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Data quality 1997, quality assurance, and field comparisons

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

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Summary

The aim of quality assurance is to provide data with sufficiently good and known data quality. This report focuses on the quality of the EMEP measurements during 1997. Part of the information is collected from the participating laboratories. Results from laboratory and field comparisons have been included, as well as an evaluation of the quality of routine data.

All participating countries except two had complete measurement programmes for the main components in precipitation. The criteria for data completeness was broadly met by most participants, but fifteen sites did not meet the criteria for one or more component. Two laboratories reported precipitation amounts from standard gauges in addition to amounts from the collectors. Only two participants determine the acid concentration in precipitation by titration.

The data completeness for air components was less satisfactory than for the precipitation measurements. Although the data completeness for sulphur dioxide and particulate sulphate was acceptable, the criteria for data capture was not met for one or more components at more than 30 per cent of the sites. Less than half of the sites, mainly located in the northern parts of Europe, report all nitrogen compounds. One site only report separate denuder measurements of gaseous and particulate nitrogen.

The ion balance is a good test on consistency in the analytical results, and may reveal contamination of a sample occurring during analysis. Ion balance for all precipitation samples are presented both as a function of ion sum and pH value. Ion balances for samples with pH below 5 were, for many countries, better than 15-20 per cent. There are still laboratories which report data with unsatisfactory ion balances, and little improvement have been made since the preceding years.

Information about precision, accuracy and detection limits have been forwarded by the participants and have as far as possible been annexed to this report. The information may not be consistent or complete, but gives valuable information for assessment of the data quality.

The sixteenth laboratory comparison was performed during the first half of 1997 and is relevant for the 1997 data. Improvements were made in results from Hungary, Estonia, Latvia and Yugoslavia. Four laboratories were responsible for a majority of the outliers.

During 1997 and 1998 field comparisons have been continued at four sites: Donon, Schauinsland, Diabla Gora and Kosetice. As in previous field comparisons, results show that improvements are needed, both with respect to sampling and chemical analyses. At Schauinsland, impregnated filters have been used for the determination of sulphur dioxide since 1997. The comparison with the reference method shows good precision and quite similar results for both sulphur dioxide and sulphate in aerosol.

For the three other sites, however, the quality of the data for sulphate in aerosol is still not satisfactory, according to EMEP data quality objectives. Results for sulphur dioxide were acceptable at Donon and Diabla Gora, although the precision may be improved. Relatively large deviations were found for the determination of the sum of the concentrations of nitric acid and nitrate, which may be due to problems with the method or contamination of impregnated filters. Results for nitrogen dioxide determined by manual methods were generally better than results from direct recording instruments, but the national methods should be replaced by the EMEP reference method for better precision and lower detection limits.

On the basis of the results from the last laboratory comparison, experience from the co-located sampling experiment, calculation of ion balance and information about methods for sampling and analysis, all precipitation and air data have been classified into different quality groups. The intention of this classification is to give an estimate of the expected errors in annual averages for 1997, to be used in connection with EMEP model validations.

Four different quality classes have been defined, corresponding to expected relative errors less than 10%, less than 25%, less than 30% and worse than 30%. The latter refers to measurements where the applied methods are unsuitable for EMEP purposes.

Data quality 1997, quality assurance, and field comparisons

1. Introduction

This is the third report in a new series of reports on data quality. The aim of quality assurance is to provide data with sufficiently good and known quality, and this series of reports is intended to document the EMEP data quality and the progress made. The present report is relevant for the 1997 data.

Parts of the information given here is collected from the participating laboratories, this being data on detection limits and precision. Besides this, results from laboratory and field comparisons have been included. The most relevant laboratory comparisons were performed during the first half of 1997 (Hanssen and Skjelmoen, 1997). The laboratory comparison documents the participating laboratories' ability to perform precise chemical analysis, but do not necessarily give the correct picture for routine work. Calculations on ion balances in precipitation samples are therefore important supplement to the organised comparisons. The recommended measurement methods in EMEP have been described in manuals (EMEP, 1977, 1996); nevertheless, many participants apply other methods. This has created a need for estimating the differences between measurements carried out in different countries, and results from field comparisons with reference instrumentation are also given here.

2. Measurement programme and data completeness

EMEP's measurement programme in 1997 is given in Table 1.

Since the start in 1978, all air and precipitation samples have been daily measurements with the following exceptions

- ozone are hourly averages,
- measurements of VOC are 10–15 minutes and 8 hourly averages for light hydrocarbons and aldehyde/ketones respectively.

All participating countries, except Iceland and Lithuania had complete measurement programmes for the main components in precipitation in 1997. In addition, one Latvian station (LV10) only has monthly sampling of chloride, which is not acceptable. The requirement to completeness is 90 per cent of the daily values (Annex 1) and as seen from Table 2 this objective was broadly met by most participants for the precipitation components. Fifteen sites had data completeness for one or more components lower than ninety per cent, which calls for improvement. Some of the low-completeness cases in Table 2 may be related to mistakes made in the data flagging.

The completeness for precipitation amount is the per cent days (of 365 days) with a precipitation record, i.e. either 0 mm or an amount larger than zero. It is important that 0 mm is reported when no measurable amounts of precipitation occurred. When countries fail to report precipitation amount this way, no distinction between zero precipitation and "precipitation information missing" can be made in the database.

Table 1: EMEP's measurement programme 1997.
Sampling periods are 24 hours except for ozone and VOC.

