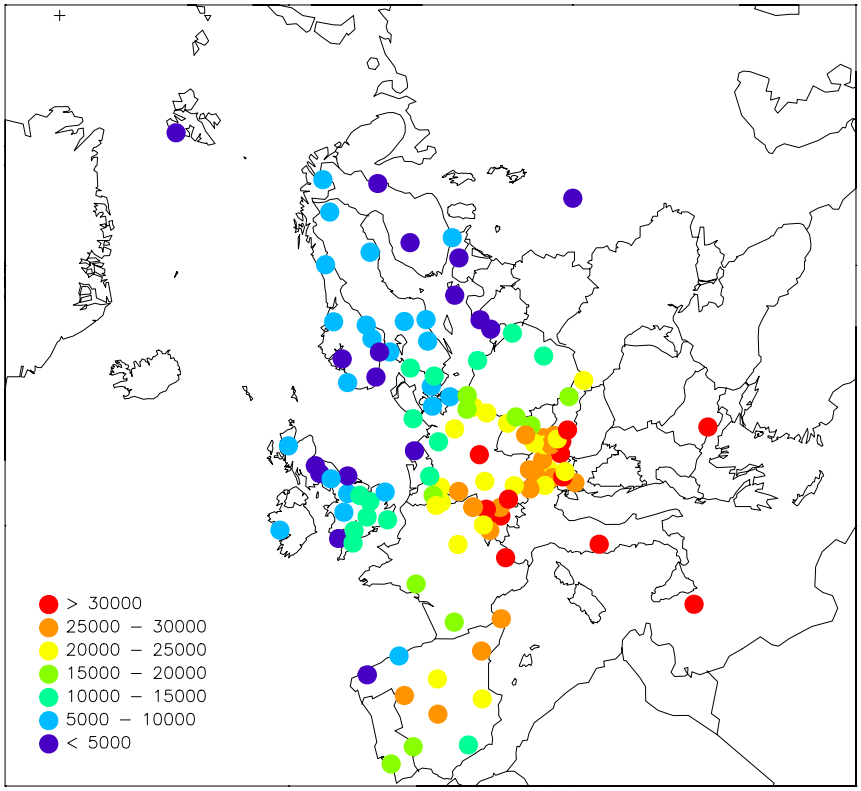


Figure 2.1: AOT40 (ppbh) April–September 2003 (daylight hours).

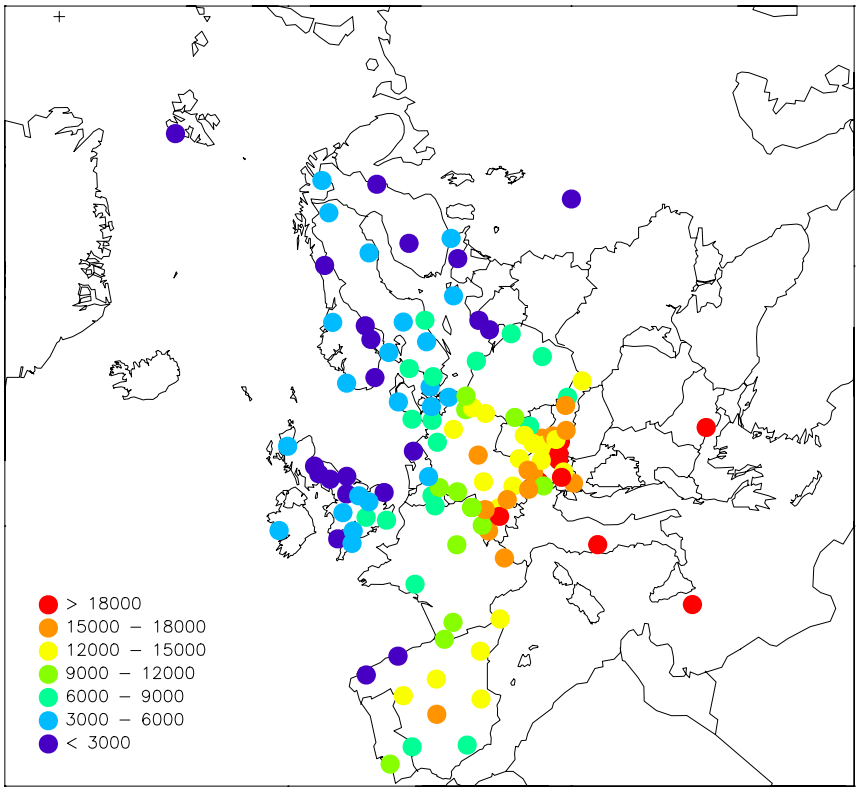


Figure 2.2: AOT40 (ppbh) May, June and July 2003 (daylight hours).

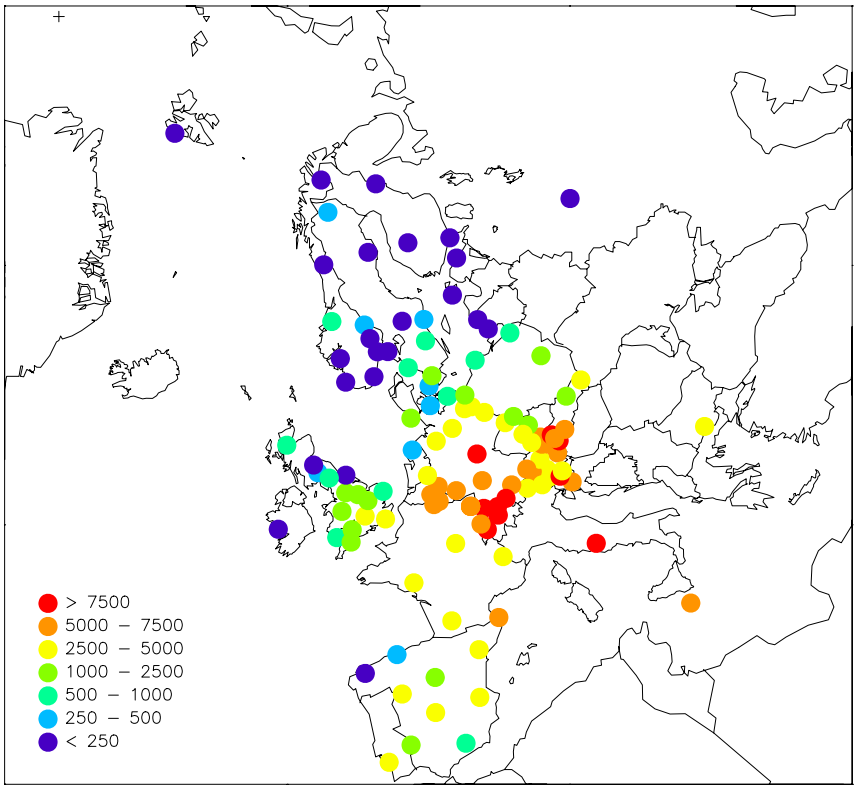


Figure 2.3: AOT60 (ppbh) April-September 2003 (daylight hours).

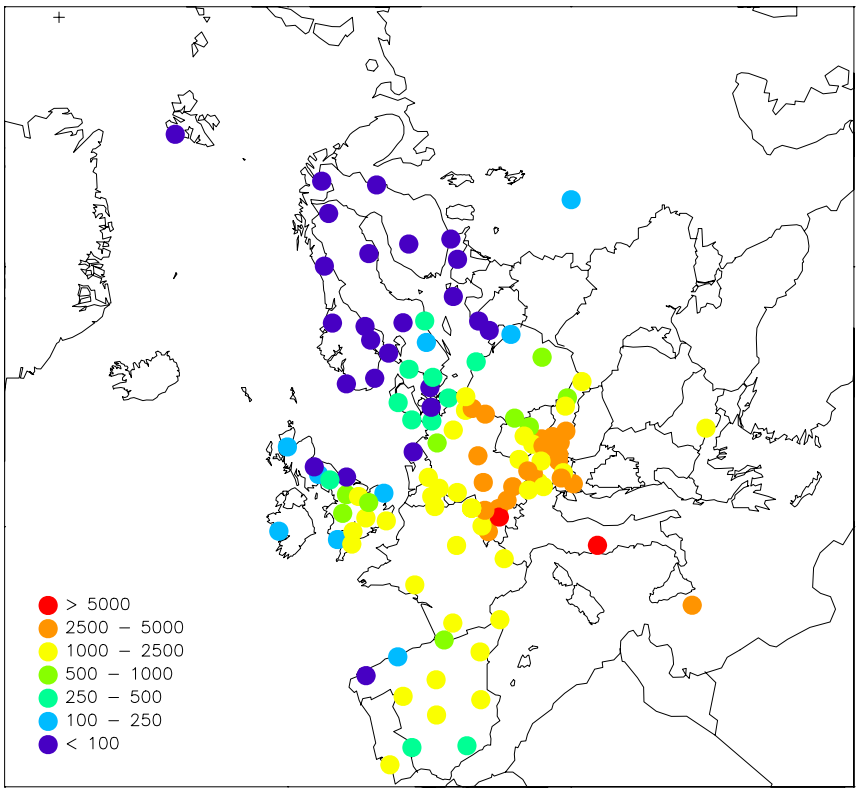


Figure 2.4: AOT60 (ppbh) May, June and July 2003 (daylight hours).

Table 2.1: AOT40 and AOT60 April–September 2003 (daylight hours).

Code	Station	AOT40	AOT40 corrected	AOT60	AOT60 corrected	Data capture
AT0002R	Illmitz	33263	35024	8754	9217	95
AT0004R	St. Koloman	28729	31072	6387	6908	92
AT0005R	Vorhegg	21774	23217	3270	3487	94
AT0030R	Pillersdorf bei Retz	27717	29497	5782	6153	94
AT0032R	Sulzberg	33894	34079	8329	8374	99
AT0033R	Stolzalpe bei Murau	22620	25155	2696	2998	90
AT0034G	Sonnblick	34549	38262	4887	5412	90
AT0037R	Zillertaler Alpen	29604	31083	3962	4159	95
AT0038R	Gerlitzen	28338	31064	3241	3553	91
AT0040R	Masenberg	35146	37292	7291	7736	94
AT0041R	Haunsberg	27509	28777	6782	7094	96
AT0042R	Heidenreichstein	23862	24966	4508	4717	96
AT0043R	Forsthof	28278	29756	6593	6937	95
AT0044R	Graz Platte	31359	35285	7545	8490	89
AT0045R	Dunkelsteinerwald	24829	26111	5966	6274	95
AT0046R	Gänserndorf	28935	30278	7927	8295	96
AT0047R	Stixneusiedl	23756	24809	5369	5607	96
AT0048R	Zoebelboden	25242	26562	4203	4422	95
BE0001R	Offagne	21534	23863	5646	6256	90
BE0032R	Eupen	21412	22457	6030	6324	95
BE0035R	Vezin	18568	19344	5154	5369	96
BG0053R	Rojen peak	35606	35712	4912	4926	100
CH0002R	Payerne	27513	28868	7888	8276	95
CH0003R	Tänikon	26565	27829	8018	8400	95
CH0004R	Chaumont	35161	37202	9867	10439	95
CH0005R	Rigi	34615	36950	10124	10807	94
CZ0001R	Svratouch	17071	17580	2324	2393	97
CZ0003R	Košetice	26926	27005	4957	4971	100
DE0001R	Westerland	14890	16051	1133	1221	93
DE0002R	Langenbrügge	22130	23170	4867	5095	96
DE0003R	Schauinsland	32417	33872	9134	9544	96
DE0004R	Deuselbach	25354	25684	6249	6330	99
DE0005R	Brotjacklriegel	22639	32607	5276	7599	69
DE0007R	Neuglobsow	16679	18164	2625	2859	92
DE0008R	Schmücke	32036	33914	9598	10160	94
DE0009R	Zingst	9462	9918	598	627	95
DE0012R	Bassum	13272	14437	2673	2907	92
DE0026R	Ueckermünde	15318	16194	1574	1664	95
DE0035R	Lückendorf	24471	27288	4979	5552	90
DE0039R	Aukrug	11364	12832	1566	1768	89
DE0042R	Öhringen	24388	25510	6675	6982	96
DE0045R	Schorfheide	22677	24852	4601	5042	91
DE0046R	Raisting	23258	24317	5573	5826	96
DE0047R	Falkenberg	22207	23957	4763	5138	93
DK0005R	Keldsnor	6393	6405	306	306	100
DK0031R	Ulborg	7905	11351	664	953	70
DK0041R	Lille Valby	8130	8640	342	363	94
EE0009R	Lahemaa	2663	2735	30	31	97
EE0011R	Vilsandy	4476	4564	40	41	98
ES0007R	Víznar	13512	13796	688	702	98
ES0008R	Niembro	6611	7074	295	315	93
ES0009R	Campisabalos	21453	22781	2446	2597	94
ES0010R	Cabo de Creus	28887	30503	5067	5350	95
ES0011R	Barcarrola	16318	16641	1532	1562	98
ES0012R	Zarra	23529	24469	2554	2656	96
ES0013R	Penausende	26614	27361	4777	4910	97
ES0014R	Els Torms	27192	28043	3865	3986	97
ES0015R	Risco Llamo	28169	29022	3318	3418	97
ES0016R	O Saviñao	4307	4666	128	138	92
FI0009R	Utö	5055	5766	70	80	88
FI0017R	Virolahti II	5243	5405	143	147	97
FI0022R	Oulanka	4292	4450	101	105	96
FI0037R	Ahtari II	4891	5279	88	95	93
FR0008R	Donon A	24909	25322	6448	6554	98
FR0008R	Donon B	27376	27829	7349	7470	98
FR0008R	Donon D	27888	28265	7490	7591	99
FR0008R	Donon C	27027	27434	7078	7185	99
FR0009R	Revin	20598	20950	5287	5377	98
FR0010R	Morvan	23320	23924	4251	4361	97

Table 2.1, cont.

Code	Station	AOT40	AOT40 corrected	AOT60	AOT60 corrected	Data capture
FR0012R	Iraty	19476	22861	2360	2770	85
FR0013R	Peyrusse Vieille	18927	19408	3011	3087	98
FR0014R	Montandon	21375	21795	5408	5514	98
FR0015R	La Tardière	19132	20117	4015	4222	95
FR0016R	Le Casset	33573	34687	4672	4827	97
GB0002R	Eskdalemuir	3644	3923	265	285	93
GB0006R	Lough Navar	1228	2368	112	216	52
GB0013R	Yarner Wood	11057	11261	2397	2441	98
GB0014R	High Muffles	2507	2551	147	150	98
GB0015R	Strath Vaich Dam	7382	8167	599	663	90
GB0031R	Aston Hill	6275	6327	1070	1079	99
GB0032R	Bottesford	11268	11513	2068	2113	98
GB0033R	Bush	2940	3014	122	125	98
GB0034R	Glazebury	3621	4684	758	981	77
GB0035R	Great Dun Fell	5945	5974	808	812	100
GB0036R	Harwell	14769	15303	3980	4124	97
GB0037R	Ladybower Res.	6211	6432	1163	1204	97
GB0038R	Lullington Heath	13856	14911	3608	3883	93
GB0039R	Sibton	7705	7830	799	812	98
GB0043R	Narberth	4498	4807	551	589	94
GB0044R	Somerton	10995	11440	2241	2332	96
GB0045R	Wicken Fen	10204	10436	1911	1954	98
GR0001R	Aliartos	118	217	0	0	54
GR0002R	Finokalia	27148	35340	3953	5146	77
HU0002R	K-puszta	24953	28271	6101	6912	88
IE0031R	Mace Head	7185	7516	246	257	96
IT0001R	Montelibretti	35661	37105	10584	11013	96
LT0015R	Preila	4712	4753	158	159	99
LV0010R	Rucava	2544	2566	74	74	99
MT0001R	Giordan lighthouse	37230	41151	6894	7620	90
NL0009R	Kollumerwaard	4680	4729	276	279	99
NL0010R	Vredepeel	11573	11825	2973	3038	98
NO0001R	Birkenes	3801	3874	11	11	98
NO0015R	Tustervatn	6089	6236	193	197	98
NO0039R	Kårvatn	7525	7561	586	588	100
NO0041R	Osen	5826	6120	333	350	95
NO0042G	Spitsbergen, Zeppelinfj	1771	1787	0	0	99
NO0043R	Prestebakke	7119	7228	168	171	98
NO0045R	Jeløya	1200	1200	14	14	100
NO0048R	Voss	3450	3450	209	209	100
NO0052R	Sandve	6886	6920	176	176	100
NO0055R	Karasjok	5597	5616	169	169	100
NO0056R	Hurdal	5223	5276	128	129	99
PL0002R	Jarczew	13950	13950	1102	1102	100
PL0003R	Sniezka	17451	17467	1620	1622	100
PL0004R	Leba	12115	12120	658	658	100
PL0005R	Diabla Gora	10599	10786	502	511	98
PT0004R	Monte Velho	18376	20179	3684	4046	91
RU0016R	Shepeljovo	2339	3395	26	38	69
RU0018R	Danki	1279	1317	139	143	97
SE0011R	Vavihill	11545	11944	1095	1133	97
SE0012R	Aspvreten	9086	9353	454	467	97
SE0013R	Esrange	5604	5614	279	280	100
SE0014R	Råö	10041	10080	595	597	100
SE0032R	Norra-Kvill	9925	9983	634	638	99
SE0035R	Vindeln	6543	6635	236	239	99
SE0039R	Grimsö	5464	5483	100	100	100
SI0008R	Iskrba	27262	29985	5479	6026	91
SI0031R	Zarodnje	21780	22450	2557	2636	97
SI0032R	Krvavec	38821	40178	8065	8347	97
SI0033R	Kovk	27281	30812	5821	6574	89
SK0002R	Chopok	29558	33397	3865	4367	89
SK0004R	Stará Lesná	17680	18866	1517	1619	94
SK0006R	Starina	24442	24935	3246	3311	98
SK0007R	Topolniky	31110	31140	7012	7019	100

Table 2.2: AOT40 and AOT60 May–July 2003 (daylight hours).

Code	Station	AOT40	AOT40 corrected	AOT60	AOT60 corrected	Data capture
AT0002R	Illmitz	19299	20227	4727	4954	95
AT0004R	St. Koloman	15783	17067	2751	2975	92
AT0005R	Vorhegg	11989	12827	1519	1625	93
AT0030R	Pillersdorf bei Retz	15634	16693	3053	3259	94
AT0032R	Sulzberg	17742	17874	3762	3790	99
AT0033R	Stolzalpe bei Murau	11639	13148	724	818	89
AT0034G	Sonnblick	18765	20867	2064	2295	90
AT0037R	Zillertaler Alpen	15071	15712	1257	1310	96
AT0038R	Gerlitzen	14868	16636	995	1113	89
AT0040R	Masenberg	19691	20756	3620	3816	95
AT0041R	Haunsberg	15366	15635	3203	3259	98
AT0042R	Heidenreichstein	13286	13932	2143	2247	95
AT0043R	Forsthof	15801	16730	3448	3651	94
AT0044R	Graz Platte	18898	20895	4517	4994	90
AT0045R	Dunkelsteinerwald	14364	15120	3352	3529	95
AT0046R	Gänserndorf	16369	17120	4201	4393	96
AT0047R	Stixneusiedl	13245	13841	2569	2685	96
AT0048R	Zoebelboden	13752	14330	1788	1863	96
BE0001R	Offagne	8919	10040	1308	1472	89
BE0032R	Eupen	9709	10106	1623	1689	96
BE0035R	Vezin	8664	9027	1709	1781	96
BG0053R	Rojen peak	19290	19308	2451	2453	100
CH0002R	Payerne	15024	15790	3912	4111	95
CH0003R	Tänikon	14937	15671	4279	4489	95
CH0004R	Chaumont	18190	19360	4253	4526	94
CH0005R	Rigi	18809	19846	5007	5283	95
CZ0001R	Svratouch	6346	6668	679	713	95
CZ0003R	Košetice	13856	13905	1833	1840	100
DE0001R	Westerland	8704	9552	484	531	91
DE0002R	Langenbrügge	12298	12862	2147	2246	96
DE0003R	Schauinsland	16715	17090	3781	3866	98
DE0004R	Deuselbach	11813	11955	1618	1637	99
DE0005R	Brotjacklriegel	14587	15656	2341	2512	93
DE0007R	Neuglobsow	10015	11002	1275	1400	91
DE0008R	Schmücke	16585	17675	3910	4167	94
DE0009R	Zingst	5571	5853	286	300	95
DE0012R	Bassum	6404	6993	872	952	92
DE0026R	Ueckermünde	10315	10866	1114	1173	95
DE0035R	Lückendorf	14323	16197	2633	2977	88
DE0039R	Aukrug	6103	6593	462	499	93
DE0042R	Öhringen	12389	12998	2675	2806	95
DE0045R	Schorfheide	13772	14883	2511	2714	93
DE0046R	Raisting	12493	13149	2593	2729	95
DE0047R	Falkenberg	12867	13974	2583	2805	92
DK0005R	Keldsnor	3155	3154	28	28	100
DK0031R	Ulborg	5153	5180	256	257	99
DK0041R	Lille Valby	4293	4506	33	35	95
EE0009R	Lahemaa	1606	1638	1	1	98
EE0011R	Vilsandy	3188	3247	18	18	98
ES0007R	Víznar	7861	8012	278	283	98
ES0008R	Niembro	2501	2736	108	118	91
ES0009R	Campisabalos	12118	12928	1420	1515	94
ES0010R	Cabo de Creus	13371	14148	1840	1946	95
ES0011R	Barcarrola	8787	8902	494	500	99
ES0012R	Zarra	13342	13824	1461	1514	97
ES0013R	Penausende	14677	14968	2310	2356	98
ES0014R	Els Torms	13559	13967	1533	1579	97
ES0015R	Risco Llamo	15163	15540	1502	1539	98
ES0016R	O Saviñao	2102	2253	92	98	93
FI0009R	Utö	4266	4849	70	80	88
FI0017R	Virolahti II	3435	3510	83	84	98
FI0022R	Oulanka	2243	2269	8	8	99
FI0037R	Ahtari II	2879	3135	0	0	92
FR0008R	Donon A	9939	10021	1575	1588	99
FR0008R	Donon B	11257	11361	1939	1957	99
FR0008R	Donon D	11623	11687	1983	1993	99
FR0008R	Donon C	11092	11163	1828	1839	99
FR0009R	Revin	8777	8932	1326	1349	98
FR0010R	Morvan	10211	10306	1130	1140	99

Table 2.2, cont.

Code	Station	AOT40	AOT40 corrected	AOT60	AOT60 corrected	Data capture
FR0012R	Iraty	9231	10294	847	944	90
FR0013R	Peyrusse Vieille	9367	9411	1141	1146	100
FR0014R	Montandon	9763	9963	1698	1732	98
FR0015R	La Tardière	8434	8457	1175	1178	100
FR0016R	Le Casset	16540	16849	1671	1702	98
GB0002R	Eskdalemuir	1609	1651	142	146	97
GB0006R	Lough Navar	37	180	0	0	21
GB0013R	Yarner Wood	4684	4753	1124	1141	99
GB0014R	High Muffles	800	819	35	36	98
GB0015R	Strath Vaich Dam	4111	4467	178	193	92
GB0031R	Aston Hill	3409	3415	786	787	100
GB0032R	Bottesford	5838	5905	1091	1104	99
GB0033R	Bush	1272	1296	65	66	98
GB0034R	Glazebury	1356	2305	319	542	59
GB0035R	Great Dun Fell	2638	2650	449	451	100
GB0036R	Harwell	7038	7309	1836	1907	96
GB0037R	Ladybower Res.	2834	2929	611	632	97
GB0038R	Lullington Heath	6822	7440	1774	1935	92
GB0039R	Sibton	2636	2695	154	157	98
GB0043R	Narberth	1335	1424	119	127	94
GB0044R	Somerton	5245	5450	1100	1143	96
GB0045R	Wicken Fen	3972	4025	676	685	99
GR0001R	Aliartos	17	78	0	0	21
GR0002R	Finokalia	17655	21158	2906	3482	83
HU0002R	K-puszta	15569	18755	4281	5156	83
IE0031R	Mace Head	3558	3749	110	116	95
IT0001R	Montelibretti	21330	22830	7026	7520	93
LT0015R	Preila	2677	2676	31	31	100
LV0010R	Rucava	1162	1168	57	57	99
MT0001R	Giordan lighthouse	19898	21839	4084	4482	91
NL0009R	Kollumerwaard	2255	2254	62	62	100
NL0010R	Vredepeel	5637	5668	1038	1043	99
NO0001R	Birkenes	1785	1825	2	2	98
NO0015R	Tustervatn	2952	3067	0	0	96
NO0039R	Kårvatn	3638	3662	33	33	99
NO0041R	Osen	2797	3032	2	2	92
NO0042G	Spitsbergen, Zeppelinf	1066	1074	0	0	99
NO0043R	Prestebakke	4051	4062	5	5	100
NO0052R	Sandve	3537	3543	1	1	100
NO0055R	Karasjok	3359	3362	5	5	100
NO0056R	Hurdal	2872	2882	1	1	100
PL0002R	Jarczew	8480	8480	621	620	100
PL0003R	Sniezka	10201	10200	668	668	100
PL0004R	Leba	7915	7915	276	276	100
PL0005R	Diabla Gora	6192	6367	249	256	97
PT0004R	Monte Velho	9186	10150	2019	2231	91
RU0016R	Shepeljovo	1491	2202	19	27	68
RU0018R	Danki	1016	1032	136	138	98
SE0011R	Vavihill	6586	6614	380	381	100
SE0012R	Aspvreten	6342	6591	271	282	96
SE0013R	Esrange	3279	3289	0	0	100
SE0014R	Råö	6743	6760	417	418	100
SE0032R	Norra-Kvill	5906	5926	185	185	100
SE0035R	Vindeln	3528	3584	21	21	98
SE0039R	Grimsö	3667	3673	52	52	100
SI0008R	Iskrba	15050	16219	2654	2860	93
SI0031R	Zarodnje	12504	12841	1368	1404	97
SI0032R	Krvavec	21782	22103	4116	4176	99
SI0033R	Kovk	15114	17627	2915	3399	86
SK0002R	Chopok	17859	18024	2381	2403	99
SK0004R	Stará Lesná	7951	8137	581	594	98
SK0006R	Starina	12717	13163	1584	1639	97
SK0007R	Topolniky	17088	17103	3653	3656	100

Annex 3

Seasonal variation

Table 3.1: Monthly mean concentrations 2003 ($\mu g/m^3$).