	Components	Measurement period	Measurement frequency
Gas	SO_2, NO_2 O_3 Light hydrocarbons C_2-C_7* ketones and aldehydes (VOC)	24 hours Hourly means stored 10 - 15 minutes 8 hours	Daily Continuously Twice weekly Twice weekly
Particles	SO_4^{2-}	24 hours	Daily
Gas + particles	HNO_3 (g) + NO_3^- (p) NH_3 (g) + NH_4^+ (p)	24 hours	Daily
Precipitation	Amount of precipitation, SO_4^{2-}, NO_3^-, Cl^-, pH/H^+ NH_4^+, Na^+ Mg^{2+}, Ca^{2+}, K^+, conductivity	24 hours	Daily

* Measurements made at a small number of sites only.

Two laboratories only (Finland and Poland–PLO5) reported precipitation amounts from standard gauges in addition to the amounts from the collectors. Gauges give valuable information on wet deposition and these data should always be reported when available.

With two exceptions only (Hungary and Netherlands), participants calculate the acid concentration in precipitation from pH measurements. For quality control purposes these concentration should be determined by titration of the acid contents (EMEP/CCC-Report 1/95) for weakly acidic samples as described in connection with the ion balances in the next section.

Although most of the sites had good data completeness during 1997, both for sulphur dioxide and sulphate in particles seen in Table 3, the data completeness for air components was less favourable than for precipitation constituents. More than 30% of the sites had one or more measurements with less than 90% completeness. From Table 3, which gives the air data completeness, it is also evident that the number of sites which provided measurements of the nitrogen components in air was far too low to establish a good data base and to give a proper understanding of the concentration levels in Europe this year.

Table 2: Completeness for precipitation components 1997.

Code	Amount collector	Amount gauge	SO4 prec.	NH4 prec.	NO3 prec.	Na prec.	Mg prec.	Cl prec.	Ca prec.	pH	Acid titrated	K prec.	Cond.
AT02	100.0	-	99.8	99.5	99.8	99.5	99.5	99.8	99.5	99.9	-	99.5	99.8
AT04	100.0	-	99.6	99.4	99.6	99.4	99.4	75.7	99.4	99.9	-	99.5	99.9
AT05	100.0	-	100.0	99.3	100.0	99.3	99.3	90.2	99.3	100.0	-	99.3	100.0
CH02	100.0	-	98.7	98.7	98.7	98.7	98.7	98.7	98.7	99.6	-	98.7	99.6
CH03	100.0	-	99.1	99.1	99.1	99.1	99.1	99.1	99.1	99.8	-	99.1	99.8
CH04	100.0	-	98.8	98.8	98.8	98.8	98.8	98.8	98.8	99.6	-	98.8	99.6
CH05	100.0	-	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.7	-	99.0	99.7
CS01	101.6	-	79.8	79.4	79.8	77.6	77.6	79.8	77.6	79.8	-	77.6	79.8
CS03	100.0	-	98.2	98.4	98.1	98.2	98.3	98.1	98.3	98.4	-	98.1	98.2
DE01	100.0	-	98.0	98.0	98.0	97.8	97.8	98.0	97.8	98.8	-	97.8	98.8
DE02	100.0	-	98.6	98.4	98.6	97.0	97.0	98.6	97.0	99.0	-	97.0	99.0
DE03	100.0	-	98.4	98.4	98.4	99.6	99.6	98.4	99.6	99.8	-	99.6	99.8
DE04	100.0	-	99.6	99.5	99.6	99.6	99.6	99.6	99.6	99.2	-	99.6	99.4
DE05	100.0	-	94.9	94.9	94.9	94.7	94.7	94.9	94.7	99.2	-	94.7	99.2
DE07	100.0	-	97.4	97.4	97.4	97.4	97.4	97.4	97.4	99.0	-	97.4	99.5
DE08	100.0	-	98.6	98.5	98.6	98.4	98.4	98.6	98.4	98.9	-	98.4	98.9
DE09	100.0	-	98.9	98.9	98.9	98.5	98.5	98.9	98.5	99.3	-	98.5	99.3
DK03	100.0	-	99.7	98.8	99.6	98.3	97.2	99.7	98.3	96.9	-	98.0	94.2
DK05	76.2	-	99.3	98.0	99.1	96.5	97.0	99.0	97.0	95.1	-	96.4	93.2
DK08	99.7	-	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.8	-	99.9	99.7
EE09	99.2	-	94.9	86.1	84.3	94.1	94.5	94.9	89.0	96.4	-	94.3	96.3
EE11	100.0	-	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	-	100.0	100.0
ES01	100.0	-	99.4	97.2	99.4	95.8	95.8	99.4	95.8	99.9	-	95.8	99.9
ES03	100.3	-	100.0	99.9	100.0	98.9	98.9	100.0	98.7	100.0	-	98.9	100.0
ES04	100.0	-	100.0	100.0	100.0	99.5	99.5	100.0	99.5	100.0	-	99.5	100.0
ES05	100.0	-	99.8	99.1	99.8	99.3	99.3	99.8	99.3	100.0	-	99.3	100.0
ES06	100.0	-	85.8	76.9	82.8	80.3	80.3	85.8	80.3	100.0	-	80.3	100.0
ES07	100.0	-	99.6	99.2	99.6	98.0	98.0	99.6	98.0	100.0	-	98.0	100.0
FI04	100.0	100.0	98.9	98.9	98.9	98.9	98.9	98.9	98.9	99.4	-	98.9	99.4
FI09	100.0	100.0	88.6	88.6	88.6	88.6	88.6	88.6	88.6	90.2	-	88.6	90.2
FI17	100.0	100.0	97.8	97.8	97.8	97.8	97.8	97.8	97.8	98.4	-	97.8	98.4
FI22	100.0	100.0	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.9	-	98.4	98.9
FR03	100.0	-	91.1	91.1	91.1	91.1	91.1	91.1	91.1	96.1	-	91.1	96.1
FR05	100.0	-	86.4	86.4	86.4	86.4	86.4	86.4	86.4	88.3	-	86.4	88.3
FR08	100.0	-	98.2	98.2	98.2	98.2	98.2	98.2	97.7	99.0	-	98.2	99.0
FR09	100.0	-	93.1	93.0	93.1	93.1	93.1	93.1	93.0	96.9	-	93.1	96.9
FR10	100.0	-	90.4	90.4	90.4	90.4	90.4	90.4	90.4	92.0	-	90.4	92.0
FR11	100.0	-	85.8	85.8	85.8	85.8	85.8	85.8	85.8	87.3	-	85.8	87.3
FR12	100.0	-	84.7	84.7	84.7	84.7	84.7	84.7	84.5	85.8	-	84.7	85.8
GB02	98.4	-	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	-	99.9	99.7
GB06	91.2	-	99.7	99.7	99.7	99.4	99.7	99.4	99.7	99.7	-	99.7	99.7
GB13	72.1	-	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	-	100.0	99.9
GB14	100.0	-	99.6	99.6	99.6	96.5	99.6	96.5	99.6	99.6	-	99.6	99.4
GB15	91.5	-	98.8	98.8	98.8	97.5	98.8	97.5	98.8	98.8	-	98.8	98.7
HU02	100.0	-	98.7	98.4	98.7	97.6	91.8	98.7	97.6	97.2	94.6	97.6	97.2
IE01	-	100.0	97.9	97.9	97.9	97.9	97.9	97.9	97.9	97.9	-	97.9	97.9
IE02	100.0	-	98.2	99.2	99.2	98.3	98.3	98.2	98.3	95.3	-	98.3	95.3
IE03	100.0	-	100.0	100.0	100.0	100.0	100.0	100.0	100.0	99.9	-	100.0	99.9
IE04	100.0	-	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	-	100.0	99.9
IS02	100.0	-	100.0	-	-	100.0	-	-	-	100.0	-	-	-
IT01	100.0	-	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	-	100.0	97.4
IT04	100.0	-	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	-	100.0	100.0
LT15	100.0	-	100.0	100.0	100.0	100.0	-	100.0	95.5	100.0	-	98.3	100.0
LV10	100.0	-	100.0	99.6	99.6	100.0	93.2	100.0	95.6	100.0	-	99.0	95.3
LV16	100.0	-	90.3	97.4	90.2	85.8	84.1	90.6	84.3	100.0	-	85.1	100.0
NL09	92.3	-	97.7	96.2	97.7	94.7	94.7	97.7	94.7	98.6	98.2	94.7	91.2
NO01	100.0	-	98.4	98.4	98.4	98.4	98.4	98.4	98.4	99.6	-	98.4	99.6
NO08	100.0	-	99.1	98.5	99.1	99.2	98.7	99.2	98.6	98.8	-	98.3	99.6
NO15	93.2	-	68.0	67.8	68.0	68.0	68.0	68.0	67.6	69.0	-	68.0	69.1
NO39	100.0	-	99.3	99.2	99.1	99.3	99.3	99.3	98.8	99.2	-	99.2	99.8
NO41	100.0	-	97.2	94.8	97.2	97.2	97.2	97.2	96.9	98.0	-	94.5	98.2
NO55	97.8	-	81.0	81.0	81.0	81.0	81.0	81.0	81.0	91.9	-	81.0	91.8
PL02	100.0	-	99.1	99.1	99.1	97.8	97.8	99.1	97.8	99.1	-	97.8	99.1
PL03	100.0	-	98.8	98.6	98.8	98.2	98.2	98.8	98.2	98.6	-	98.2	98.4
PL04	100.0	-	97.2	97.2	97.2	97.2	97.2	97.2	97.2	97.2	-	97.2	97.2
PL05	100.0	100.0	96.3	95.1	96.3	94.3	94.5	95.8	94.5	99.2	-	94.5	96.2
PT01	-	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	-	100.0	100.0
PT03	-	100.0	98.5	90.7	90.7	98.5	98.5	95.5	98.5	90.7	-	98.5	98.5
PT04	-	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	-	100.0	100.0
RU01	100.0	-	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	-	100.0	100.0
RU13	100.0	-	100.0	100.0	100.0	100.0	100.0	100.0	99.9	100.0	-	100.0	100.0
RU16	100.0	-	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	-	100.0	100.0

Table 2, contd.

Code	Amount collector	Amount gauge	SO4 prec.	NH4 prec.	NO3 prec.	Na prec.	Mg prec.	Cl prec.	Ca prec.	pH	Acid titrated	K prec.	Cond.
SE02	100.0	-	99.9	99.9	99.9	99.8	99.9	99.9	99.9	100.0	-	99.9	97.9
SE05	100.0	-	99.9	99.9	99.9	99.9	99.9	99.9	99.9	100.0	-	99.9	99.3
SE11	100.0	-	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	-	100.0	99.7
SE12	99.7	-	99.9	99.9	99.9	99.9	99.9	99.9	99.9	100.0	-	99.9	99.6
SK02	99.7	-	91.3	90.4	91.3	90.4	90.4	91.3	90.4	91.3	-	90.4	91.3
SK04	100.0	-	89.0	88.6	89.0	88.6	88.6	89.0	88.6	89.0	-	88.6	89.0
SK05	99.5	-	88.9	89.1	88.9	89.1	89.1	88.9	89.1	89.1	-	89.1	89.0
SK06	99.7	-	78.2	78.2	78.2	78.2	78.2	78.2	78.2	78.2	-	78.2	78.2
TR01	100.3	-	99.5	94.1	99.5	96.5	94.8	99.5	99.6	100.0	-	99.6	99.1
YU05	100.0	-	99.9	99.9	99.9	42.6	42.6	98.9	42.6	99.9	-	42.6	99.9
YU08	100.0	-	98.3	98.3	98.3	42.0	42.0	96.5	42.0	98.3	-	42.0	98.3

Table 3: Completeness of air components.