Code	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
AT0002R	Illmitz	43.5	57.3	74.9	85.3	96.6	105.0	96.1	99.4	73.6	45.1	26.9	33.8
AT0004R	St. Koloman	59.6	55.8	95.5	102.3	98.4	116.8	114.8	132.0	86.2	63.8	55.1	71.0
AT0005R	Vorhegg	56.9	76.9	95.0	91.5	98.1	93.6	91.8	101.9	78.1	56.6	45.5	62.7
AT0030R	Pillersdorf bei Retz	45.3	59.2	76.5	86.5	93.1	104.4	96.2	106.6	75.4	47.1	27.6	32.9
AT0032R	Sulzberg	60.3	78.7	98.2	101.1	94.0	119.7	116.4	135.8	96.8	66.0	62.0	69.2
AT0033R	Stolzalpe bei Murau	66.4	78.0	93.9	95.2	88.6	84.2	93.6	101.2	75.5	57.2	45.9	60.7
AT0034G	Sonnblick	86.8	97.3	111.2	119.4	117.9	124.3	120.9	129.7	106.3	95.0	89.1	87.7
AT0037R	Zillertaler Alpen	79.7	91.3	106.1	113.7	105.4	117.3	115.2	128.3	100.4	83.0	79.5	81.0
AT0038R	Gerlitzen	76.3	88.6	104.5	105.9	109.9	118.5	111.2	128.9	97.8	81.0	77.6	83.3
AT0040R	Masenberg	69.5	85.5	104.0	106.8	115.0	121.0	114.5	131.6	103.4	68.1	60.3	71.4
AT0041R	Haunsberg	55.6	70.2	87.6	95.9	93.5	110.1	109.0	123.5	79.3	53.2	35.3	49.9
AT0042R	Heidenreichstein	50.0	66.4	73.6	84.5	85.7	92.8	89.5	97.1	69.7	46.0	31.6	36.9
AT0043R	Forsthof	46.3	62.5	85.3	93.6	98.7	113.5	105.8	123.4	86.4	52.7	34.4	44.2
AT0044R	Graz Platte	47.3	72.4	93.7	101.1	112.5	119.7	111.9	125.1	98.1	49.7	38.4	41.1
AT0045R	Dunkelsteinerwald	37.8	55.2	69.4	77.1	85.1	88.0	90.5	96.2	65.8	41.9	23.9	27.3
AT0046R	Gänserndorf	39.6	50.4	72.2	84.8	92.9	98.6	94.0	98.7	71.5	42.8	25.6	32.0
AT0047R	Stixneusiedl	42.5	58.8	71.1	79.1	90.3	98.3	92.6	102.9	73.0	43.8	25.4	31.0
AT0048R	Zoebelboden	62.3	79.6	95.9	102.1	99.4	109.9	106.8	123.5	82.5	61.6	50.5	62.1
BE0001R	Offagne	48.9	53.9	68.0	89.4	76.0	88.0	78.4	102.3	72.1	48.3	37.8	36.9
BE0032R	Eupen	46.1	56.8	58.3	82.9	73.8	81.0	77.7	85.7	66.7	38.3	40.3	37.2
BE0035R	Vezin	37.5	35.9	49.1	70.3	65.8	65.5	64.6	67.9	46.2	28.6	29.4	27.2
BG0053R	Rojen peak	82.6	98.4	119.2	114.4	115.5	115.6	120.9	131.1	99.5	78.1	77.2	82.6
CH0002R	Payerne	36.9	46.6	65.2	78.2	72.8	92.8	92.7	99.3	66.6	34.3	15.8	27.0
CH0003R	Tänikon	42.5	49.7	61.9	74.7	74.2	96.5	88.5	97.2	64.3	33.7	18.5	28.1
CH0004R	Chaumont	62.7	83.5	98.9	103.7	97.2	123.2	120.0	141.3	101.1	64.2	64.2	67.1
CH0005R	Rigi	61.9	82.5	97.5	106.4	96.0	124.5	118.7	135.1	95.8	59.9	63.9	68.8
CZ0001R	Svratouch	47.9	73.6	88.7	92.7	95.0	86.7	89.8	107.3	82.9	50.3	-	-
CZ0003R	Košetice	46.8	68.9	79.3	88.3	88.8	95.9	87.1	103.4	78.8	49.8	-	-
DE0001R	Westerland	55.6	52.2	71.9	92.0	91.2	91.7	89.6	85.3	80.6	60.4	37.6	49.2
DE0002R	Langenbrügge	39.0	52.7	66.0	85.8	77.9	85.9	79.8	84.0	61.5	38.1	24.3	32.2
DE0003R	Schauinsland	64.6	81.6	95.1	100.1	93.4	121.7	114.7	139.0	99.1	67.7	68.0	67.3
DE0004R	Deuselbach	50.7	56.3	72.6	88.7	84.2	96.2	87.7	115.0	83.0	50.5	41.5	40.8
DE0005R	Brotjacklriegel	57.0	79.8	78.4	-	97.6	116.5	104.2	128.1	78.3	62.7	56.9	61.9
DE0007R	Neuglobsow	36.7	54.2	63.1	76.9	79.2	84.4	72.2	76.5	54.3	35.2	19.2	30.6
DE0008R	Schmücke	50.0	71.8	81.8	96.3	97.7	122.1	109.8	128.0	99.6	55.8	44.5	54.4

Table 3.1, cont.

Code	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
DE0009R	Zingst	45.7	62.8	70.9	83.4	80.2	85.2	70.9	72.7	65.1	46.6	27.7	38.6
DE0012R	Bassum	32.6	33.2	50.7	73.8	64.6	72.1	68.1	77.3	53.1	30.9	20.3	27.8
DE0026R	Ueckermünde	38.6	54.8	61.4	75.9	83.4	93.6	76.3	75.5	59.5	42.8	20.3	33.2
DE0035R	Lückendorf	43.6	70.2	82.5	92.3	94.9	105.8	103.7	101.9	80.8	44.4	26.7	35.7
DE0039R	Aukrug	31.6	36.3	53.7	73.2	64.3	71.6	65.7	65.1	47.5	32.0	19.5	27.5
DE0042R	Öhringen	33.3	46.5	60.1	78.3	70.1	92.9	82.7	101.1	66.7	38.5	22.0	29.0
DE0045R	Schorfheide	37.7	57.0	66.2	85.1	80.7	90.9	77.2	79.5	60.6	37.5	17.8	30.9
DE0046R	Raisting	42.7	46.3	59.9	69.8	65.5	76.7	77.1	83.9	51.0	35.0	15.9	28.0
DE0047R	Falkenberg	35.9	53.5	63.5	78.4	83.1	90.6	77.7	83.1	68.6	42.0	22.3	31.2
DK0005R	Keldsnor	44.3	49.3	63.6	74.4	73.9	76.9	75.0	76.2	68.3	54.3	28.8	38.2
DK0031R	Ulborg	47.6	42.9	65.4	85.6	78.7	77.0	73.6	-	-	-	-	-
DK0041R	Lille Valby	41.3	44.4	60.9	72.0	73.4	72.9	64.8	68.3	61.0	45.7	29.0	42.6
EE0009R	Lahemaa	54.9	63.7	83.7	79.7	78.9	63.2	55.2	47.2	46.6	46.8	35.3	48.5
EE0011R	Vilsandy	56.8	68.4	82.8	83.0	91.5	82.1	83.2	74.9	66.6	61.3	39.4	54.2
ES0007R	Víznar	58.8	61.0	74.1	81.2	89.3	86.1	88.0	88.9	79.7	63.3	56.0	60.7
ES0008R	Niembro	60.7	65.1	76.9	87.3	87.3	69.0	65.8	74.3	65.3	42.4	38.1	59.1
ES0009R	Campisabalos	66.8	66.8	75.8	85.1	81.1	89.8	97.6	98.4	76.5	65.0	57.8	62.0
ES0010R	Cabo de Creus	63.3	83.2	95.3	99.9	97.7	98.9	105.9	122.8	106.8	86.9	79.0	76.7
ES0011R	Barcarrola	57.4	55.5	64.9	71.9	76.7	79.1	78.5	82.8	76.2	61.1	49.8	46.7
ES0012R	Zarra	65.9	67.6	88.3	92.8	94.1	102.4	100.8	108.5	86.8	68.1	59.2	57.9
ES0013R	Penausende	68.6	72.1	84.8	94.1	96.0	100.2	96.9	105.0	91.7	73.6	61.4	55.3
ES0014R	Els Torms	55.8	66.5	87.0	96.3	90.9	101.3	102.0	109.5	87.0	66.3	50.6	48.6
ES0015R	Risco Llamo	75.9	78.3	93.4	98.9	102.9	108.1	112.7	116.6	102.3	80.1	69.8	74.1
ES0016R	O Saviñao	59.5	66.7	91.8	80.4	67.6	62.8	48.6	50.8	60.5	42.2	59.9	54.8
FI0009R	Utö	57.7	66.0	84.4	78.1	82.9	79.1	79.1	69.2	63.0	59.1	40.3	55.4
FI0017R	Virolahti II	53.2	56.9	81.0	74.1	74.7	58.3	55.4	49.0	43.5	41.8	35.2	46.3
FI0022R	Oulanka	68.6	68.1	87.2	88.1	79.3	69.2	63.7	52.0	51.0	52.4	42.4	63.7
FI0037R	Ahtari II	60.0	65.3	88.4	83.6	79.3	65.5	54.6	50.5	48.8	45.1	27.2	46.0
FR0008R	Donon A	59.5	69.4	89.7	97.0	79.0	99.3	102.1	129.0	96.9	56.7	55.7	53.5
FR0008R	Donon B	59.3	72.2	91.0	98.4	81.1	101.7	104.4	131.0	98.9	58.0	56.9	54.4
FR0008R	Donon D	60.9	71.3	92.2	99.6	82.8	103.4	105.5	132.3	100.2	59.2	58.1	55.6
FR0008R	Donon C	60.5	70.6	91.2	98.7	81.7	102.0	104.4	131.1	99.4	58.6	57.6	55.0
FR0009R	Revin	45.7	51.0	68.6	84.8	78.6	82.2	79.2	99.2	74.0	45.7	36.1	35.6
FR0010R	Morvan	54.0	68.9	80.4	91.8	78.5	88.5	83.2	106.1	73.3	55.7	53.0	48.5
FR0012R	Iraty	80.5	90.7	103.3	107.3	99.8	104.3	101.4	119.9	102.7	82.9	81.4	82.9

Table 3.1, cont.

Code	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
FR0013R	Peyrusse Vieille	52.4	63.2	73.8	85.7	82.9	86.4	85.1	100.2	77.5	59.5	49.7	49.9
FR0014R	Montandon	44.7	60.3	65.6	73.7	64.4	86.1	87.3	111.0	65.3	41.1	35.3	41.5
FR0015R	La Tardière	47.2	54.8	68.7	82.8	77.0	77.6	74.8	96.2	77.0	46.2	42.9	43.2
FR0016R	Le Casset	83.1	97.5	109.0	113.3	103.6	105.8	117.7	126.6	107.6	84.1	79.8	81.8
GB0002R	Eskdalemuir	50.9	40.8	54.6	69.3	64.7	59.8	49.2	49.9	47.2	44.4	41.7	37.2
GB0006R	Lough Navar	34.7	42.0	53.5	57.1	-	58.3	49.8	50.6	43.2	44.7	48.3	13.4
GB0013R	Yarner Wood	60.6	48.4	67.7	84.3	77.3	72.0	63.7	74.2	60.3	48.0	55.4	50.7
GB0014R	High Muffles	55.5	42.8	52.9	62.2	50.1	54.2	53.7	68.9	55.7	62.7	41.0	45.2
GB0015R	Strath Vaich Dam	68.7	69.3	81.7	89.6	84.8	77.6	68.0	67.7	64.4	68.5	60.6	68.8
GB0031R	Aston Hill	57.6	47.0	70.5	76.3	76.7	71.3	63.4	67.1	66.8	51.2	53.8	44.8
GB0032R	Bottesford	40.4	32.2	51.7	69.7	73.8	69.0	59.0	67.5	55.5	48.8	40.0	36.2
GB0033R	Bush	61.6	52.7	72.3	64.9	70.6	65.9	54.2	58.3	58.5	54.9	49.4	43.4
GB0034R	Glazebury	44.3	35.2	46.0	60.3	63.9	45.3	41.4	41.3	27.7	28.3	19.4	20.0
GB0035R	Great Dun Fell	62.6	57.1	74.6	81.8	74.0	72.0	63.3	74.0	66.7	62.9	57.0	55.3
GB0036R	Harwell	51.2	40.9	60.0	74.9	80.8	75.2	66.0	77.8	63.6	44.4	42.3	36.1
GB0037R	Ladybower Res.	51.5	38.1	59.8	72.9	71.2	64.3	55.1	62.9	60.9	56.0	46.0	44.2
GB0038R	Lullington Heath	43.0	39.2	62.3	80.0	85.4	77.2	69.8	81.1	69.7	48.3	52.6	48.0
GB0039R	Sibton	45.4	34.3	53.9	71.7	64.6	62.8	55.2	71.2	62.2	47.5	36.2	34.1
GB0043R	Narberth	62.9	66.1	72.3	83.7	62.9	51.7	44.0	57.9	47.2	39.1	44.7	38.9
GB0044R	Somerton	55.4	50.3	61.3	76.5	76.9	72.1	63.9	71.5	61.6	43.4	47.3	39.7
GB0045R	Wicken Fen	39.7	31.2	50.4	66.5	62.6	59.3	50.4	65.7	55.3	46.9	37.1	37.3
GR0001R	Aliartos	18.4	26.4	40.2	24.9	-	50.8	38.8	35.1	24.8	20.3	12.7	16.3
GR0002R	Finokalia	-	-	106.1	102.7	118.4	124.3	114.4	117.2	99.9	75.7	63.9	55.8
HU0002R	K-puszta	37.8	64.5	60.2	63.9	80.0	108.7	86.5	97.4	68.7	45.6	-	37.1
IE0031R	Mace Head	72.3	68.5	86.1	92.7	93.0	79.7	68.6	61.6	69.3	64.2	77.0	67.3
IT0001R	Montelibretti	31.9	48.2	55.9	66.8	67.9	81.5	84.3	81.8	62.7	41.1	19.2	23.2
LT0015R	Preila	50.8	68.6	76.6	77.6	76.3	72.7	54.1	61.4	55.0	42.3	29.3	35.1
LV0010R	Rucava	42.2	55.9	68.2	69.7	42.9	61.5	49.9	47.6	42.4	38.2	24.0	36.3
MT0001R	Giordan lighthouse	96.2	107.6	122.4	118.7	123.5	117.4	119.5	127.1	111.2	90.4	88.6	89.3
NL0009R	Kollumerwaard	36.7	25.9	49.8	68.2	64.6	63.7	56.2	61.3	49.4	42.6	20.9	29.6
NL0010R	Vredepeel	31.1	22.8	41.1	58.9	58.6	59.7	53.1	55.6	39.7	23.0	15.7	21.6
NO0001R	Birkenes	53.2	48.5	62.4	71.0	65.3	64.3	55.5	53.2	49.7	41.7	30.7	48.1
NO0015R	Tustervatn	78.0	79.9	92.6	98.1	85.8	73.8	63.5	56.7	61.2	63.3	58.7	73.5

Table 3.1, cont.

Code	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
NO0039R	Kårvatn	69.5	64.2	75.3	87.3	74.6	57.9	48.0	41.6	40.2	42.5	44.7	59.9
NO0041R	Osen	59.4	52.4	83.0	87.6	72.7	64.3	49.0	42.0	41.7	38.4	30.0	44.7
NO0042G	Spitsbergen, Zeppelinfjell	74.4	77.3	81.5	73.3	75.4	72.0	58.6	55.7	64.5	70.7	76.1	71.0
NO0043R	Prestebakke	57.9	56.9	74.7	80.7	79.3	72.5	66.2	62.1	58.0	47.9	32.1	47.9
NO0045R	Jeløya	48.2	44.6	63.5	76.2	-	-	-	-	-	-	-	-
NO0048R	Voss	64.8	73.8	82.0	96.1	-	-	-	-	-	-	-	-
NO0052R	Sandve	66.1	57.8	72.9	88.1	84.3	73.4	70.9	66.0	65.0	55.5	50.3	59.2
NO0055R	Karasjok	76.7	80.3	92.3	93.2	86.7	77.7	65.1	60.7	56.7	61.5	53.8	70.8
NO0056R	Hurdal	53.6	47.6	73.8	82.7	70.6	67.8	57.5	55.0	48.7	44.2	27.7	45.9
PL0002R	Jarczew	35.0	60.9	66.1	73.3	72.4	75.7	67.1	67.2	55.2	44.1	31.5	34.8
PL0003R	Sniezka	62.6	71.9	87.3	89.9	99.8	105.1	86.1	97.3	82.2	58.7	62.5	60.5
PL0004R	Leba	54.4	68.3	78.4	84.3	86.5	89.8	74.2	70.5	61.1	55.2	33.2	44.5
PL0005R	Diabla Gora	46.2	73.8	77.8	79.7	75.3	76.4	68.6	63.3	54.6	42.5	29.0	38.9
PT0004R	Monte Velho	65.9	66.5	71.4	91.4	88.6	75.7	65.7	70.4	69.5	70.0	59.6	53.5
RU0016R	Shepeljovo	32.5	58.2	66.7	63.2	47.7	53.3	43.0	32.5	-	-	-	-
RU0018R	Danki	50.2	50.7	59.3	53.9	64.8	48.4	48.5	33.0	38.1	38.4	35.5	40.1
SE0011R	Vavihill	49.0	63.2	84.4	94.5	86.8	82.9	65.8	70.7	53.4	41.6	27.5	36.8
SE0012R	Aspvreten	60.6	65.7	84.0	82.6	84.3	79.3	70.7	59.4	61.5	46.6	35.6	48.3
SE0013R	Esrange	69.8	72.9	87.6	92.3	82.9	75.7	70.0	59.3	59.3	60.6	55.0	66.2
SE0014R	Råö	52.6	54.0	66.8	79.6	88.3	82.4	74.0	69.7	64.8	56.7	33.1	46.7
SE0032R	Norra-Kvill	62.7	70.9	91.6	88.8	90.7	80.9	69.7	67.2	69.3	56.7	37.5	48.1
SE0035R	Vindeln	66.3	65.2	86.6	89.9	74.7	70.0	58.6	46.9	43.2	49.4	35.5	55.0
SE0039R	Grimsö	53.6	54.1	71.4	72.2	76.1	67.5	57.4	49.2	48.5	36.7	22.5	43.3
SI0008R	Iskrba	48.9	67.8	71.9	77.8	71.8	66.8	74.7	77.8	49.5	37.5	35.5	39.6
SI0031R	Zarodnje	48.3	73.0	83.2	92.8	101.0	101.1	101.2	109.6	82.4	55.0	41.7	45.1
SI0032R	Krvavec	78.8	91.4	108.7	113.6	118.8	127.9	121.2	136.2	104.4	80.8	76.8	80.9
SI0033R	Kovk	52.9	75.7	87.1	90.4	103.5	109.8	106.5	123.1	85.4	37.7	27.5	46.0
SK0002R	Chopok	84.9	95.6	117.2	119.5	115.4	119.6	110.1	119.8	89.4	-	-	-
SK0004R	Stará Lesná	48.9	73.2	85.6	87.7	64.5	70.4	74.4	82.1	72.5	47.5	44.5	51.8
SK0006R	Starina	56.3	79.5	90.0	89.2	81.2	89.1	78.2	94.4	66.8	52.9	48.5	47.3
SK0007R	Topolniky	46.6	66.5	75.0	80.5	88.6	90.4	85.8	92.0	71.4	42.5	27.3	31.1

Table 3.2: Monthly data capture 2003 (μg/m³).

Code	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
AT0002R	Illmitz	87	87	95	97	96	96	93	96	96	96	96	95
AT0004R	St. Koloman	89	96	92	94	96	90	96	96	95	94	96	95
AT0005R	Vorhegg	95	95	96	97	97	96	95	96	96	95	95	95
AT0030R	Pillersdorf bei Retz	96	96	95	95	96	97	95	96	96	95	95	95
AT0032R	Sulzberg	100	94	100	100	100	100	100	100	100	99	96	72
AT0033R	Stolzalpe bei Murau	95	96	96	95	75	96	96	95	96	84	95	74
AT0034G	Sonnblick	96	96	96	95	95	91	92	92	95	95	95	95
AT0037R	Zillertaler Alpen	96	87	88	96	96	96	96	96	96	96	95	95
AT0038R	Gerlitzen	97	97	94	96	95	85	96	96	96	94	91	93
AT0040R	Masenberg	95	95	95	95	96	92	96	96	96	93	95	95
AT0041R	Haunsberg	99	100	100	100	100	100	97	95	85	95	95	96
AT0042R	Heidenreichstein	95	96	96	96	96	96	96	96	96	95	96	96
AT0043R	Forsthof	95	96	95	96	96	96	96	96	96	95	94	96
AT0044R	Graz Platte	96	96	96	96	95	86	94	93	88	69	96	95
AT0045R	Dunkelsteinerwald	96	96	96	96	95	96	94	96	95	95	92	95
AT0046R	Gänserndorf	96	99	95	96	96	96	96	96	96	95	96	96
AT0047R	Stixneusiedl	96	3	81	92	95	96	97	99	96	95	96	96
AT0048R	Zoebelboden	96	96	96	95	97	97	95	96	96	92	94	94
BE0001R	Offagne	91	96	96	84	95	91	84	96	95	95	62	90
BE0032R	Eupen	94	72	94	84	96	97	97	97	97	75	90	91
BE0035R	Vezin	95	96	74	96	97	96	95	96	96	85	91	92
BG0053R	Rojen peak	100	100	98	100	100	100	100	100	100	99	91	96
CH0002R	Payerne	95	95	95	95	96	95	95	95	95	95	95	96
CH0003R	Tänikon	95	95	96	95	96	95	95	96	95	95	96	95
CH0004R	Chaumont	96	95	95	95	92	95	95	96	96	95	95	95
CH0005R	Rigi	95	95	95	88	96	95	94	95	95	95	95	96
CZ0001R	Svratouch	99	99	100	100	100	100	88	98	100	94	0	0
CZ0003R	Košetice	100	100	100	100	100	99	100	100	100	100	0	0
DE0001R	Westerland	87	92	92	91	92	92	92	96	96	96	96	96
DE0002R	Langenbrügge	95	96	96	95	96	94	96	96	96	95	96	96
DE0003R	Schauinsland	96	96	96	95	96	95	96	87	91	96	93	95
DE0004R	Deuselbach	95	96	96	96	96	96	96	96	96	96	96	96
DE0005R	Brotjacklriegel	98	93	52	0	82	96	98	95	23	49	97	98
DE0007R	Neuglobsow	92	91	91	92	92	92	92	92	92	91	79	89
DE0008R	Schmücke	91	92	93	95	96	94	95	94	95	95	92	92

Table 3.2, cont.

Code	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
DE0009R	Zingst	96	96	96	95	96	95	96	96	96	95	96	96
DE0012R	Bassum	92	92	92	92	91	91	92	92	92	92	92	92
DE0026R	Ueckermünde	96	96	96	91	96	92	96	96	96	96	96	96
DE0035R	Lückendorf	92	92	92	91	83	91	91	91	92	92	92	96
DE0039R	Aukrug	96	96	95	92	92	88	93	96	57	96	96	96
DE0042R	Öhringen	96	96	96	96	96	94	96	96	96	96	96	96
DE0045R	Schorfheide	92	92	92	85	89	95	92	92	92	90	92	92
DE0046R	Raisting	96	96	96	96	96	95	96	96	96	95	92	95
DE0047R	Falkenberg	92	92	92	92	92	91	92	96	96	95	96	96
DK0005R	Keldsnor	100	100	100	100	100	100	100	100	100	100	100	100
DK0031R	Ulborg	99	100	99	100	99	100	100	0	0	0	0	0
DK0041R	Lille Valby	94	100	99	97	100	91	96	88	96	99	100	100
EE0009R	Lahemaa	99	100	99	97	97	100	97	95	99	100	100	87
EE0011R	Vilsandy	100	100	100	99	100	100	97	97	100	50	77	98
ES0007R	Víznar	90	98	99	96	99	99	99	98	99	98	98	92
ES0008R	Niembro	99	98	99	97	70	76	97	95	90	98	93	94
ES0009R	Campisabalos	91	97	99	98	91	95	98	96	94	98	98	90
ES0010R	Cabo de Creus	92	86	99	96	95	98	91	94	99	93	99	98
ES0011R	Barcarrola	99	99	90	99	99	99	99	99	96	98	95	97
ES0012R	Zarra	99	92	93	99	99	96	98	98	95	98	99	99
ES0013R	Penausende	98	99	99	98	99	98	99	99	96	99	76	90
ES0014R	Els Torms	94	93	99	99	98	99	98	98	94	99	99	94
ES0015R	Risco Llamo	97	98	99	97	98	98	98	95	98	90	96	98
ES0016R	O Saviñao	97	87	92	84	96	94	91	80	98	93	97	99
FI0009R	Utö	100	100	92	69	59	100	99	100	98	95	100	96
FI0017R	Virolahti II	94	100	100	100	95	99	99	96	94	100	100	97
FI0022R	Oulanka	99	100	97	90	97	100	100	100	86	100	100	97
FI0037R	Ahtari II	95	96	100	100	96	100	77	87	95	79	100	85
FR0008R	Donon A	98	99	99	94	98	98	98	99	95	98	99	96
FR0008R	Donon B	99	84	98	94	98	98	98	99	95	98	98	95
FR0008R	Donon D	100	100	100	95	100	99	100	100	96	100	100	97
FR0008R	Donon C	100	100	99	95	100	99	100	100	96	99	100	97
FR0009R	Revin	100	99	99	99	97	99	99	99	99	99	100	97
FR0010R	Morvan	99	99	96	100	99	100	100	100	86	97	100	100

Table 3.2, cont.