Code	SO2	SO4	O3	NO2	HNO3	NO3	SumNO3	NH3	NH4	sumNH3	H+	SPM
AT02	78.9	70.1	90.2	68.2	-	-	-	-	-	-	-	-
AT04	40.3	-	95.0	47.1	-	-	-	-	-	-	-	-
AT05	20.0	-	90.6	25.8	-	-	-	-	-	-	-	-
CH01	96.4	96.4	-	74.5	-	-	-	-	-	-	-	78.1
CH02	98.9	99.2	99.0	97.5	-	-	99.2	-	-	98.1	-	94.5
CH03	96.4	-	98.2	96.7	-	-	-	-	-	-	-	95.1
CH04	97.0	-	98.0	96.2	-	-	-	-	-	-	-	95.6
CH05	94.5	97.8	97.5	96.2	-	-	-	-	-	-	-	99.5
CS01	99.7	99.7	90.3	49.9	-	-	98.6	-	-	98.6	-	-
CS03	98.6	98.9	98.2	96.7	-	-	98.4	-	-	98.6	-	-
DE01	98.6	99.7	97.8	99.2	-	-	-	-	-	-	-	96.4
DE02	98.4	99.5	95.7	99.2	-	-	-	-	-	-	-	96.7
DE03	100.0	100.0	95.5	100.0	-	-	-	-	-	-	-	95.3
DE04	100.0	99.2	98.4	100.0	-	-	-	-	-	-	-	99.7
DE05	99.5	100.0	98.9	99.5	-	-	-	-	-	-	-	97.5
DE07	99.5	99.7	96.2	99.5	-	-	-	-	-	-	-	94.5
DE08	100.0	100.0	97.4	100.0	-	-	-	-	-	-	-	99.2
DE09	99.5	99.5	96.5	99.5	-	-	-	-	-	-	-	99.5
DE11	-	-	92.5	-	-	-	-	-	-	-	-	-
DE12	-	-	94.6	-	-	-	-	-	-	-	-	-
DE14	-	-	93.9	-	-	-	-	-	-	-	-	-
DE17	-	-	95.9	-	-	-	-	-	-	-	-	-
DE26	-	-	88.4	-	-	-	-	-	-	-	-	-
DE31	-	-	95.5	-	-	-	-	-	-	-	-	-
DE35	-	-	92.3	-	-	-	-	-	-	-	-	-
DE38	-	-	88.7	-	-	-	-	-	-	-	-	-
DK03	93.2	92.9	-	-	-	-	93.2	-	-	88.8	-	-
DK05	98.1	98.1	-	-	-	-	98.1	-	-	95.3	-	-
DK08	92.1	92.6	-	91.0	-	-	90.4	-	-	88.8	-	-
DK31	-	-	91.3	-	-	-	-	-	-	-	-	-
DK32	-	-	95.6	-	-	-	-	-	-	-	-	-
EE09	-	-	52.0	94.8	-	-	-	-	-	-	-	-
EE11	70.1	-	80.8	76.4	-	-	-	-	-	-	-	-
ES01	94.2	96.7	95.8	92.9	-	-	97.3	-	96.7	94.5	96.4	96.2
ES03	100.0	89.6	91.9	94.2	-	-	91.2	-	89.6	95.6	89.3	89.3
ES04	98.1	94.0	93.0	95.6	-	-	86.6	-	94.0	94.0	93.7	93.2
ES05	92.3	63.0	83.9	92.1	-	-	69.3	-	62.5	75.3	62.5	61.6
ES06	95.1	84.7	-	81.4	-	-	76.2	-	84.7	42.5	84.7	84.4
ES07	99.2	91.8	58.3	92.9	-	-	81.4	-	91.8	87.7	91.5	91.5
FI04	40.5	40.8	40.5	0.3	-	-	40.5	-	-	40.8	-	-
FI09	89.6	90.1	98.8	82.7	-	-	89.6	-	-	86.3	-	-
FI17	100.0	100.0	98.5	83.8	-	-	100.0	-	-	98.4	-	-
FI22	98.9	98.9	99.0	89.6	-	-	98.9	-	-	100.0	-	-
FI37	56.7	56.7	58.7	59.2	-	-	56.7	-	-	59.2	-	-
FR03	92.9	91.2	-	-	-	-	-	-	-	-	-	-
FR05	92.9	94.2	-	-	-	-	-	-	-	-	-	-
FR08	96.4	98.6	81.5	-	-	-	-	-	-	-	-	-
FR09	96.7	100.0	95.9	-	-	-	-	-	-	-	-	-
FR10	88.2	90.1	-	-	-	-	-	-	-	-	-	-
FR11	91.5	92.3	98.0	-	-	-	-	-	-	-	-	-
FR12	82.2	80.5	-	-	-	-	-	-	-	-	-	-
GB02	99.7	99.7	90.6	-	-	-	99.2	-	-	98.1	-	-
GB04	99.5	99.5	-	-	-	-	-	-	-	-	-	-
GB06	97.8	98.1	96.9	-	-	-	-	-	-	-	-	-
GB07	99.7	99.7	-	-	-	-	-	-	-	-	-	-

Table 3, contd.