Code	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
FR0012R	Iraty	91	77	67	75	74	97	97	80	93	93	96	99
FR0013R	Peyrusse Vieille	100	99	78	100	99	100	100	90	93	100	100	100
FR0014R	Montandon	96	98	98	98	97	98	97	97	98	98	73	98
FR0015R	La Tardière	100	100	100	100	100	100	99	97	70	99	100	100
FR0016R	Le Casset	99	98	100	93	99	95	100	92	99	98	97	99
GB0002R	Eskdalemuir	99	99	100	100	99	98	99	98	65	100	100	100
GB0006R	Lough Navar	69	87	97	77	0	18	44	99	99	100	96	92
GB0013R	Yarner Wood	100	96	99	98	98	100	98	99	99	100	100	100
GB0014R	High Muffles	97	99	97	100	100	96	99	100	98	100	100	100
GB0015R	Strath Vaich Dam	86	100	100	72	90	99	89	99	100	75	32	100
GB0031R	Aston Hill	100	100	95	98	100	100	100	99	99	99	99	100
GB0032R	Bottesford	99	100	100	93	100	100	99	100	100	100	100	100
GB0033R	Bush	98	99	99	99	100	100	96	96	99	98	99	100
GB0034R	Glazebury	97	99	100	100	16	62	100	100	100	99	94	100
GB0035R	Great Dun Fell	99	99	100	100	100	100	100	100	100	100	99	92
GB0036R	Harwell	95	99	99	99	96	99	97	94	99	99	76	100
GB0037R	Ladybower Res.	99	95	100	95	99	99	94	98	99	99	99	99
GB0038R	Lullington Heath	98	95	95	99	99	99	79	95	89	98	100	99
GB0039R	Sibton	99	96	100	100	100	100	95	100	99	100	45	67
GB0043R	Narberth	94	34	89	97	93	99	90	95	95	99	79	94
GB0044R	Somerton	99	91	96	98	99	97	96	95	99	98	100	100
GB0045R	Wicken Fen	99	99	95	100	99	99	99	95	99	99	99	99
GR0001R	Aliartos	16	100	100	86	0	1	62	98	100	100	100	99
GR0002R	Finokalia	0	0	40	18	55	93	98	93	100	100	45	79
HU0002R	K-puszta	100	100	100	95	76	89	80	90	100	99	0	73
IE0031R	Mace Head	100	100	93	97	99	87	97	92	99	100	100	100
IT0001R	Montelibretti	100	100	100	100	99	87	95	100	98	100	99	100
LT0015R	Preila	100	89	88	100	100	100	100	100	92	88	97	87
LV0010R	Rucava	100	100	100	100	100	99	99	98	96	97	30	99
MT0001R	Giordan lighthouse	54	98	57	88	100	78	98	100	80	38	79	94
NL0009R	Kollumerwaard	92	100	99	100	100	100	100	100	94	100	100	100
NL0010R	Vredepeel	99	100	98	92	100	100	99	99	98	99	99	99

Table 3.2, cont.

Code	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
NO0001R	Birkenes	99	99	99	99	99	98	99	100	99	99	97	100
NO0015R	Tustervatn	100	100	100	99	100	99	89	100	100	100	100	0
NO0039R	Kårvatn	100	100	100	100	100	99	100	100	100	100	100	100
NO0041R	Osen	100	98	100	100	100	78	99	100	96	100	100	98
NO0042G	Spitsbergen, Zeppelinfjell	97	99	99	99	100	99	99	99	100	87	100	98
NO0043R	Prestebakke	100	100	100	99	100	100	100	100	91	99	100	99
NO0045R	Jeløya	100	100	100	100	0	0	0	0	0	0	0	0
NO0048R	Voss	100	100	100	100	0	0	0	0	0	0	0	0
NO0052R	Sandve	100	100	100	100	100	100	100	99	99	100	100	100
NO0055R	Karasjok	99	100	100	100	100	100	100	100	99	100	100	100
NO0056R	Hurdal	99	99	100	100	99	100	100	98	99	100	100	98
PL0002R	Jarczew	100	100	100	100	100	100	100	100	100	100	100	100
PL0003R	Sniezka	100	100	100	100	100	100	100	100	100	100	100	100
PL0004R	Leba	100	100	100	100	100	100	100	100	100	100	100	100
PL0005R	Diabla Gora	100	100	95	100	100	95	97	98	100	100	100	94
PT0004R	Monte Velho	78	97	85	88	72	98	97	93	100	89	78	94
RU0016R	Shepeljovo	0	100	100	100	0	100	100	99	0	0	0	0
RU0018R	Danki	100	97	100	97	100	100	97	98	90	97	96	100
SE0011R	Vavihill	99	100	100	100	100	99	100	82	100	100	100	100
SE0012R	Aspvreten	100	89	93	96	100	88	100	100	100	91	96	99
SE0013R	Esrange	99	100	100	100	100	100	99	100	100	100	100	100
SE0014R	Råö	99	100	100	99	100	100	100	100	100	89	100	100
SE0032R	Norra-Kvill	99	100	100	99	100	100	100	100	99	100	100	98
SE0035R	Vindeln	99	100	100	99	100	100	95	100	98	100	90	100
SE0039R	Grimsö	99	100	100	99	100	100	100	100	100	99	98	100
SI0008R	Iskrba	95	93	87	87	93	94	94	91	93	81	94	95
SI0031R	Zarodnje	96	96	96	95	93	95	95	91	91	91	95	95
SI0032R	Krvavec	96	91	95	92	99	98	100	97	95	99	99	98
SI0033R	Kovk	91	88	84	95	81	87	89	89	83	94	96	91
SK0002R	Chopok	100	82	5	99	98	99	100	89	34	0	0	0
SK0004R	Stará Lesná	99	100	100	100	96	100	98	91	75	100	100	98
SK0006R	Starina	100	100	100	100	97	93	100	99	100	100	98	100
SK0007R	Topolniky	99	100	100	100	100	100	100	100	100	98	100	95

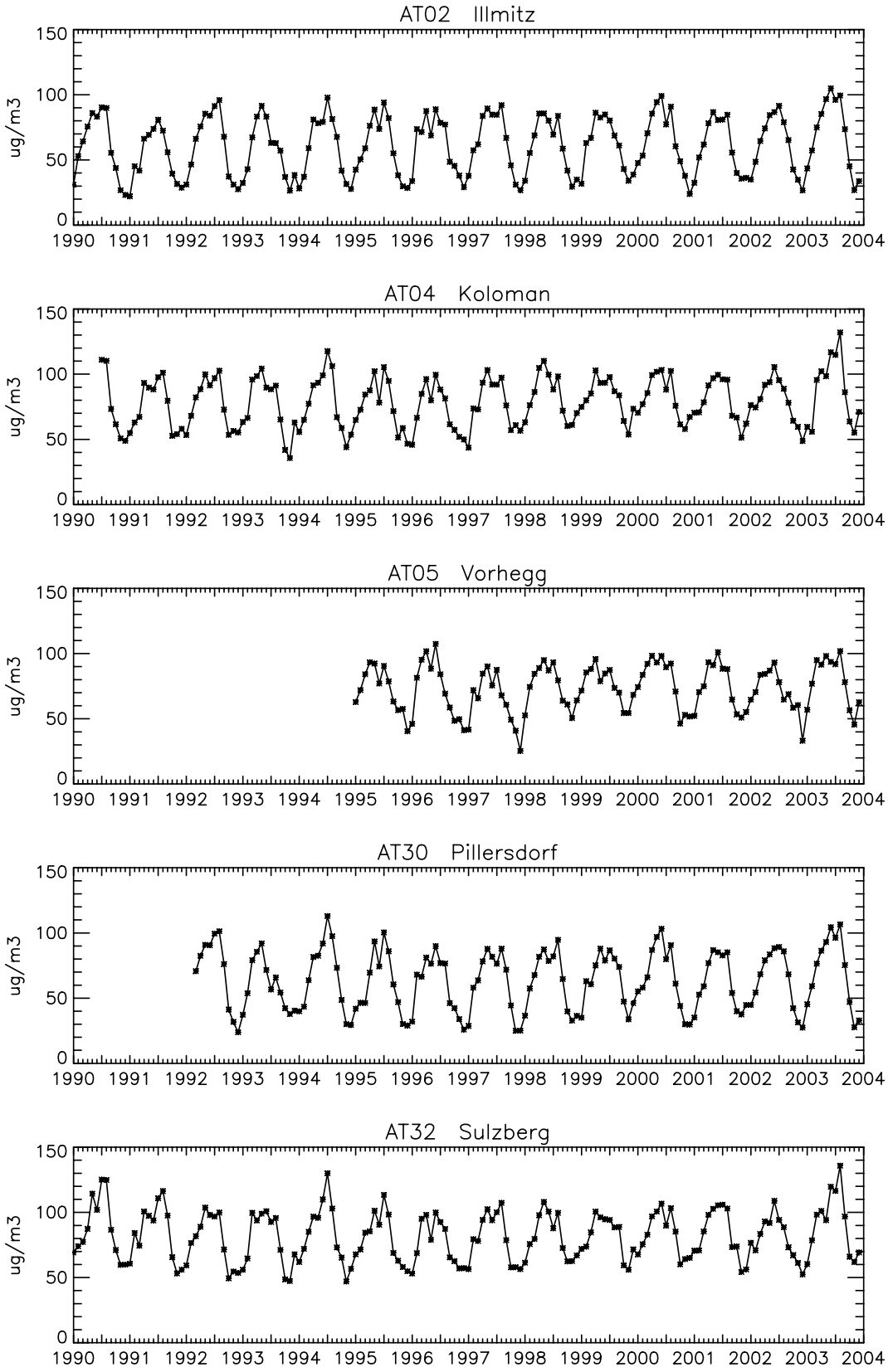


Figure 3.1: Seasonal variation, 1990–2003.

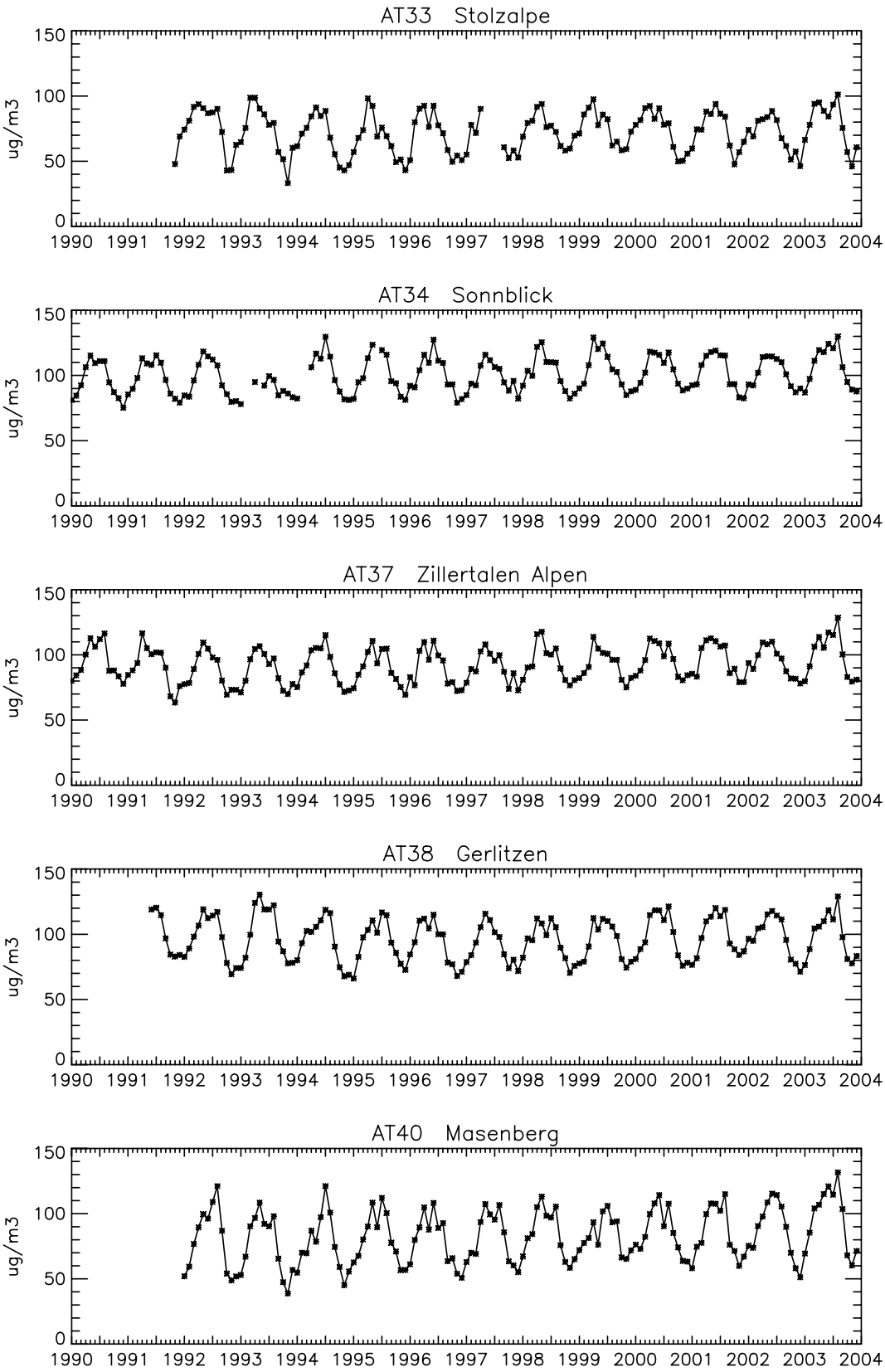


Figure 3.1, cont.

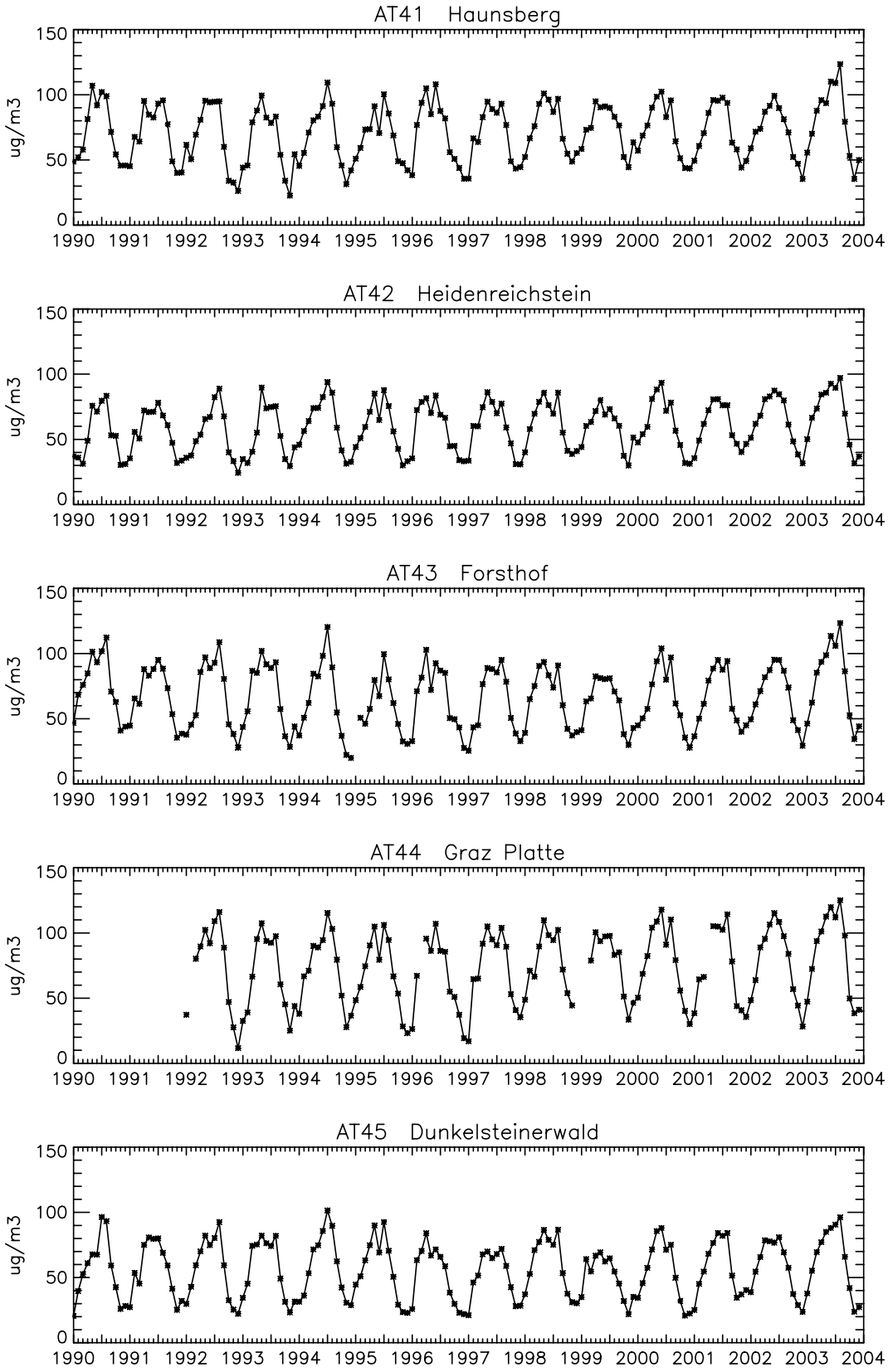


Figure 3.1, cont.

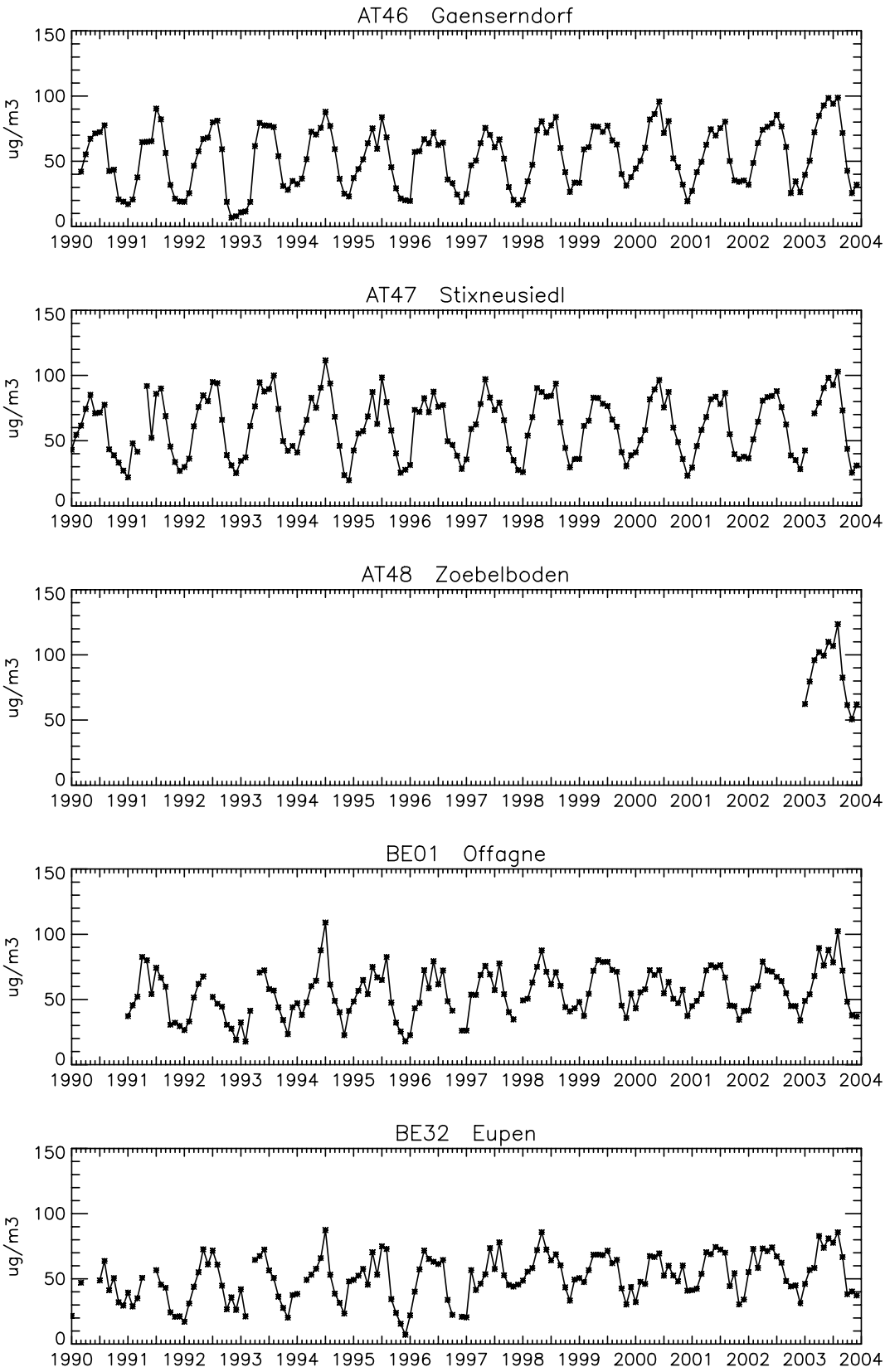


Figure 3.1, cont.

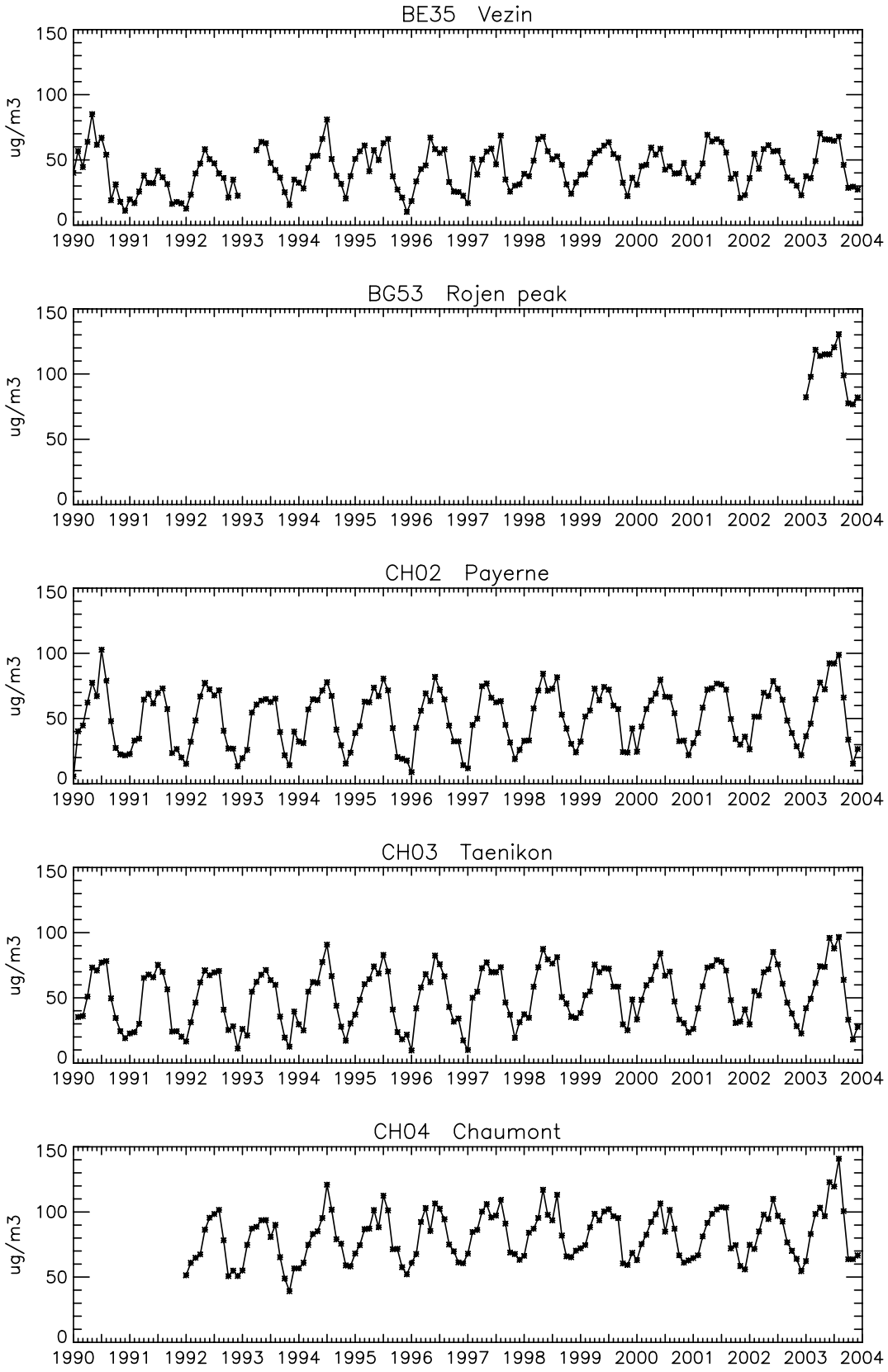


Figure 3.1, cont.

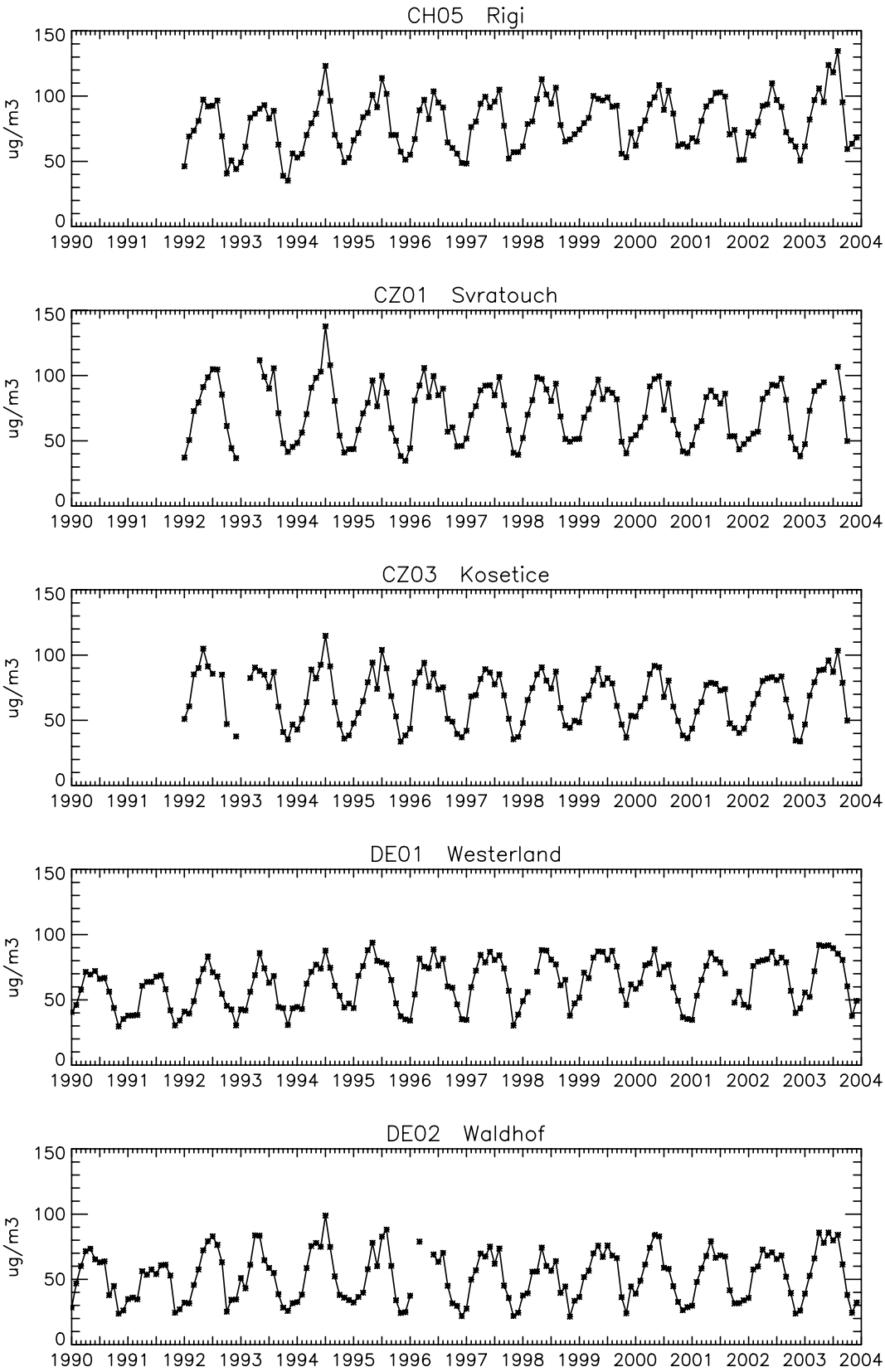


Figure 3.1, cont.

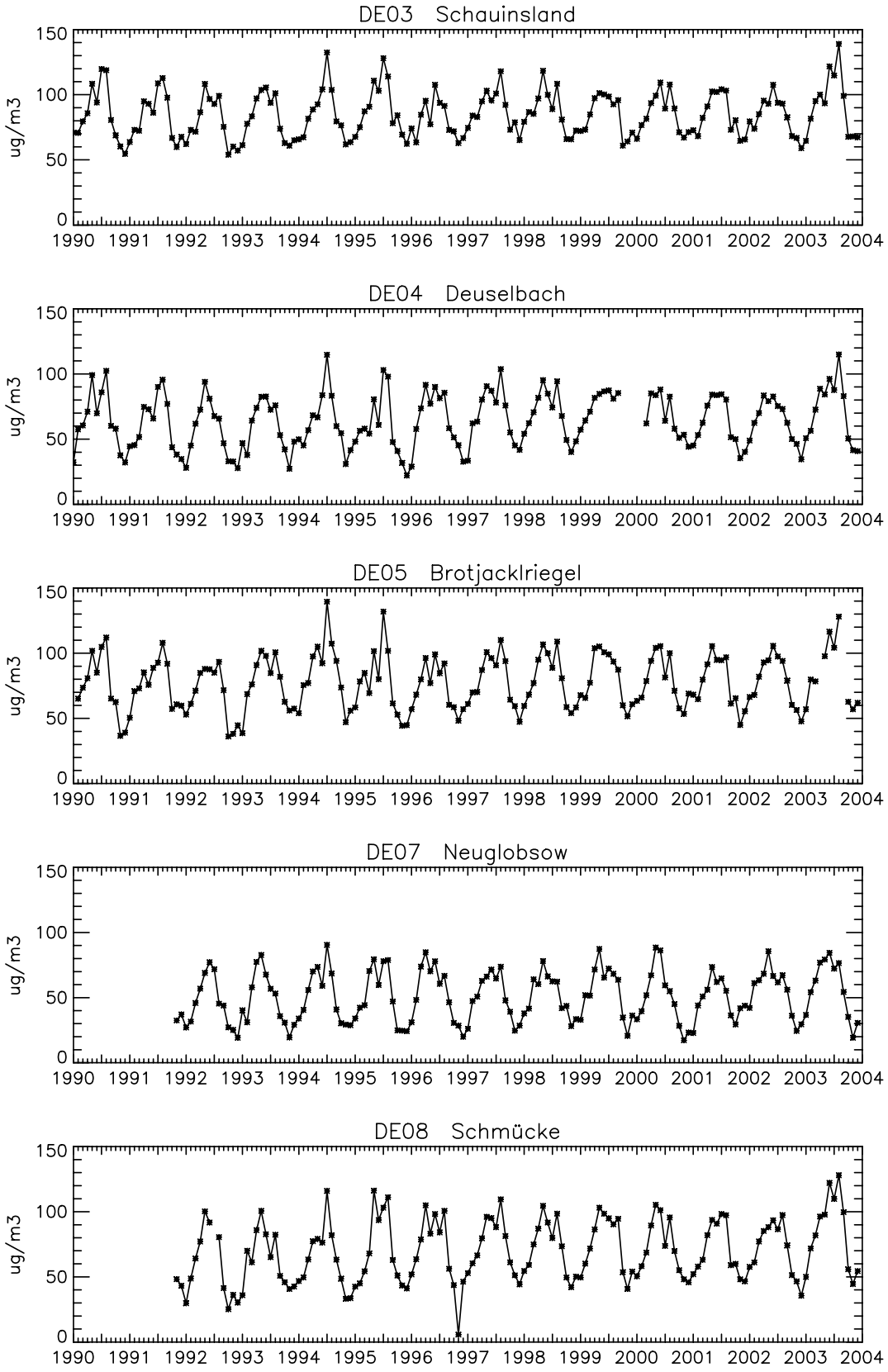


Figure 3.1, cont.

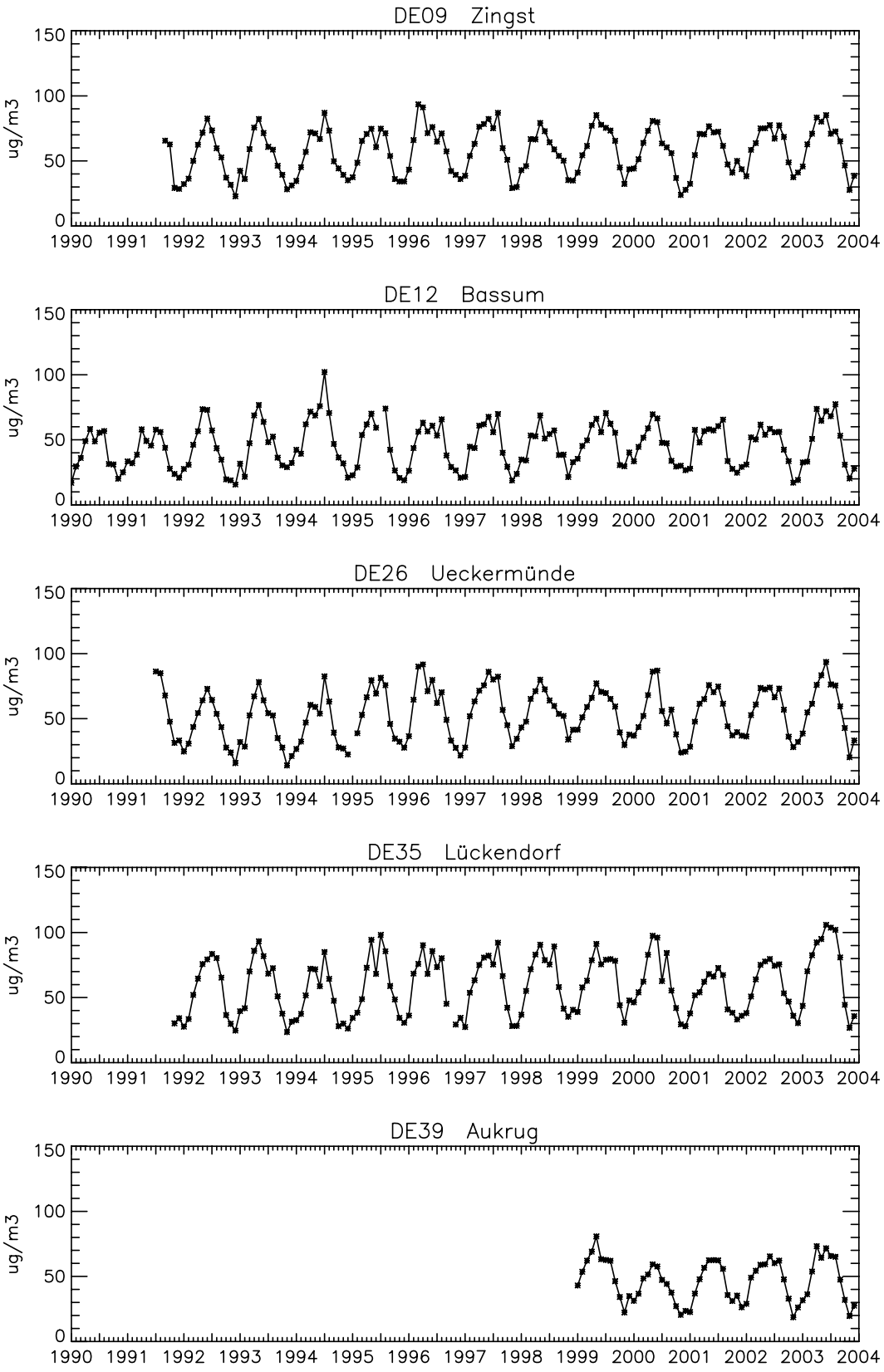
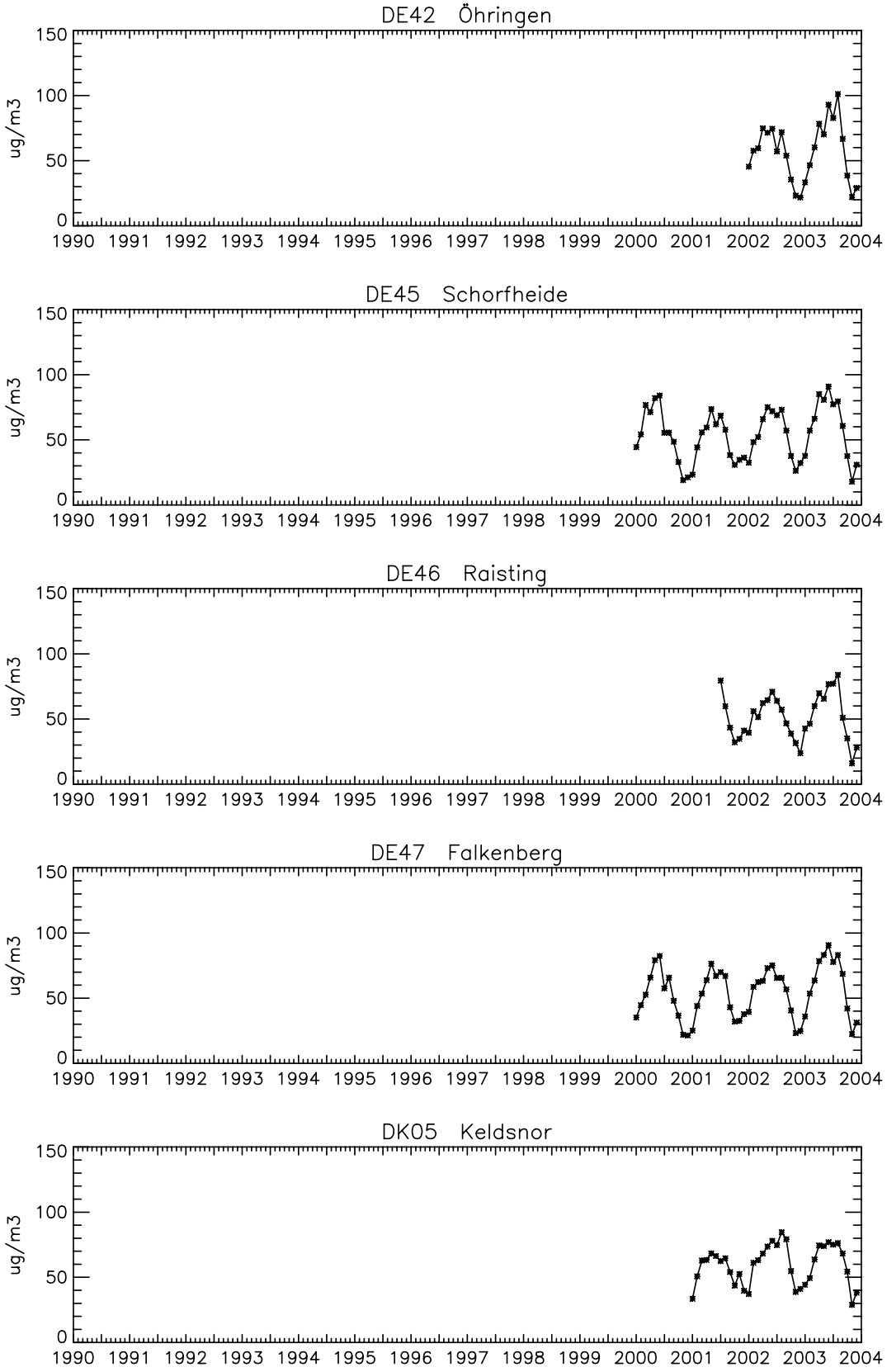


Figure 3.1, cont.



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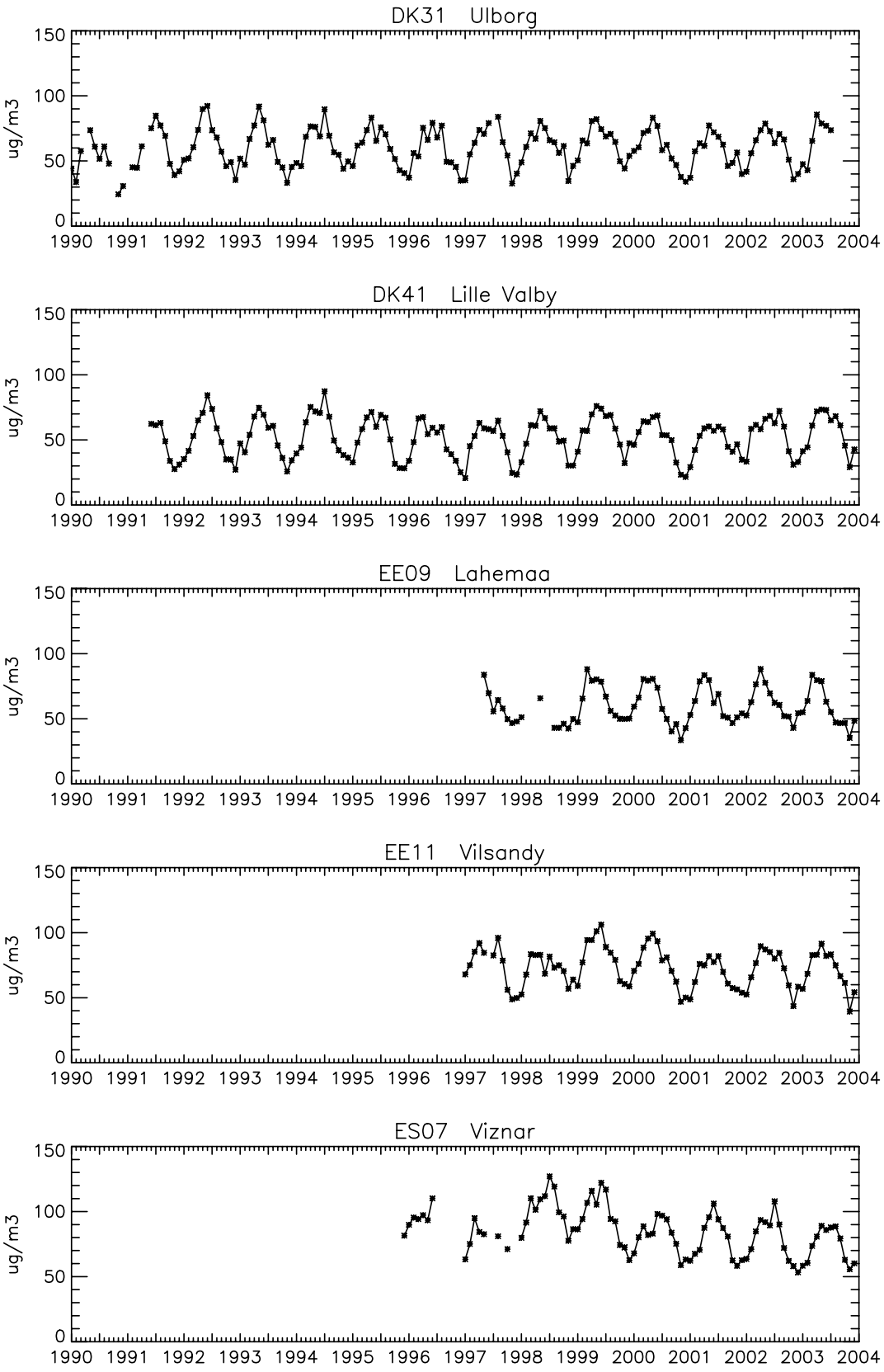


Figure 3.1, cont.

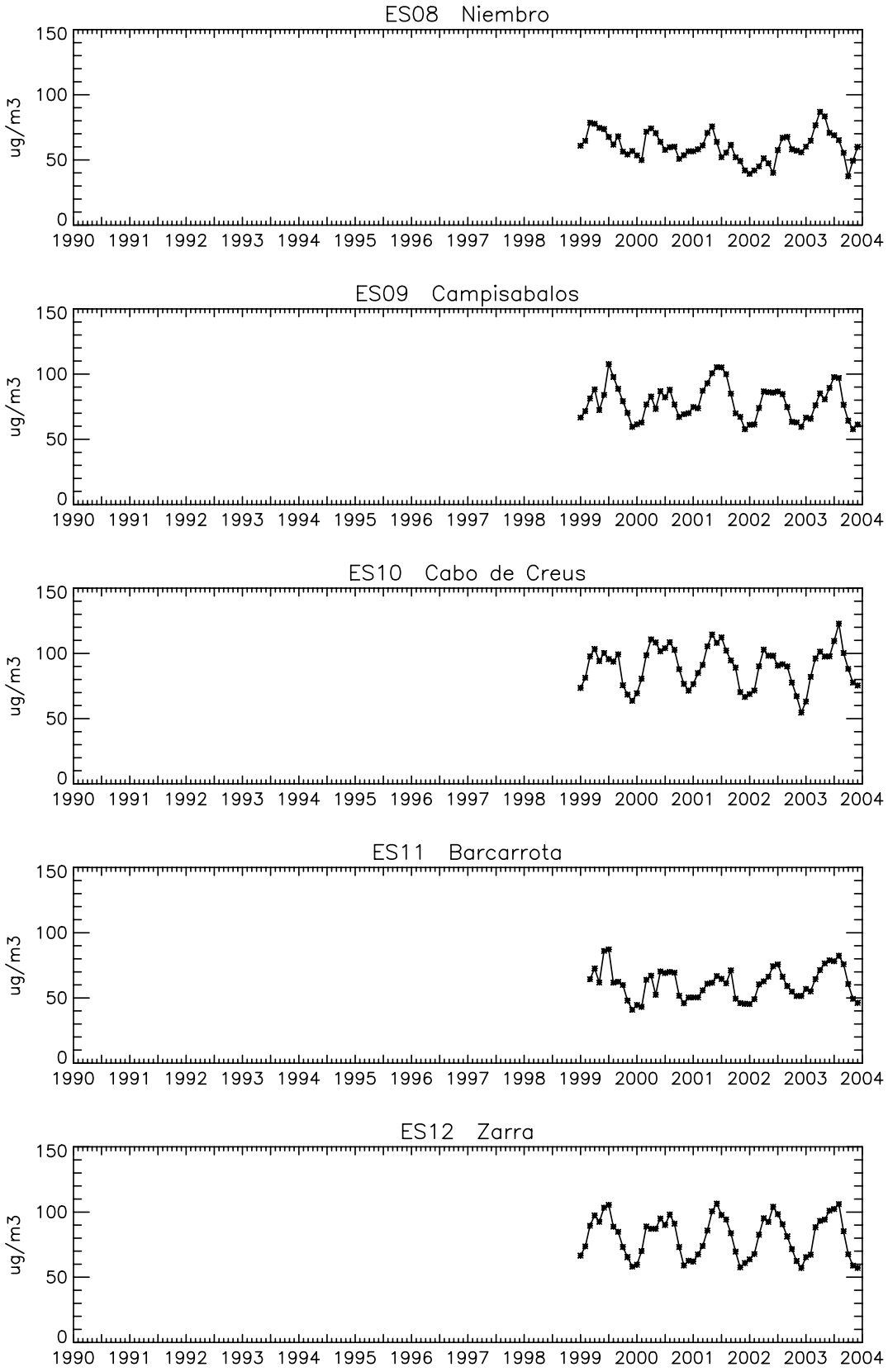
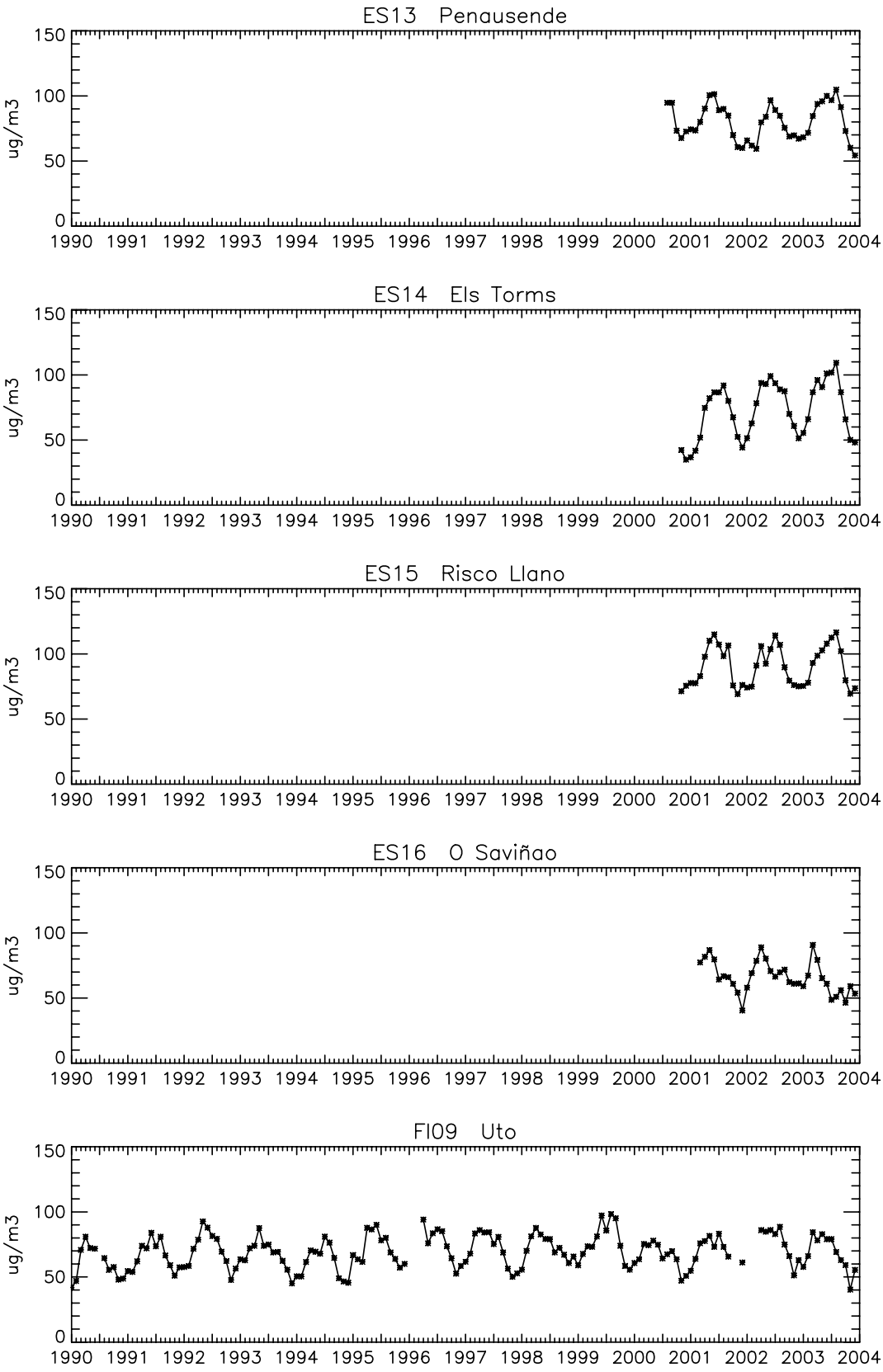


Figure 3.1, cont.