Code	SO2	SO4	O3	NO2	HNO3	NO3	SumNO3	NH3	NH4	sumNH3	H+	SPM
GB13	84.7	85.2	88.6	-	-	-	-	-	-	-	-	-
GB14	-	-	97.3	-	-	-	94.8	-	-	95.1	-	-
GB15	92.9	93.2	85.1	16.4	-	-	-	-	-	-	-	-
GB16	99.2	98.9	-	-	-	-	-	-	-	-	-	-
GB31	-	-	89.8	-	-	-	-	-	-	-	-	-
GB32	-	-	98.9	-	-	-	-	-	-	-	-	-
GB33	-	-	98.8	-	-	-	-	-	-	-	-	-
GB34	-	-	94.8	-	-	-	-	-	-	-	-	-
GB35	-	-	93.6	-	-	-	-	-	-	-	-	-
GB36	-	-	94.8	71.8	-	-	-	-	-	-	-	-
GB37	-	-	89.6	86.3	-	-	-	-	-	-	-	-
GB38	-	-	94.8	78.4	-	-	-	-	-	-	-	-
GB39	-	-	98.7	-	-	-	-	-	-	-	-	-
GB43	-	-	75.5	70.4	-	-	-	-	-	-	-	-
GB44	-	-	98.0	-	-	-	-	-	-	-	-	-
GB45	-	-	20.5	13.2	-	-	-	-	-	-	-	-
GR01	66.0	62.7	68.3	67.9	-	-	-	-	-	-	-	-
HU02	98.1	94.0	94.8	89.0	-	-	94.0	92.3	92.6	-	46.0	-
IE01	98.4	98.6	-	98.9	-	-	-	-	-	-	-	-
IE02	97.8	97.5	-	-	-	-	-	-	-	-	-	-
IE03	-	99.7	-	-	-	-	-	-	-	-	-	-
IE04	-	97.5	-	-	-	-	-	-	-	-	-	-
IE31	-	-	98.2	-	-	-	-	-	-	-	-	-
IS02	-	100.0	-	-	-	-	-	-	-	-	-	-
IT01	95.6	95.6	94.4	77.8	95.6	95.6	-	95.6	95.6	-	-	-
IT04	100.0	100.0	100.0	100.0	-	100.0	-	-	100.0	-	100.0	100.0
LT15	95.3	-	89.2	97.5	-	95.6	96.2	-	95.6	95.1	-	-
LV10	104.1	104.1	64.5	103.6	-	104.1	-	103.3	104.1	103.3	-	-
LV16	87.1	89.0	-	88.2	-	78.9	-	37.8	74.2	88.5	-	-
NL09	70.1	99.5	92.5	69.6	-	99.5	-	-	99.5	-	-	-
NL10	99.2	93.4	90.1	94.5	-	93.4	-	71.0	93.4	-	-	-
NO01	97.8	97.5	97.5	99.7	-	-	97.5	-	-	97.8	-	-
NO08	98.9	98.4	-	100.0	-	-	98.1	-	-	99.2	-	-
NO15	99.5	98.9	99.7	99.2	-	-	98.9	-	-	99.5	-	-
NO39	99.7	99.7	99.7	100.0	-	-	99.7	-	-	99.5	-	-
NO41	98.4	98.4	99.6	99.7	-	-	98.1	-	-	97.8	-	-
NO42	97.3	97.3	97.2	-	-	-	97.3	-	-	97.0	-	-
NO43	-	-	87.8	-	-	-	-	-	-	-	-	-
NO45	-	-	99.6	-	-	-	-	-	-	-	-	-
NO48	-	-	99.7	-	-	-	-	-	-	-	-	-
NO52	-	-	99.8	-	-	-	-	-	-	-	-	-
NO55	92.3	94.2	60.5	96.7	-	-	92.3	-	-	94.2	-	-
NO56	-	-	99.3	-	-	-	-	-	-	-	-	-
PL02	99.2	99.2	97.1	97.3	-	99.2	97.5	-	99.2	97.8	-	-
PL03	99.2	99.2	79.5	99.2	-	99.2	99.2	-	99.2	99.2	-	-
PL04	98.4	98.4	99.4	98.9	-	98.4	99.5	-	98.4	99.5	-	-
PL05	98.6	97.3	94.8	96.7	-	-	97.5	-	-	100.0	-	-
PT04	-	-	75.5	-	-	-	-	-	-	-	-	-
RU01	43.0	43.0	26.4	43.0	-	43.0	-	-	43.0	43.0	-	-
RU13	62.7	63.0	41.0	57.3	-	63.0	-	-	63.0	-	-	-
RU16	80.3	80.3	81.5	81.1	-	80.3	-	-	80.3	-	-	-
SE02	98.9	98.6	99.6	99.5	-	-	98.6	-	-	98.6	-	-
SE05	98.9	98.9	-	99.2	-	-	98.9	-	-	98.4	-	-
SE08	99.5	99.5	-	98.6	-	-	-	-	-	-	-	-
SE11	99.2	99.2	98.8	99.7	-	-	99.2	-	-	98.9	-	-
SE12	98.6	98.9	97.4	99.7	-	-	98.6	-	-	98.6	-	-
SE13	94.5	94.8	99.9	32.9	-	-	-	-	-	-	-	-
SE32	-	-	98.6	-	-	-	-	-	-	-	-	-
SE35	-	-	99.8	-	-	-	-	-	-	-	-	-
SI08	99.2	99.2	76.4	-	-	-	99.2	-	-	99.2	-	-
SI31	-	-	84.3	-	-	-	-	-	-	-	-	-
SI32	-	-	92.6	-	-	-	-	-	-	-	-	-
SI33	-	-	80.8	-	-	-	-	-	-	-	-	-
SK02	98.9	98.9	78.3	99.2	-	-	98.9	-	-	-	-	-
SK04	99.5	99.2	86.6	96.7	-	-	99.2	-	-	-	-	-
SK05	95.1	95.3	-	96.7	-	-	95.1	-	-	-	-	-
SK06	97.0	98.6	85.2	97.8	-	-	98.6	-	-	-	-	-
TR01	83.8	84.4	-	90.1	-	-	84.4	-	-	84.4	-	-
YU05	94.8	-	-	93.4	-	-	-	-	-	-	-	-
YU08	87.9	-	-	98.9	-	-	-	-	-	-	-	-

The columns for HNO_3 and NH_3 in Table 3 contain denuder measurements only, sites with results from aerosol- and impregnated filters were not included. Such results should be added and reported as the sums of reduced and of oxidised nitrogen components, as it is well known that the filter results normally will be biased due to chemical reactions, and loss of volatile substances from the aerosol filter followed by a corresponding increase of substance at the impregnated filter. In order to separate gaseous and particle bound nitrogen components, denuders have to be applied, but only sites in Hungary and Italy reported denuder results from 1997. Netherlands uses denuders as well, but only for collecting aerosol particles; they use absorption solution for sampling of ammonia.