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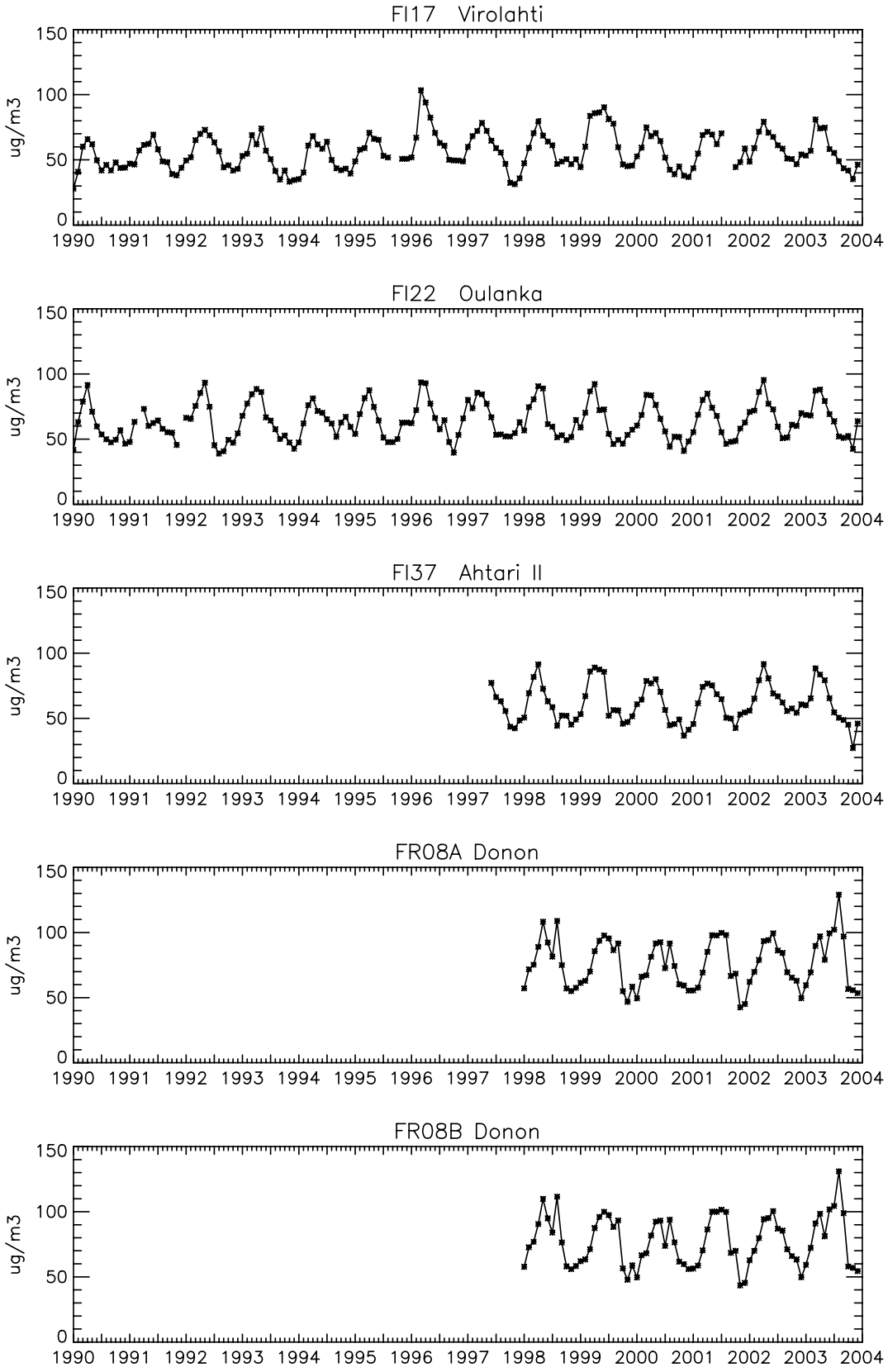

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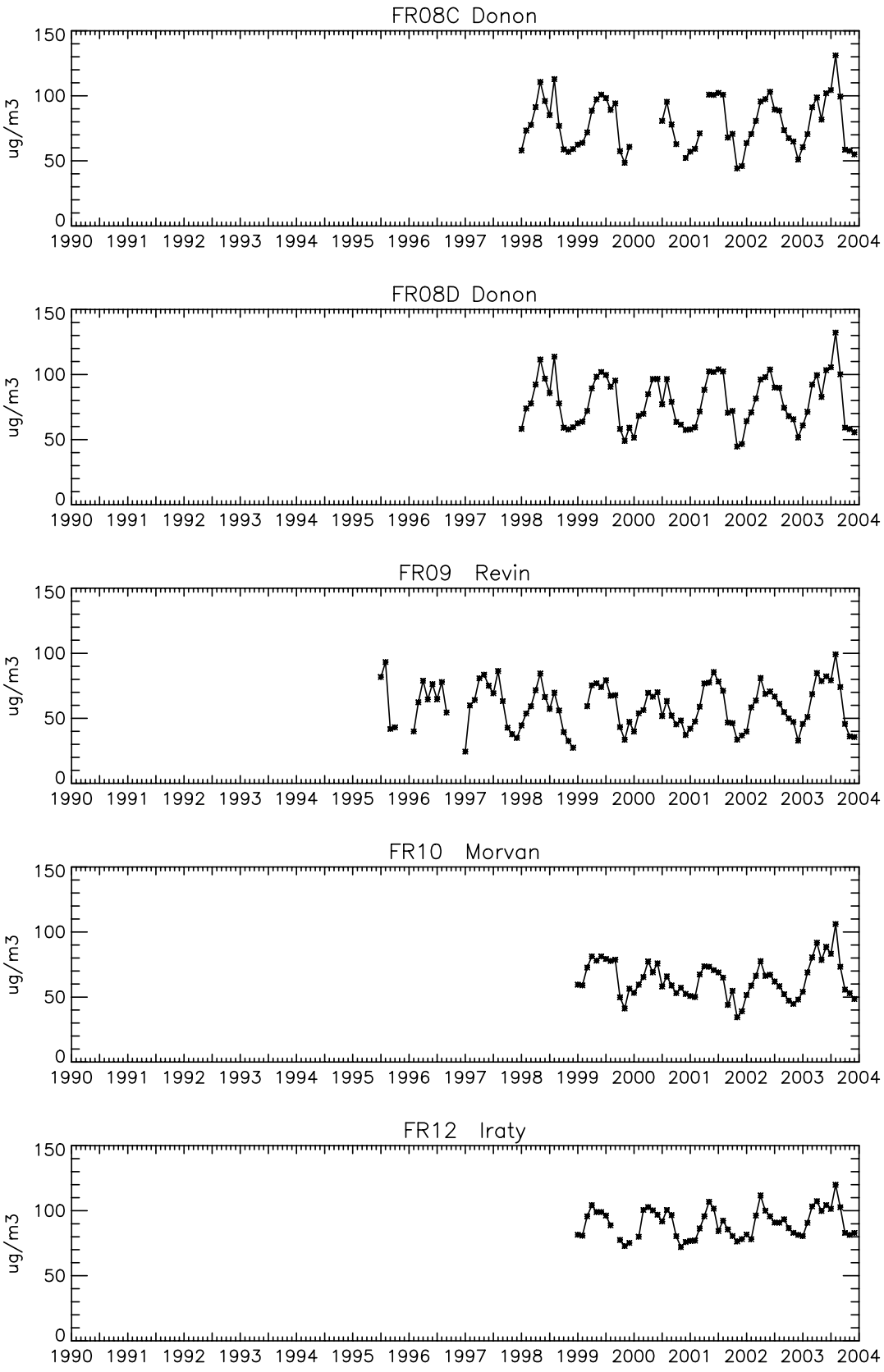

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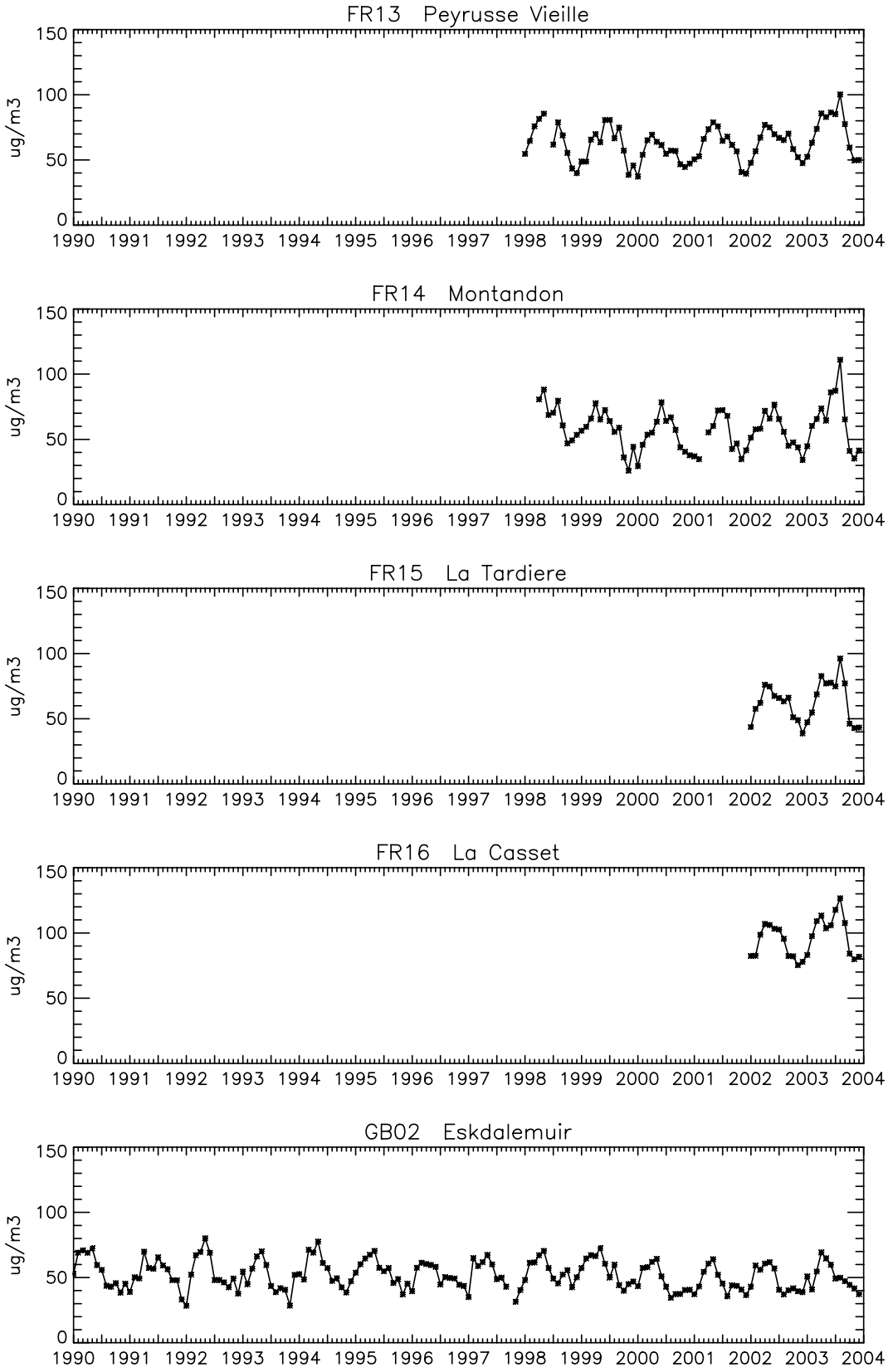

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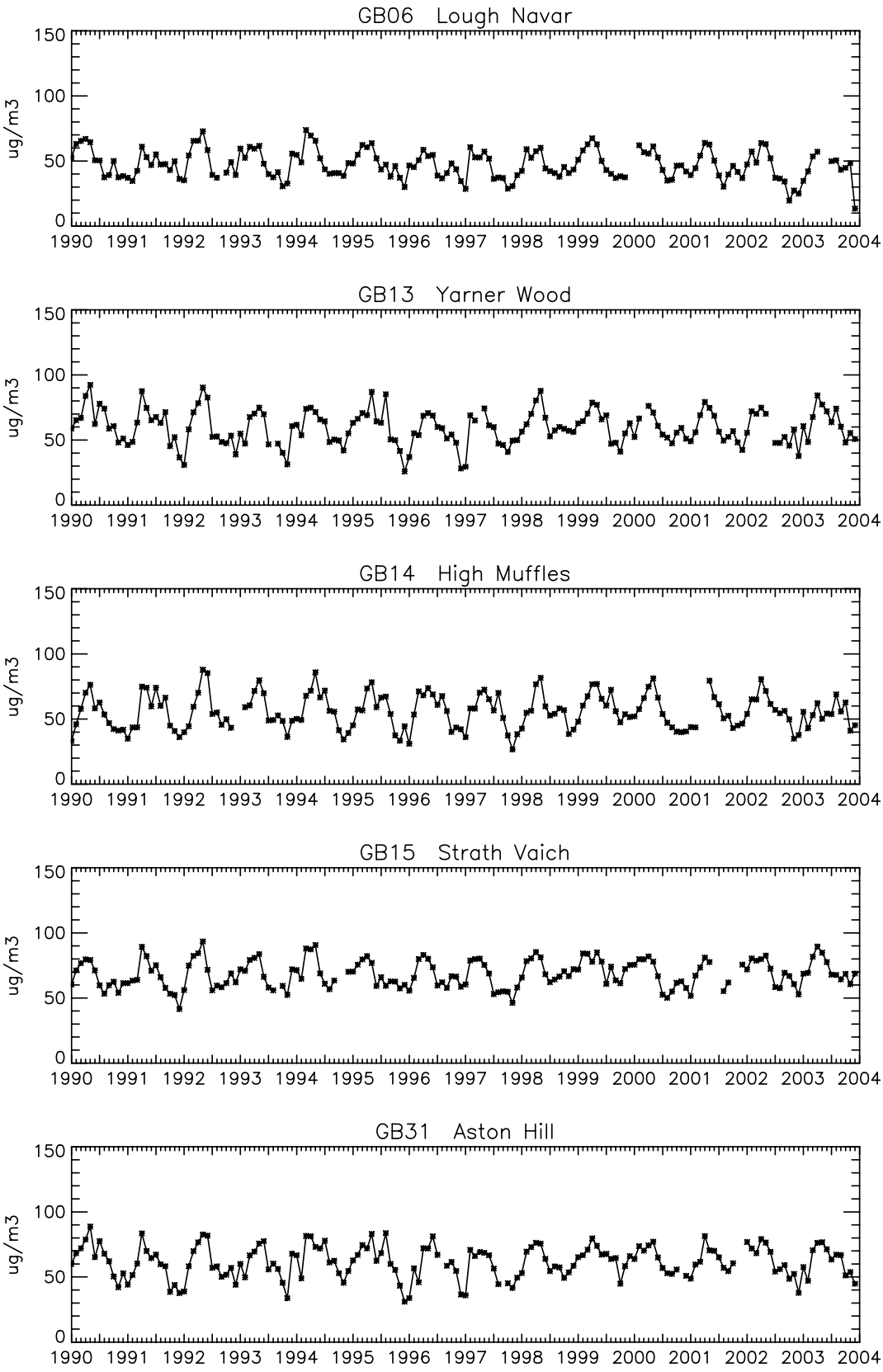

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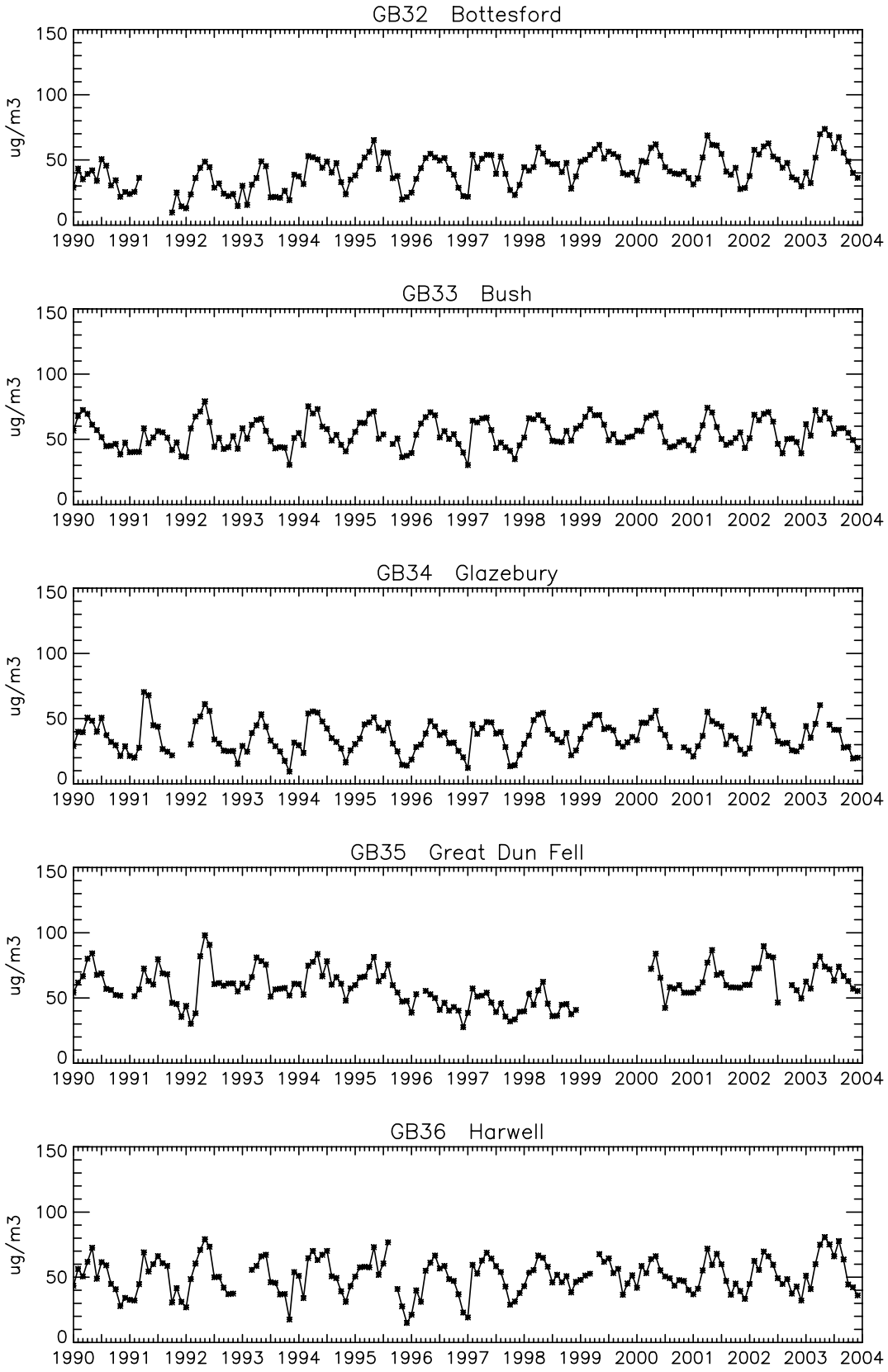

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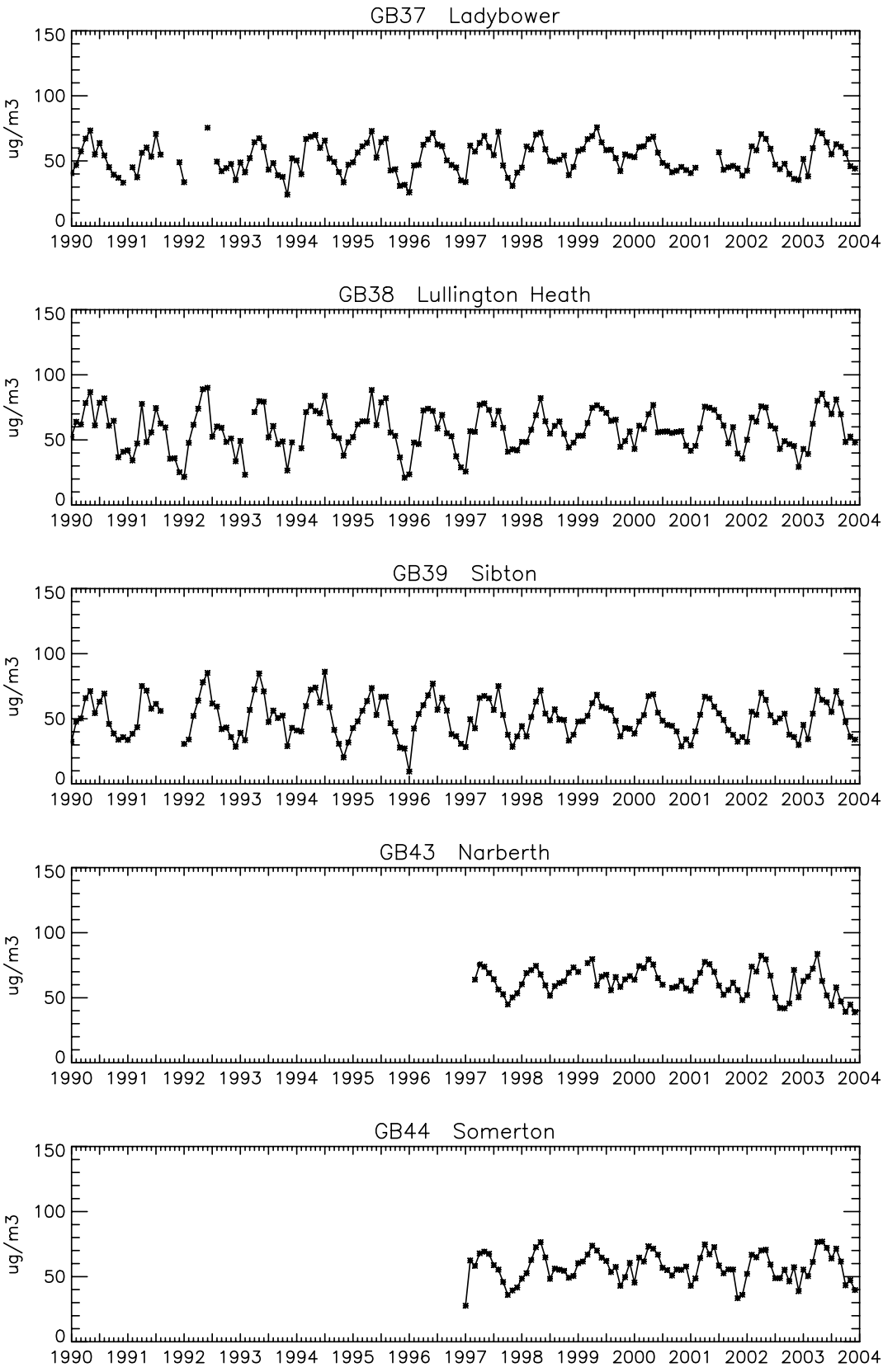

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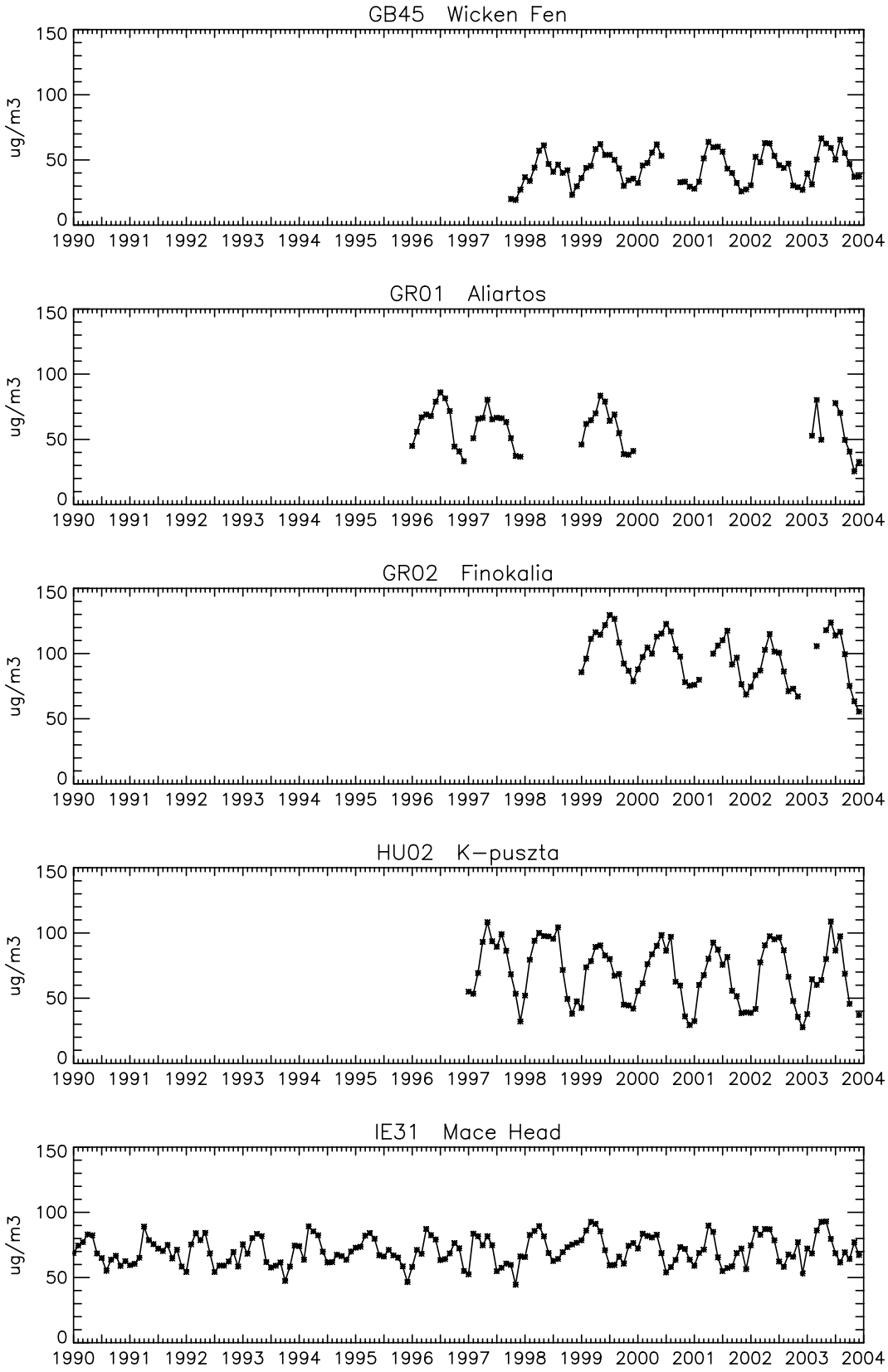

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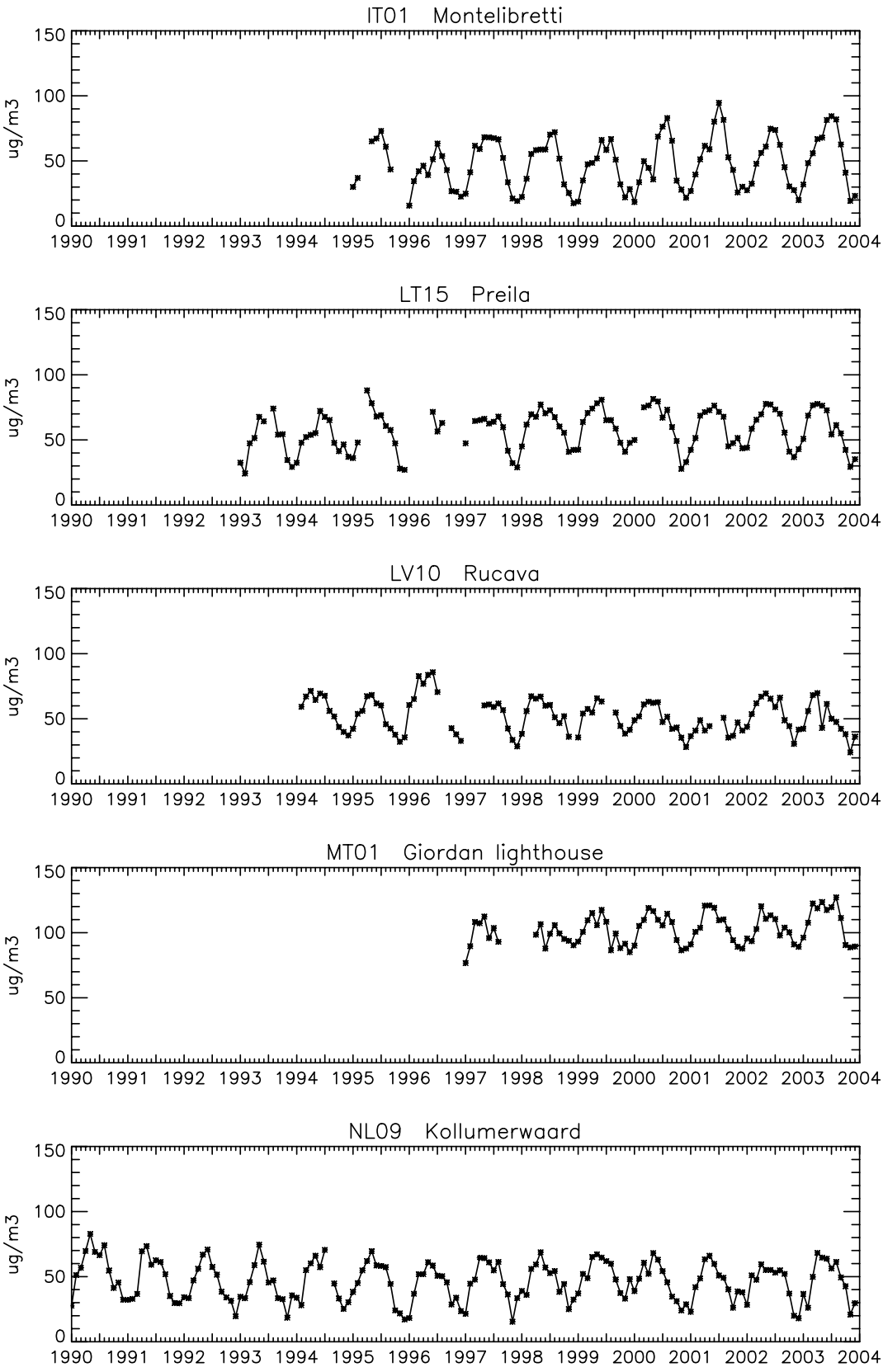

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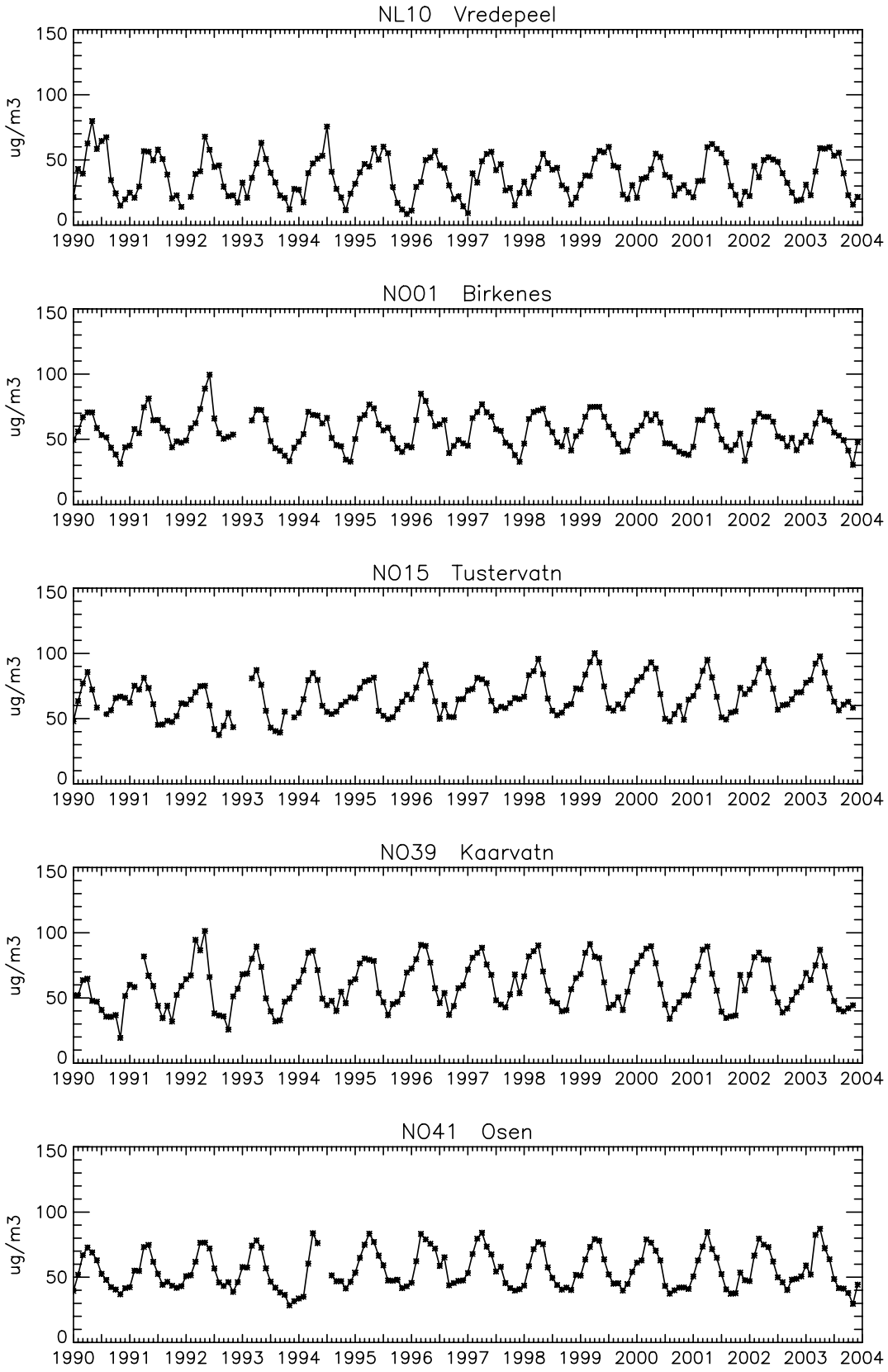

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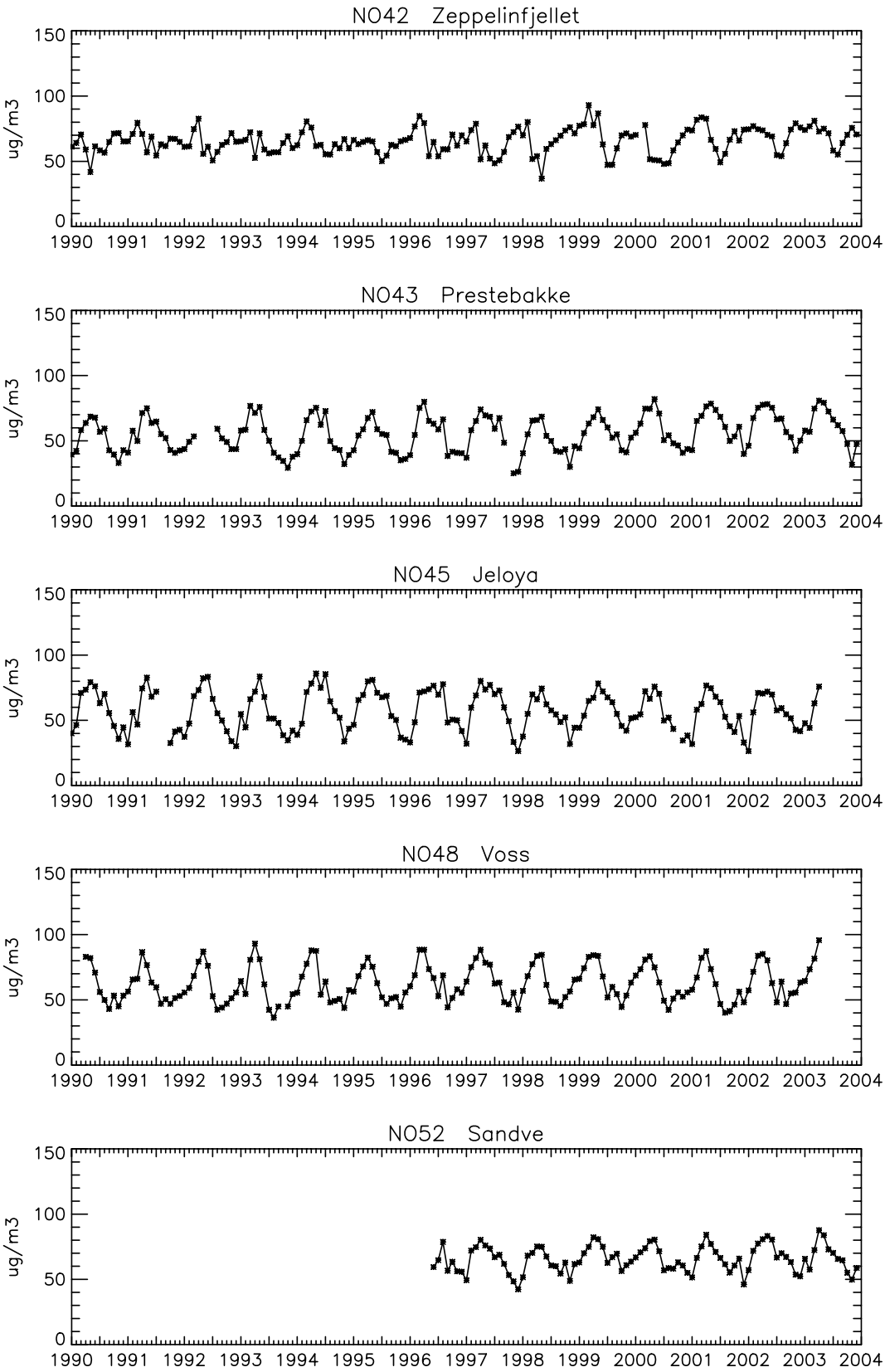


Figure 3.1, cont.

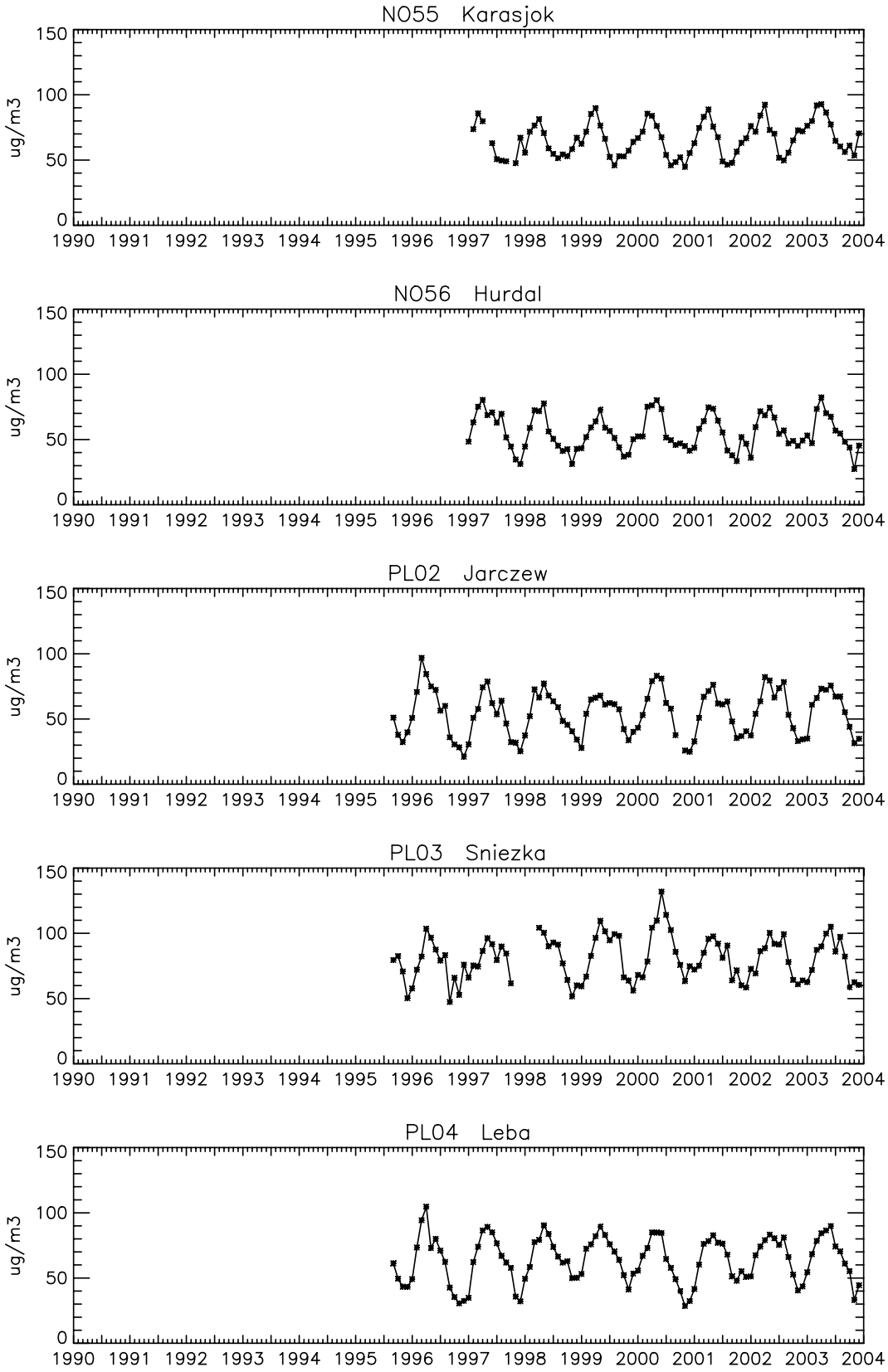
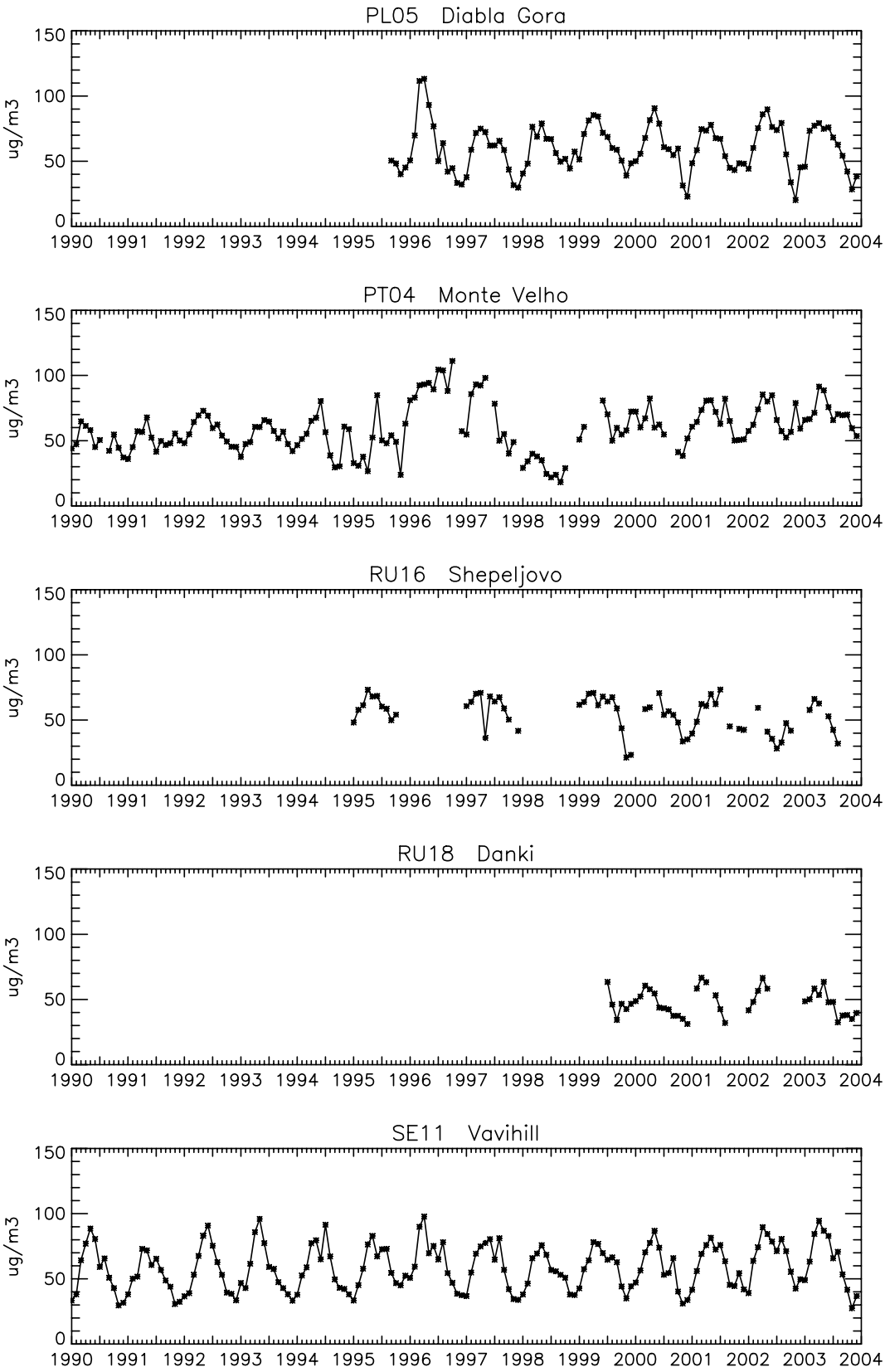


Figure 3.1, cont.



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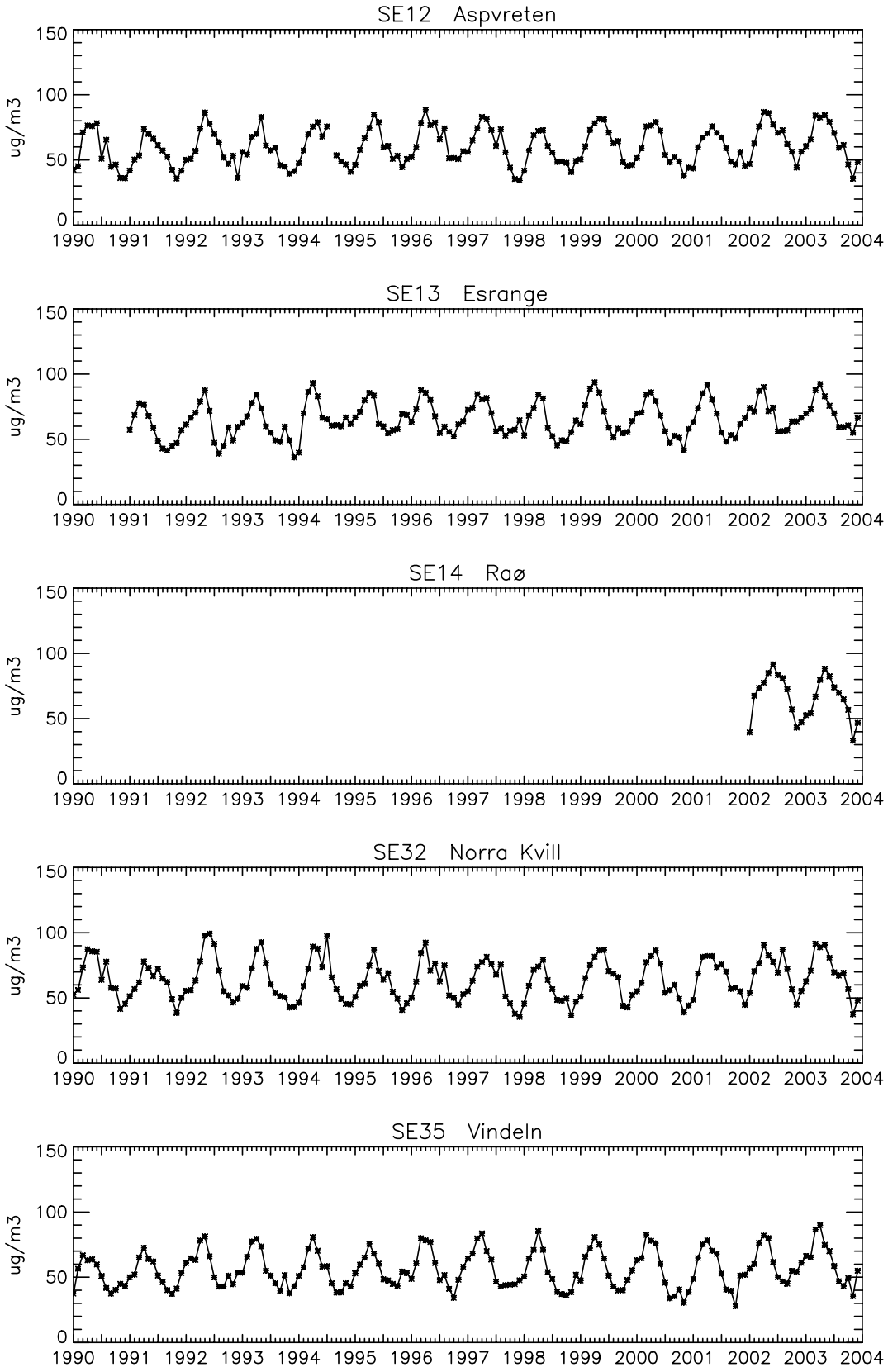


Figure 3.1, cont.

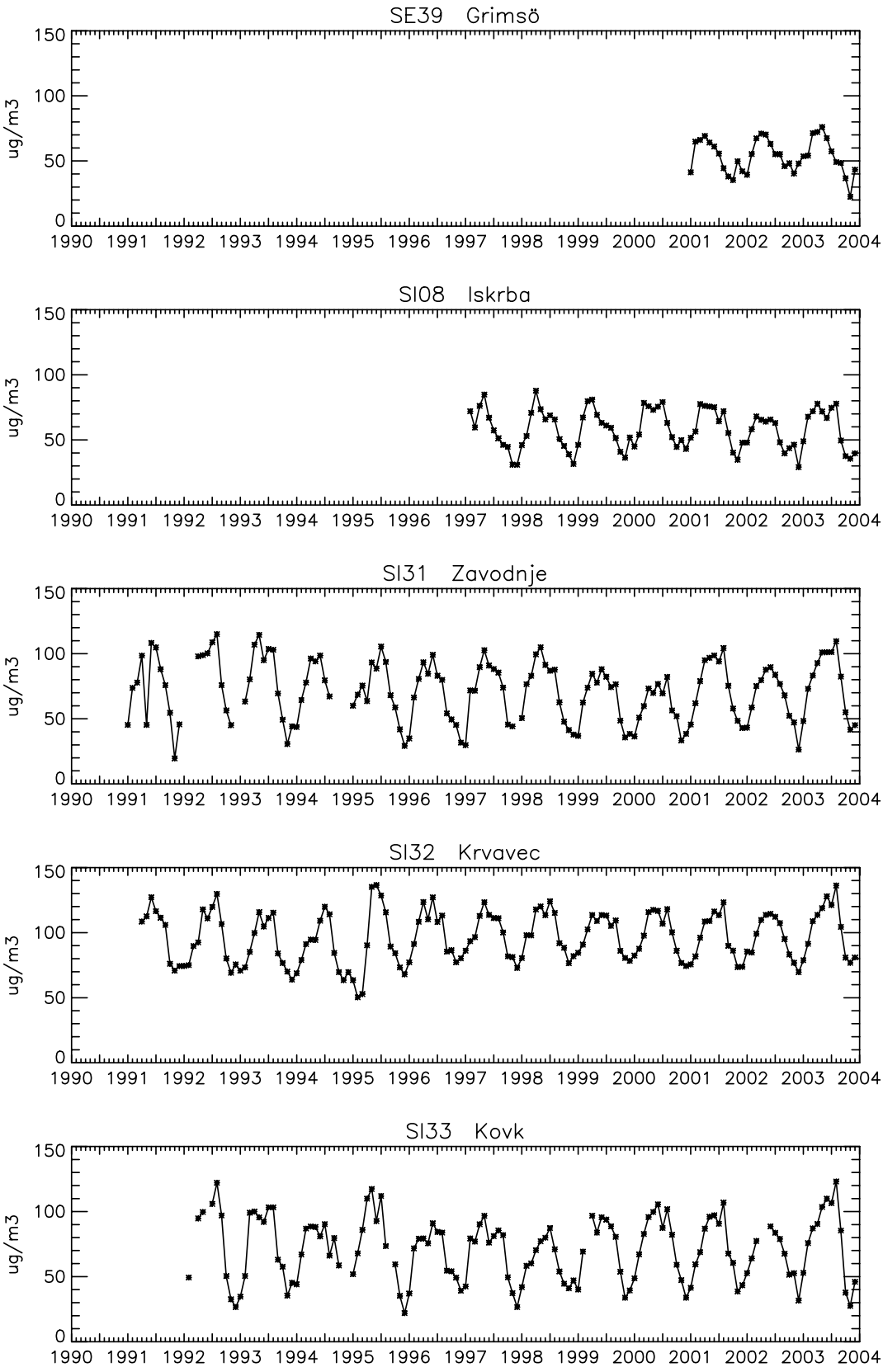


Figure 3.1, cont.