Ozone measurements was carried out at "normal" EMEP sites but also at sites designated for ozone alone or in combination with other measurements not included in EMEP's programme. The two rightmost columns in Table 3 give sites which report suspended particulate matter and soot and acidity in airborne particles, neither of which were elements of the measurements programme. Only a small number of sites have VOC measurements and this is reported separately.

3. Ion balances

The ion balance is a good test on consistency and errors in the analytical results, but will not necessarily reveal a contamination of the sample. This will depend on whether or not the contamination occurred before the analysis started. IB will also fail to discover errors related to the precipitation sampling.

The ion balance (IB) of a precipitation sample can be expressed as

$$IB = ID \bullet 100/IS \tag{1}$$

where ID is the difference between the sum of the cation and the anion concentrations, and IS is the sum of all ion concentrations. All concentrations are expressed in micro-equivalents per litre, and the resulting IB is given in per cent.

Random errors in the ion balances can be calculated from the corresponding errors in the precipitation data when these are known. In a similar way the data quality objectives (DQO), which specify goals for data accuracy, can be used to calculate expected errors in IB, given this accuracy and a pH <5. The result is different for different compositions and concentrations; e.g. the expected error in IB is between 5 and 10 per cent at an ion sum 200 µeq/L. A sample with this ion sum and an error of this order will therefore have a quality as specified in the DQO i.e. will contain valid results. A draft system for classification of precipitation samples in valid, qualified, and invalid data is underway and will be discussed with the EMEP NQAM this year.

The data quality objective for pH was 0.05 pH units but is now relaxed to 0.1 unit since precise pH-measurements in highly dilute solutions, as precipitation samples normally are, are difficult to perform. In the last laboratory comparison (Hanssen and Skjelmoen, 1997) more than 10 per cent of the laboratories had results deviating more than 0.1 unit from the theoretical value. During routine analysis of precipitation samples one may suspect even larger and more frequent errors in the pH determination. The pH scale is logarithmic and a 0.1 unit error in pH gives a 20-25 per cent error in the acid concentration. Good SOPs for pH measurements are therefore essential for good ion balance.

The data quality objectives (DQO) are given in Annex 1. The objectives require 10–15 % relative laboratory accuracy for the major ions sulphate, nitrate and ammonium, and 15 % relative accuracy in the determination of the less important species. Hydrogen ion concentrations are, as mentioned above, today unfortunately determined from measured pH values alone. An uncertainty in the ion concentrations in correspondence with the DQO and allowing for 0.1 unit for pH will, under the assumptions above, result in a 5-13 % error in the ion balance IB when the ion sum is larger than 50-100 µeq/l.

The ion balances for all precipitation samples from 1997 are presented in Annex 2, both as a function of pH value in the sample and as a function of the ion sum. Ion balances for samples with pH < 5 were, for many countries, better than 15-20%, indicating fairly good accuracy in the determination of the individual ions. Highly consistent results were e.g. given by Denmark, Finland, Germany, Netherlands, Poland (Institute of Meteorology and Water Management), Russian Federation, and Sweden. It is also clearly seen from Annex 2 that there were laboratories which still report data with unsatisfactory ion balances, and that little progress seems to be made since the preceding years (Schaug et al., 1997 and 1998).

At some sites there were many samples with pH > 5. This is particularly the case in Mediterranean countries due to alkaline dust as clearly seen from the Portuguese and Spanish results, as well as at other Continental sites and in the far north of Europe. It is an experience made that ion balances become markedly poorer with increasing pH above 5. Some countries seem to have systematic deficit of anions in contrast to the large spread in the ion balances seen in the Mediterranean. This is seen at many Continental sites and Nordic sites. Plots made for Norwegian sites show that the bias was site dependent, and highly correlated with pH. The Russian and Finish data demonstrate, however, that even samples with pH above 5 or even 6 can have satisfactory ion balances (Schaug et al., 1998).

The precise reason for the poor ion balances at pH values above 5 is not yet clear. One contributing factor is that not-measured ion species have been present in the samples. Organic acids, mainly formic and acetic acid, are known to be present in air and precipitation, and the concentrations of the two acids in air are not negligible. Organic acids are not expected to be absorbed in strongly acidic particles or droplets. The acids can, however, easily be absorbed in alkaline or weakly acidic particles, which can be washed out and give weakly acidic precipitation samples. Bicarbonate concentrations in the precipitation samples may also be higher than the assumed equilibrium values.

The current situation with the very poor ion balances for samples with pH above 5, is highly unsatisfactory since we will only have limited information about the consistency of these results. Countries having weakly acidic samples as a larger fraction of their precipitation should supplement their current pH measurements with titration for determining weak acid concentrations, preferably as described in the Manual (EMEP, 1996).

4. Accuracy, detection limits and precision

It is in principle not possible to determine the accuracy in air and precipitation measurements if accuracy is defined as deviation from the true concentration. Comparisons between national and reference methods for sulphur dioxide, sulphate in aerosols, nitrogen dioxide and sum of nitrate and nitric acid are summarised later in Chapter 6.