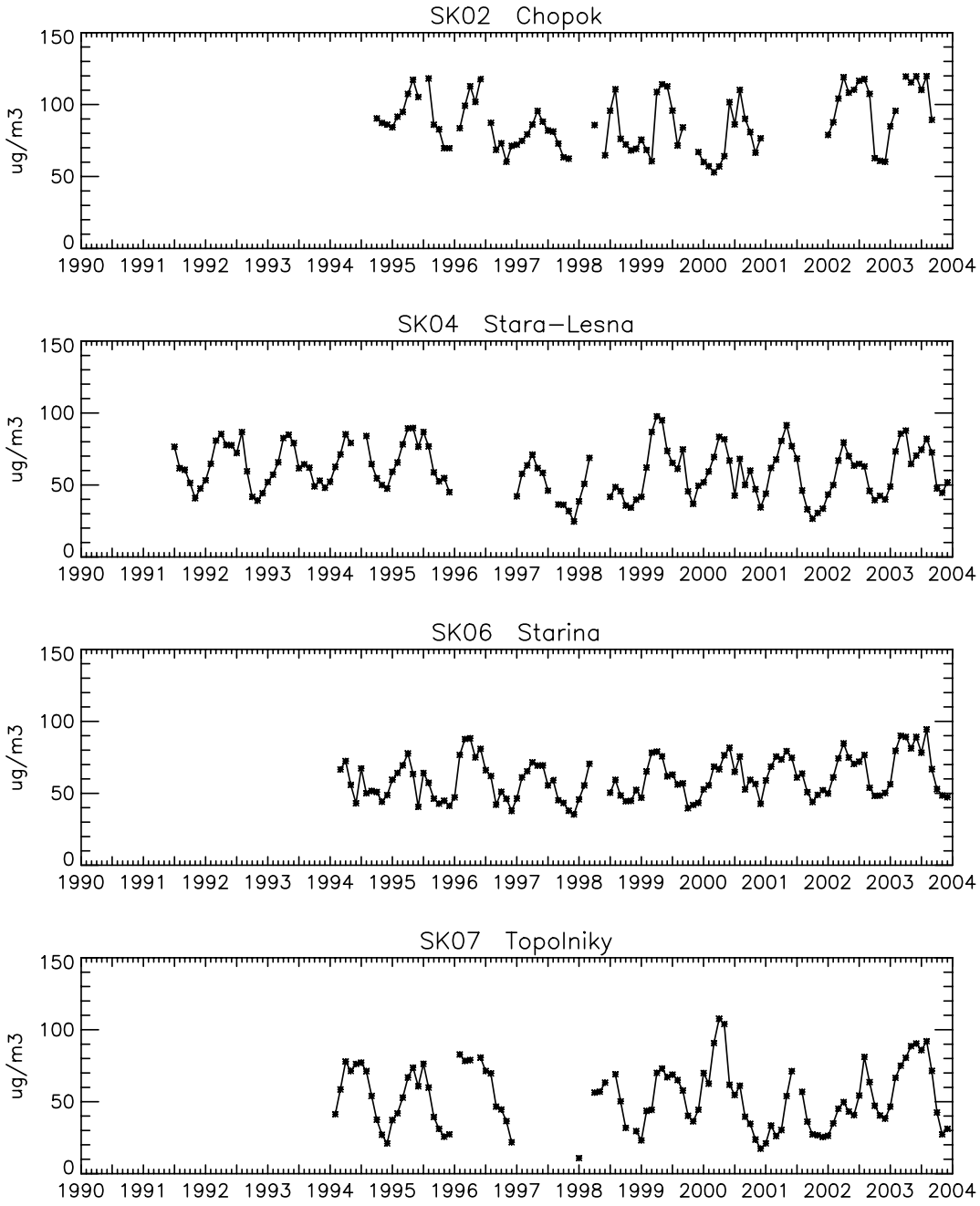


Figure 3.1, cont.

Annex 4

Diurnal variation, April–September 2003

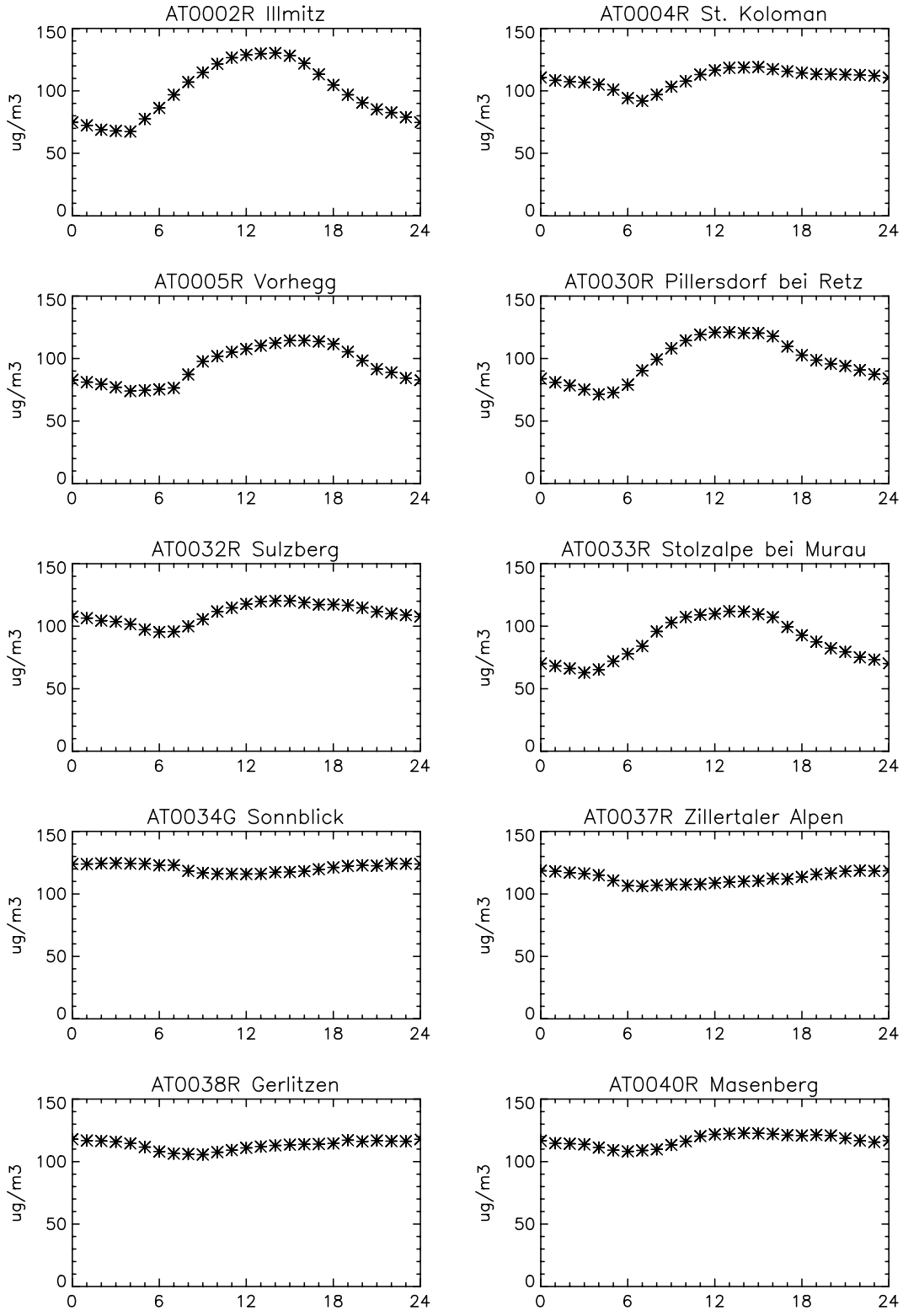


Figure 4.1: Diurnal variation, April–September 2003.

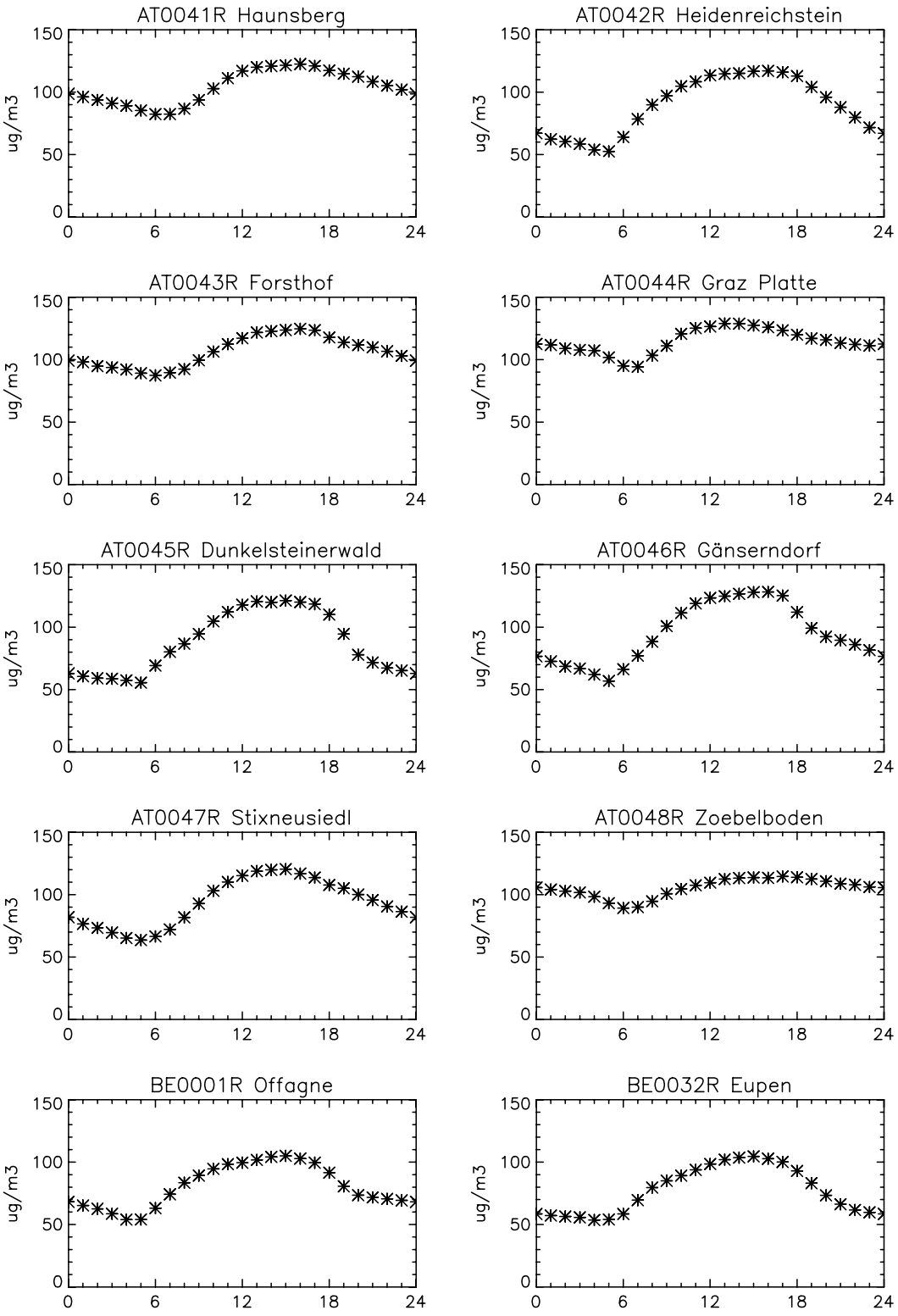


Figure 4.1, cont.

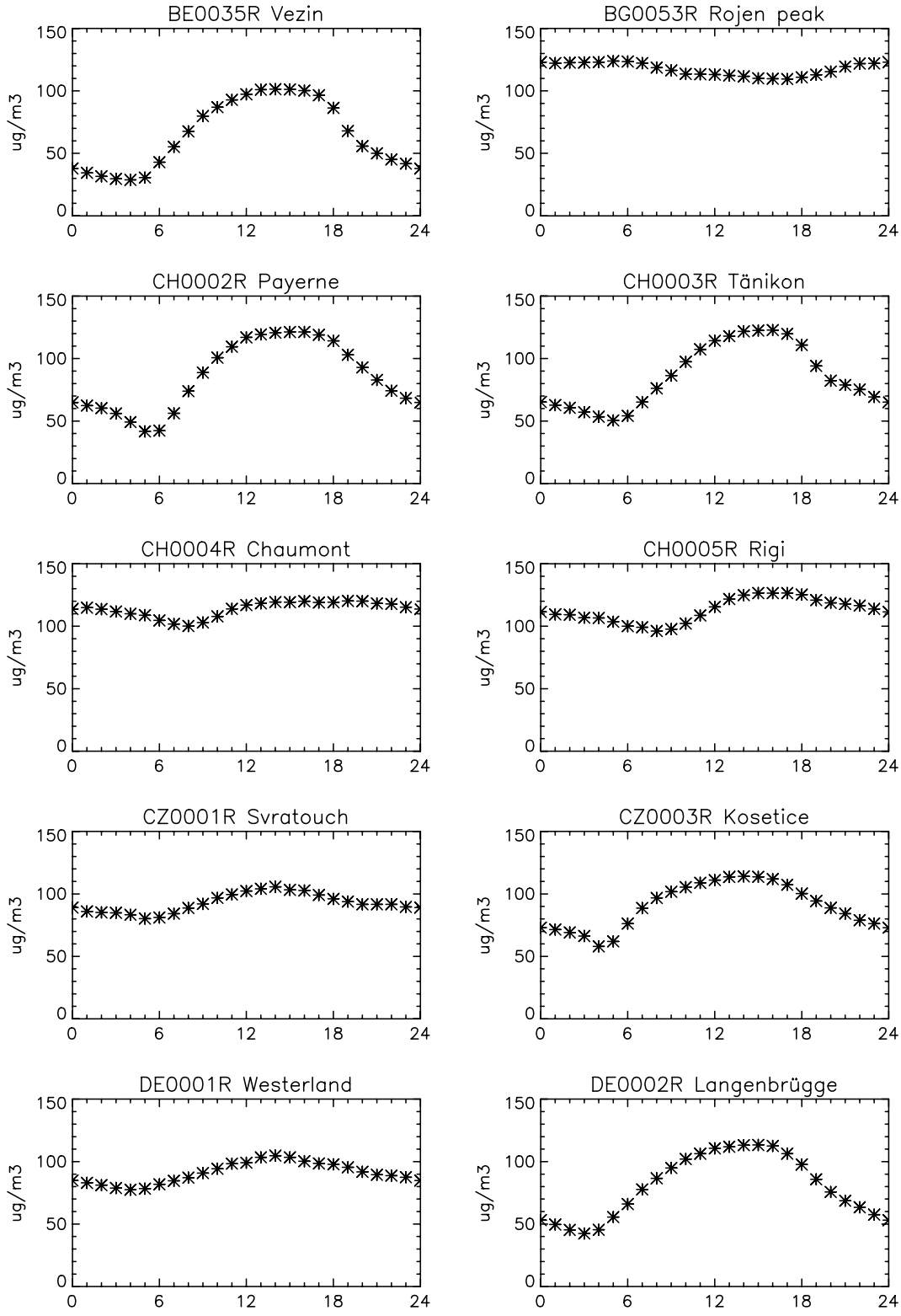


Figure 4.1, cont.

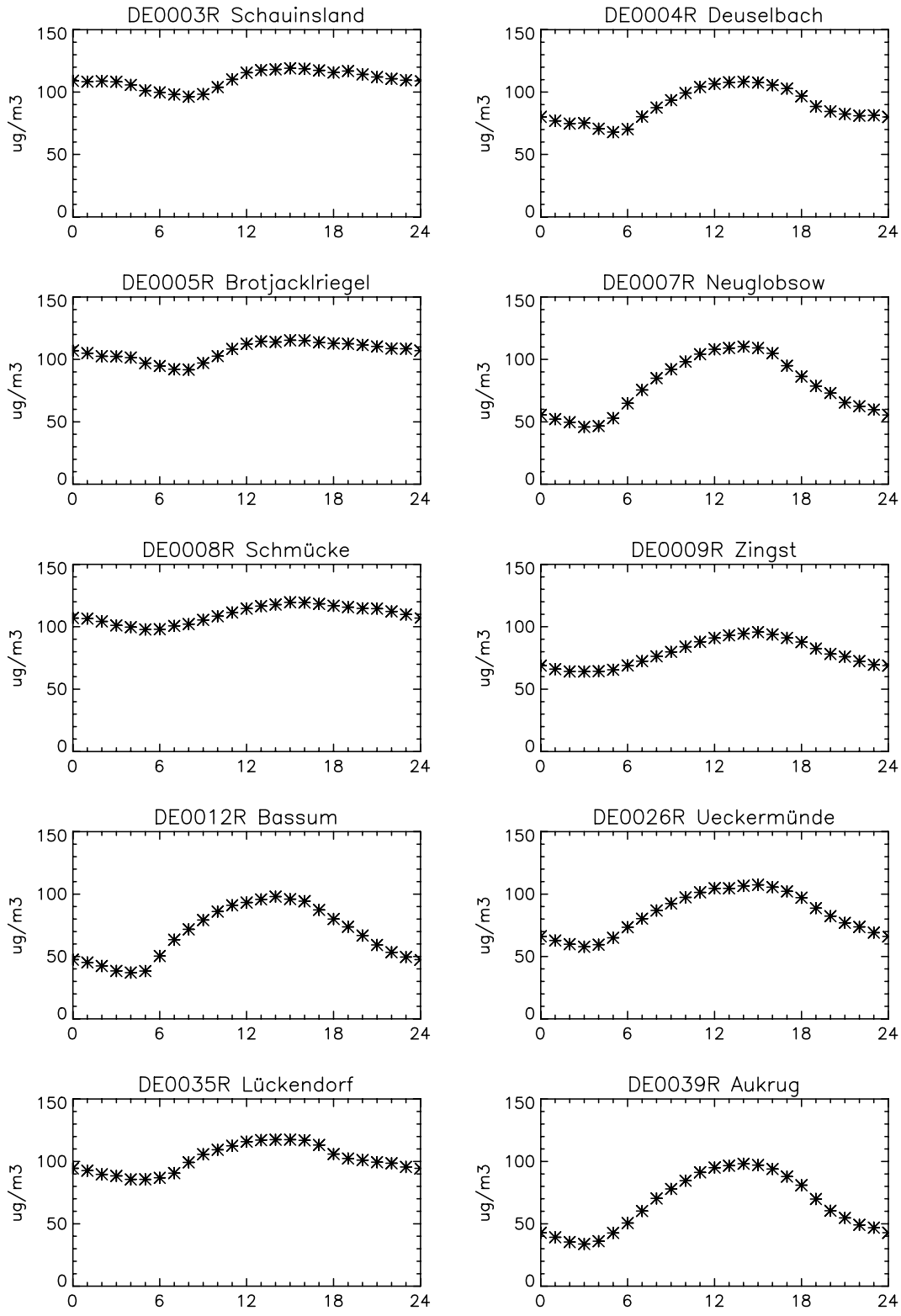
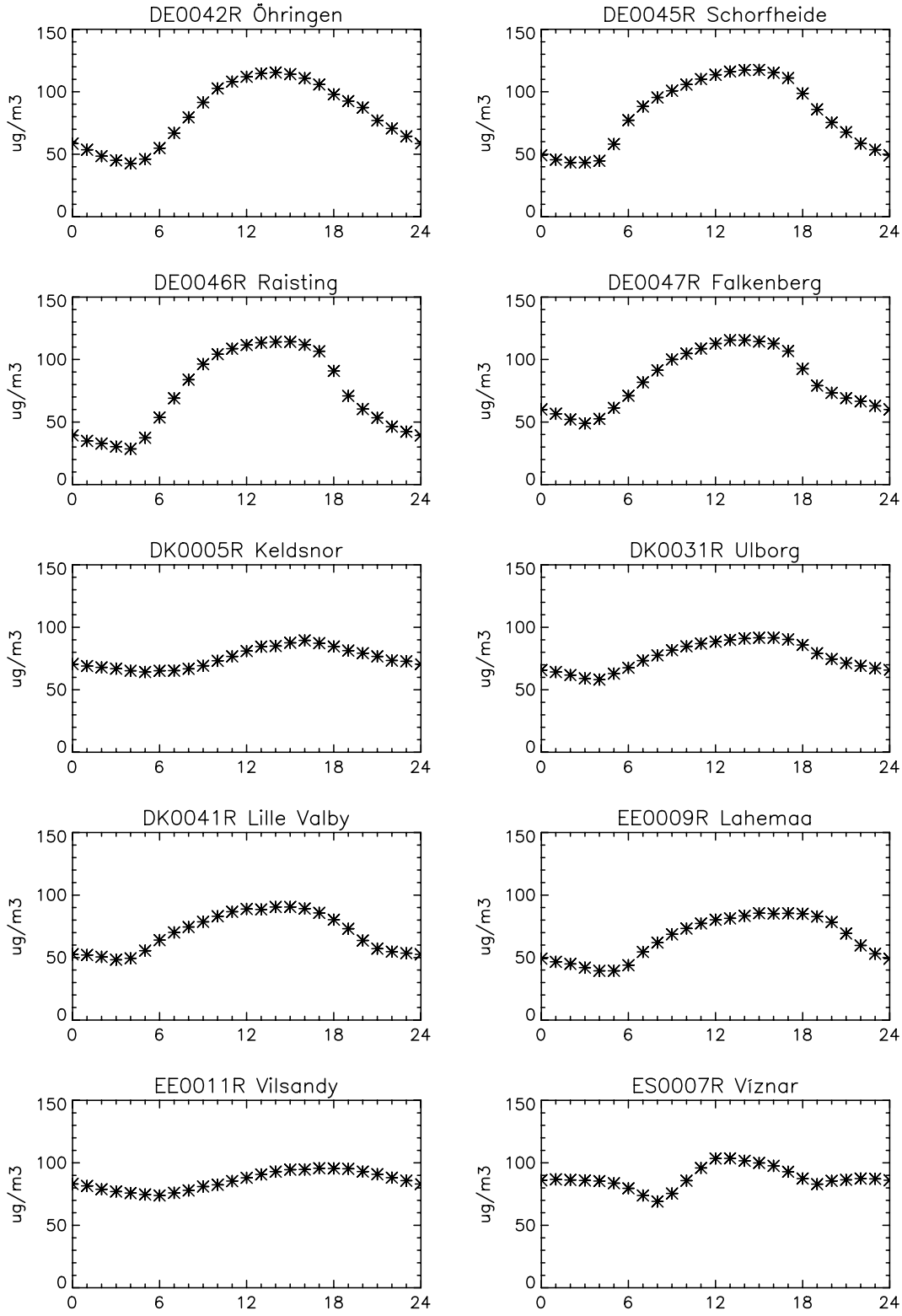


Figure 4.1, cont.



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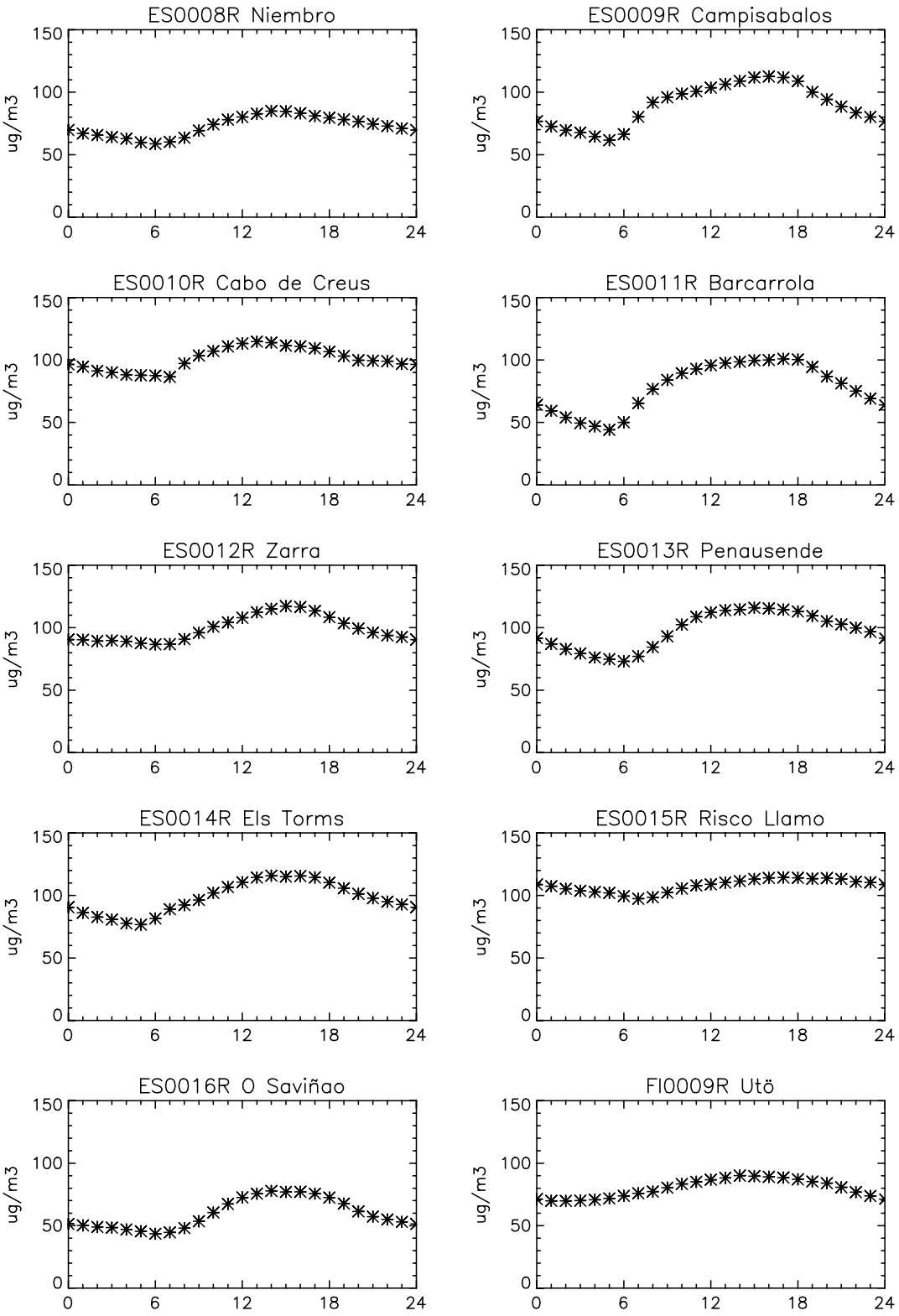