A request for quality assurance data was made earlier this year: method and laboratory lower detection limit, method and laboratory precision, lower detection limit in the laboratory, results from control samples and detection limits and precision for monitors. The data received reveal that the laboratories often use different ways to quantify this. It is most important that the laboratories have good quality control and are able to quantify detection limits and other characteristics of the data quality. As pointed out in the past there is a need to have one common set of procedures for statistical parameters in EMEP as a supplement to the ongoing calculations in the laboratories. The information collected on detection limits and precision is given in Annex 3.

5. Laboratory comparisons

The laboratory comparisons are reported separately. The relevant comparison for the 1997 data is the sixteenth comparison, which was performed during the first half of 1997 (Hanssen and Skjelmoen, 1997).

Among the conclusions are that the numbers of outliers are approximately as in the preceding comparison. Improvements were made in laboratories with non-satisfactory results in 1995; Hungary had generally good results in the intercomparison and Estonia, Latvia and Yugoslavia had also improved their results.

Four laboratories (in Croatia, Estonia, Greece, and Romania) were responsible for 62 per cent of the outliers. Romania is not operating EMEP sites. Estonia has recently started the participation, has improved its results from the preceding comparison, but they need more time to gain experience before satisfactory results can be obtained. Croatia did not report any data for 1997, while the problems in Greece may be related to the quality assurance procedures.

6. Summary of the results from the field comparisons at Donon, Schauinsland, Diabla Gora and Kosetice

6.1 Introduction

Since many countries still use methods which deviate from the recommended ones for determining sulphur dioxide, nitrogen dioxide and sulphate concentrations in air, it is of particular interest to see if the use of these methods lead to systematic differences in the reported concentrations. This need to quantify the accuracy of the EMEP measurements initiated field comparisons of several EMEP sites. Field comparisons in Great Britain, Ireland and Portugal and the results from these are reported in last year data quality report (Schaug et al., 1998). Earlier field comparisons have been done in Langenbrügge (Nodop et al., 1982); Vavihill (Semb et al., 1991) and Kleiner Feldberg (Fähnrich et al., 1990). The results from these EMEP field comparisons concluded that the recommended reference methods are robust and able to provide reliable air concentrations even at remote sites with low concentration levels. It was also seen that the quality of the sites own measured data varied considerably. These studies have now been extended with field comparisons in France, Germany, Poland and Czech Republic reported here. Co-located sampling will eventually be carried out in all of the participating countries.

A co-located measurement with reference instrumentation is a very direct method for determining the actual quality of the routinely reported EMEP data. Instead of carrying out a field comparison at one site, it has been found more useful to carry out the comparisons at one site in each country, using a set of reference instruments, which correspond to the specifications in the EMEP Manual. An inherent advantage of the reference methods is that the samples are stable and may be mailed from one country to another without any deterioration or change of concentrations. In order to make the comparison valid for a representative period, it was also decided to distribute the comparison measurements over a whole year and about 100 measurements were considered necessary. The reference samples were collected two days every week, or in some cases during one week every month of practical reasons.

To compare the two measurements, different statistical calculations can be used. The systematic difference between two measurement series is usually described by the median of the differences between the sample pairs. For comparison of mean values, the mean difference may be more useful. The modified median absolute deviation (M.MAD) is a non-parametric measure of the spread difference between corresponding daily results from two samplers, which becomes identical to the standard deviation if the differences have a normal distribution (Sirois and Vet, 1994). The previous field comparison (Schaug et al., 1998), showed clearly that the errors in sampling and chemical analysis are small when the samples are collected with identical equipment and analysed at the same laboratory. Deviations between the average concentrations obtained from the analyses are mostly caused by a few (1-2) outlier values. These outlier values do not influence the modified median absolute deviation, which in all cases was well below 10% of the average concentrations.

6.2 Reference instrumentation

The EMEP manual recommends a filterpack method with an aerosol filter for collection of sulphate, and subsequent absorption of sulphur dioxide on a cellulose filter impregnated with KOH. This filterpack is also suitable for determining the sum of nitrate aerosol and gaseous nitric acid. Evaporation of ammonium nitrate collected on the aerosol filter during the sampling period will lead to nitric acid that is collected on the impregnated filter. The quantity of nitrate accumulated on the impregnated filter will therefore usually represent an overestimate of the airborne gaseous nitric acid.

For nitrogen dioxide, the adopted sampling method is conversion to nitrite, using sodium iodide as an electron donor and absorbing agent. In order to achieve good sensitivity and low detection limits, sodium iodide is added to glass sinter frits, contained in glass bulbs which can be stoppered. Cleaning and impregnation of these sampling devices is carried out in the laboratory, after which the glass frits are exposed at the sampling site and returned to the laboratory for chemical analysis. The glass frits are stoppered during transportation and storage. The sampling rate here is lower, about 0.5 litres/min. and is kept constant with a glass capillary. The sampler used is a sequential air sampler, which will collect eight 24-h samples sequentially. A gas meter is used to read the total volume after exposure of 7 or 8 samples. The methods are described in more detail in the EMEP Manual for Sampling and Chemical Analysis (EMEP, 1996).