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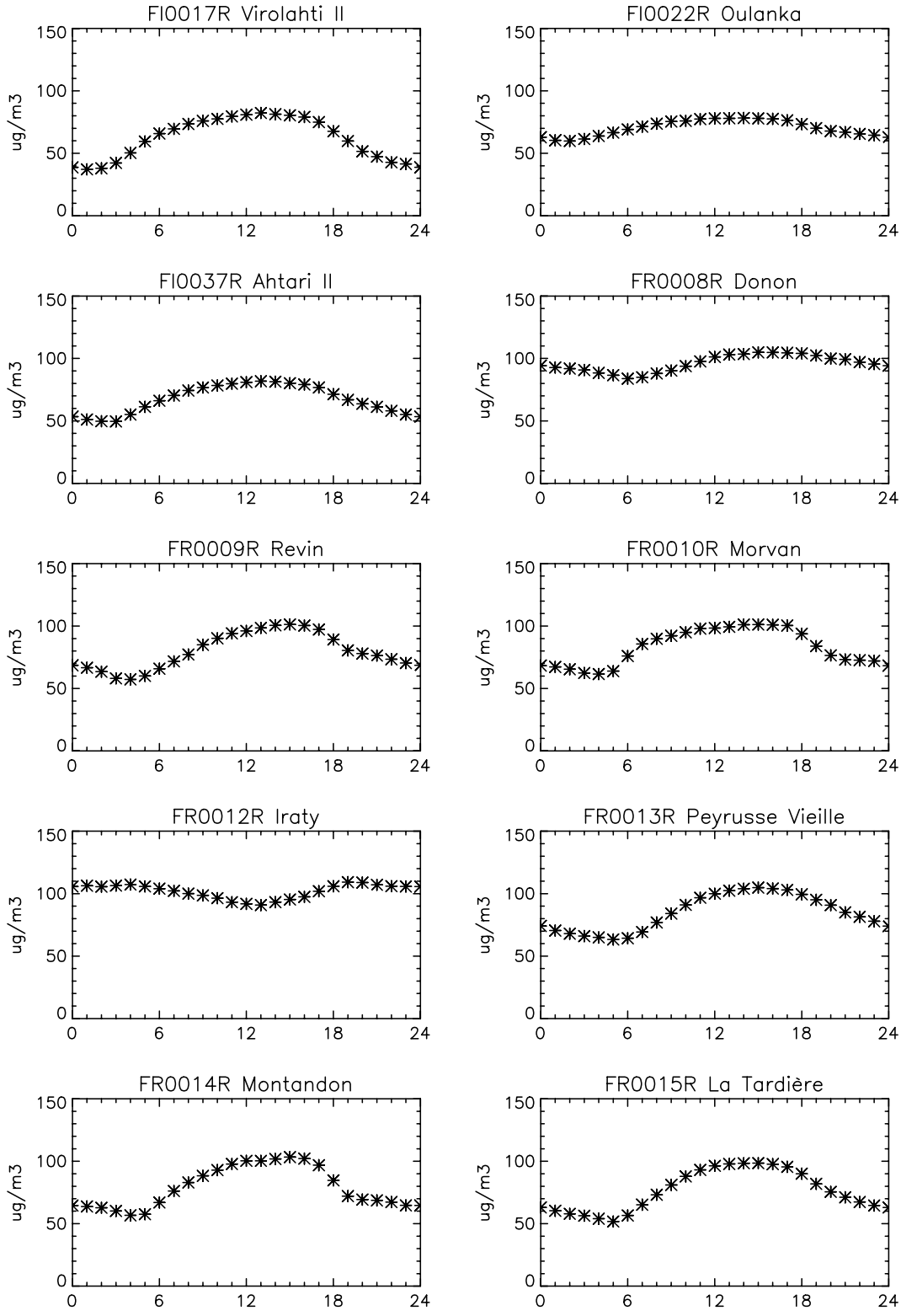

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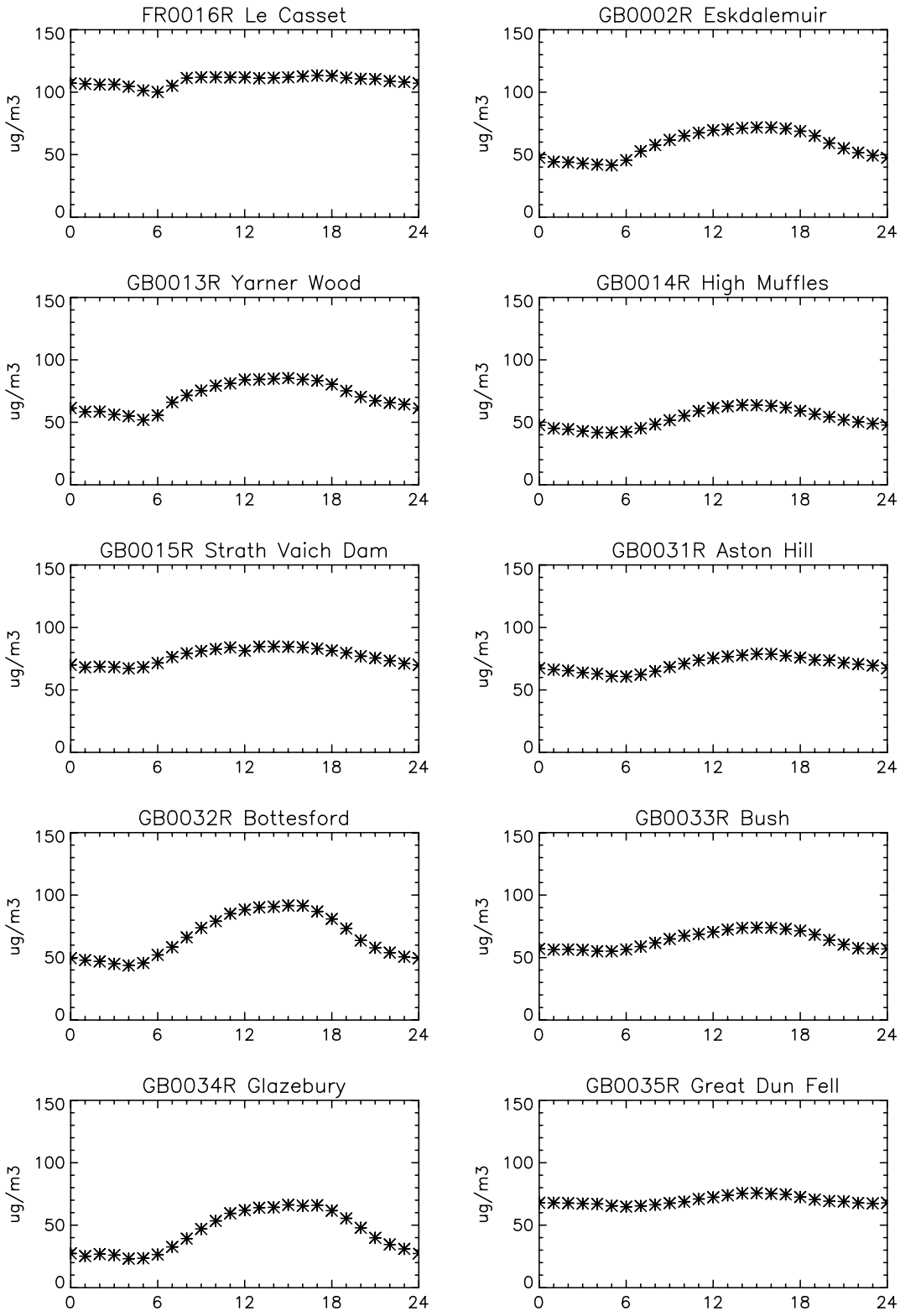


Figure 4.1, cont.

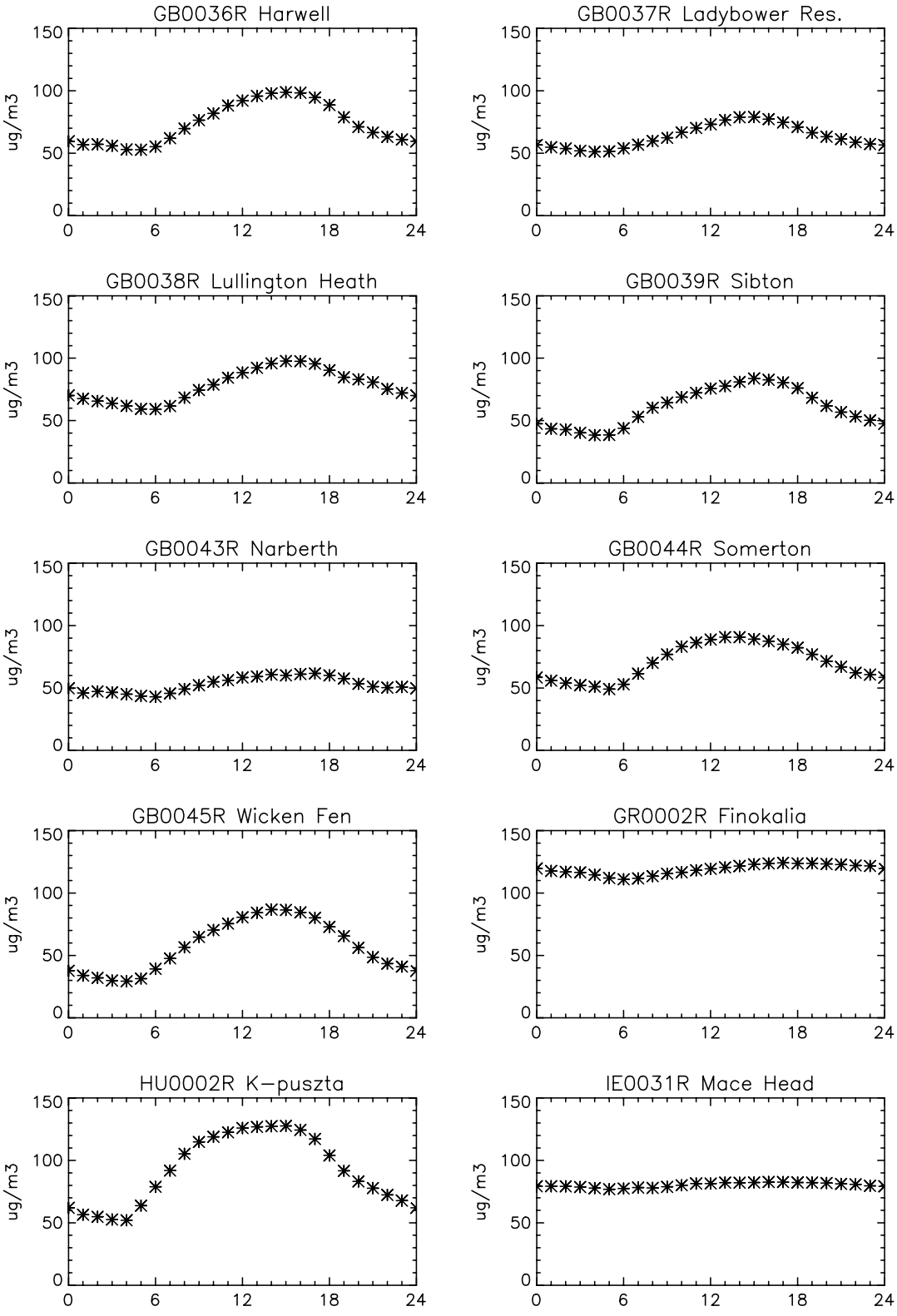
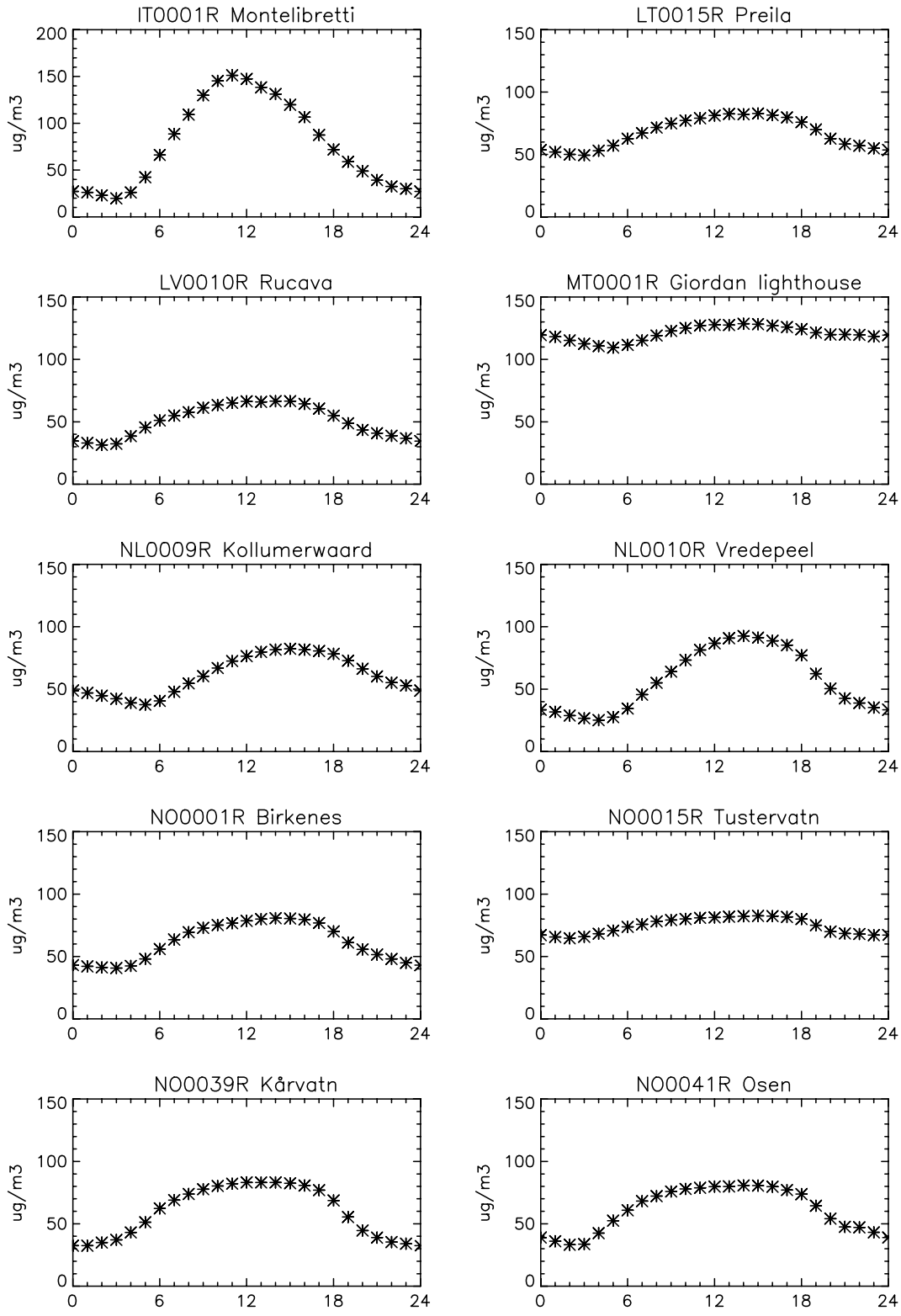


Figure 4.1, cont.



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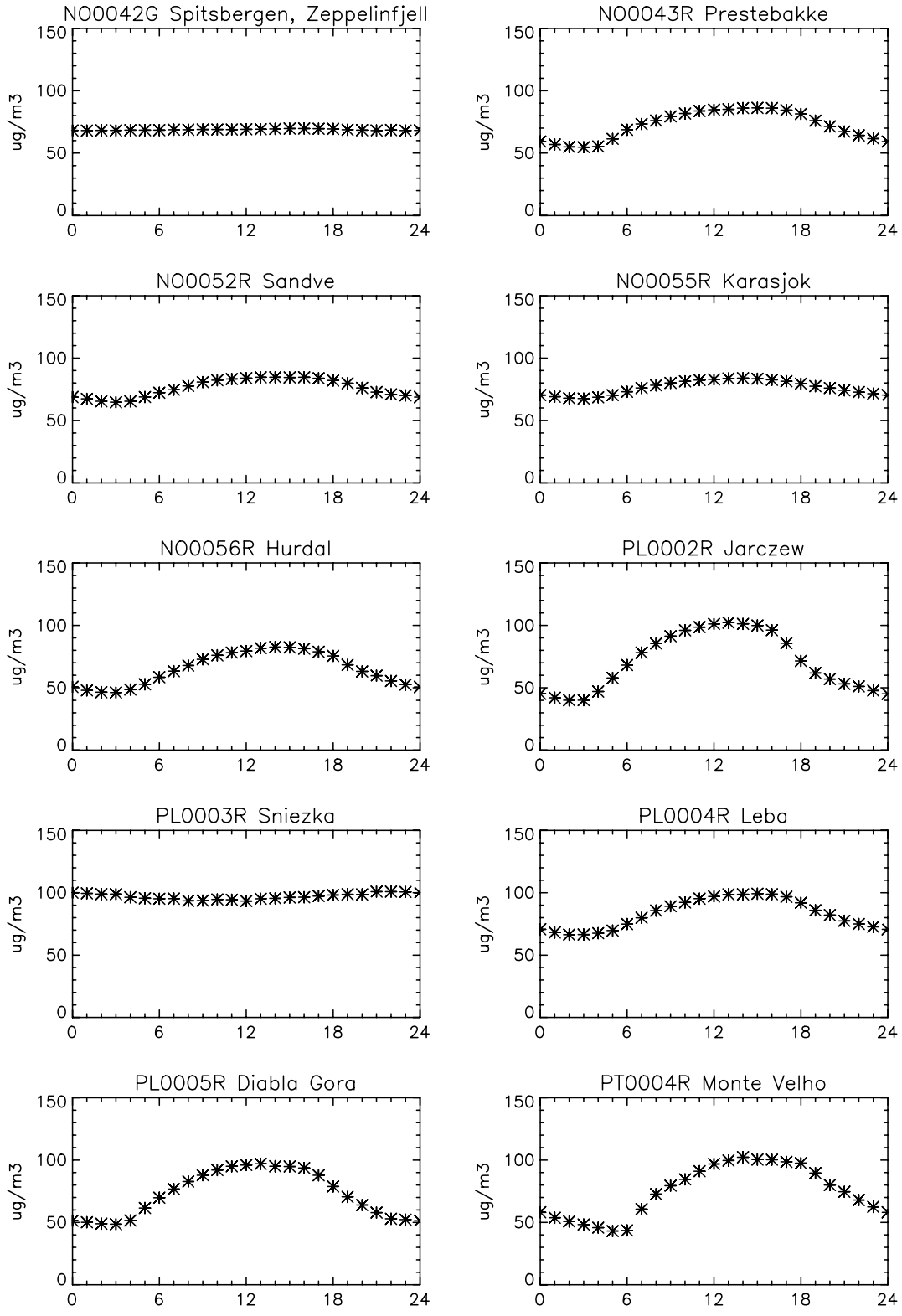

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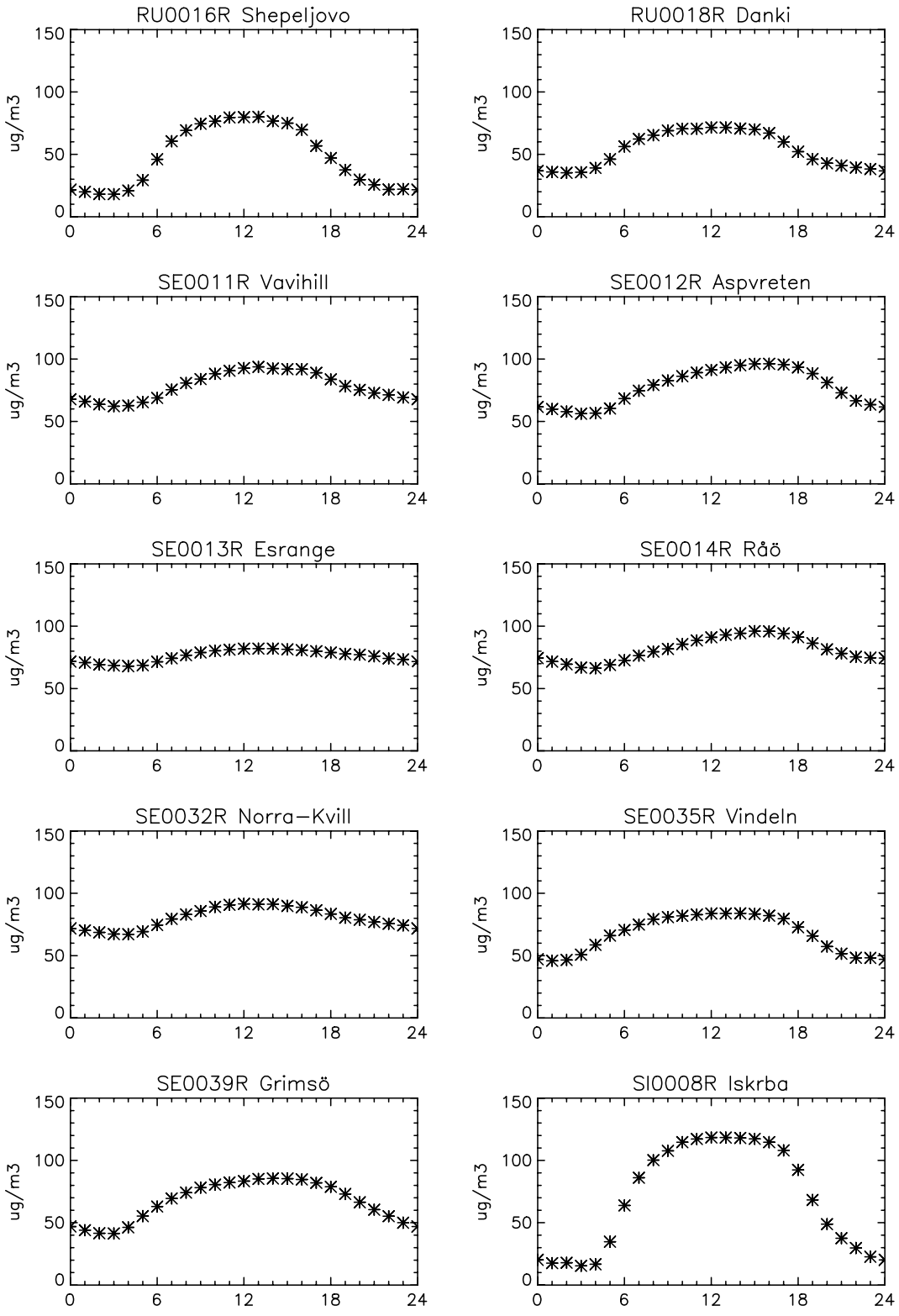

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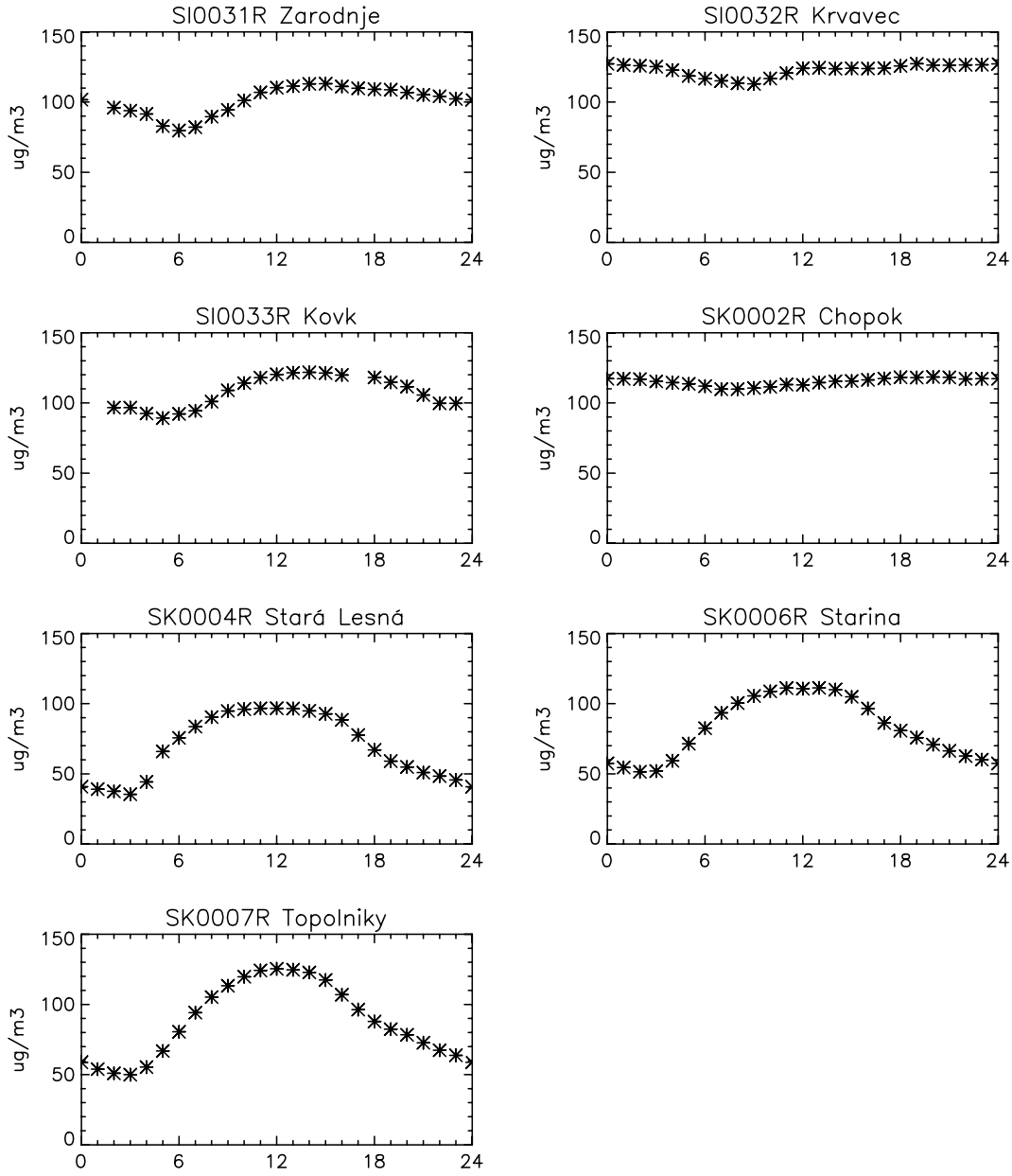

Figure 4.1, cont.

Annex 5

List of data reports

Ozone measurements in the ECE region January 1985–December 1985. Report no. 1.
EMEP/CCC-Report 3/89 by U. Feister and U. Pedersen.
Potsdam/Lillestrøm, Meteorological Service of the GDR/Norwegian Institute for Air Research, 1989.

Ozone measurements January 1986–December 1986. Report no. 2.
EMEP/CCC-Report 8/90 by U. Feister, U. Pedersen, E. Schulz and S. Hechler.
Lillestrøm, Norwegian Institute for Air Research, 1990.

Ozone data report 1988.
EMEP/CCC-Report 1/92 by U. Pedersen.
Lillestrøm, Norwegian Institute for Air Research, 1992.

Ozone data report 1989.
EMEP/CCC-Report 2/93 by U. Pedersen and I.M. Kvalvågnes.
Lillestrøm, Norwegian Institute for Air Research, 1993.

Ozone measurements 1990–1992.
EMEP/CCC-Report 4/95 by A.-G. Hjellbrekke.
Kjeller, Norwegian Institute for Air Research, 1995.

Ozone measurements 1993–1994.
EMEP/CCC-Report 1/96 by A.-G. Hjellbrekke.
Kjeller, Norwegian Institute for Air Research, 1996.

Ozone measurements 1995.
EMEP/CCC-Report 3/97 by A.-G. Hjellbrekke.
Kjeller, Norwegian Institute for Air Research, 1997.

Ozone measurements 1996.
EMEP/CCC-Report 3/98 by A.-G. Hjellbrekke.
Kjeller, Norwegian Institute for Air Research, 1998.

Ozone measurements 1997.
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