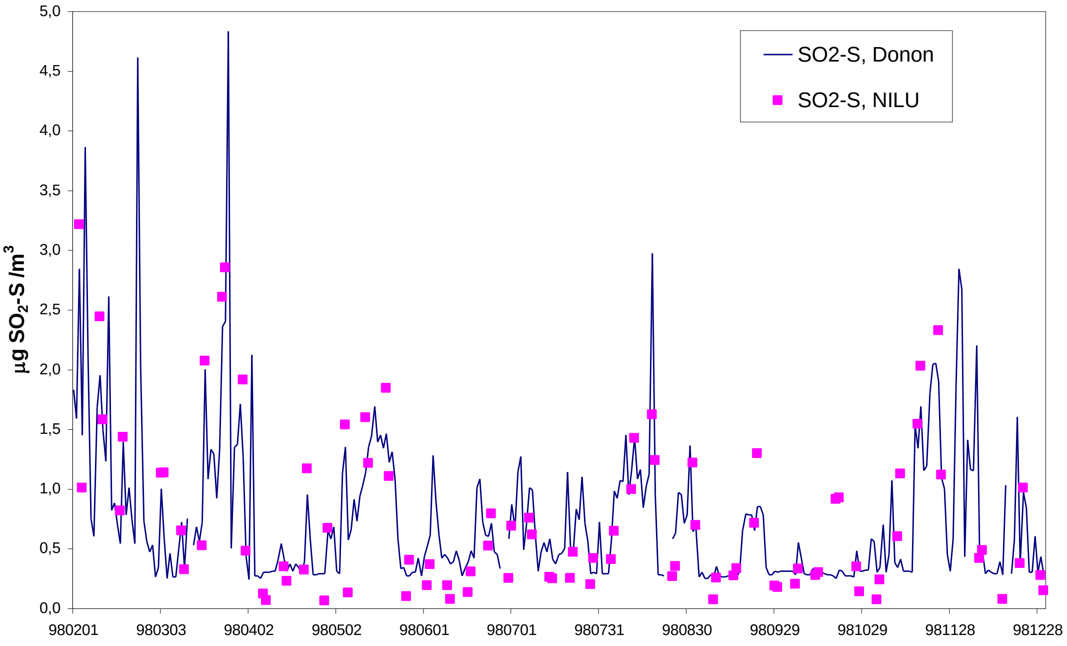
6.3 Comparisons at Donon (FR8)

The data collection for the field comparison at Donon started in February 1998. Since they only reports sulphur air components in the EMEP program, only these comparisons are done. Results from the comparison are shown in Figure 1 and the statistical summary in Table 4.

The method for sampling SO_2 is absorption in a hydrogen peroxide solution and it gives satisfactory correspondence with the reference method, an average difference of 10%; however, higher deviations for the median difference. Earlier studies has shown that the hydrogen peroxide absorption method tends to give higher figures for SO_2 (Semb et al., 1991; Schaug et al., 1998) so even better correspondence is expected if the sampling is changed to the reference method. Particulate sulphate, on the other hand, gives surprisingly poor fit with a difference of 25%. This is underestimated compared to the reference method and is not satisfactory. A similar trend is seen in the sixteenth intercomparison of analytical methods (Hanssen and Skjelmoen, 1997) so the analytical procedure needs to be revised.

Table 4: Results of co-located sampling at Donon. Unit: μg S/m^3.

Sulphur dioxide (SO_2-S)	Donon	Ref. (NILU)
Average	0.81	0.73
Median	0.57	0.44
Number of sample pairs	94	
Average difference	0.07	
Median difference	0.08	
M.MAD	0.22	
Sulphate aerosol (SO_4S)		
Average	0.62	0.82
Median	0.46	0.68
Number of sample pairs	93	
Average difference	-0.20	
Median difference	-0.21	
M.MAD	0,26	



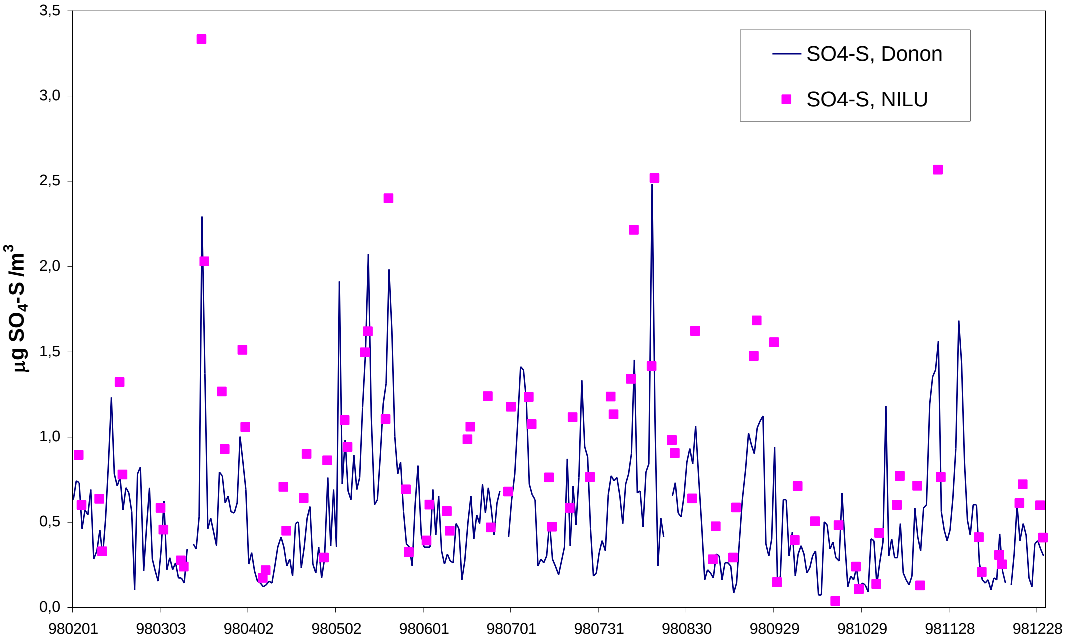


Figure 1: Comparison of measurements at Donon with reference sampler measurements.

6.4 Comparison at Schauinsland (DE3)

In Schauinsland the comparison stared in February 1998. The data reported from DE3 have been corrected to 1atm and 0^{o}C while the reference sample volumes are recorded at ambient temperature and pressure. The site is located at an altitude of about 1000m, which correspond to a pressure difference of 10-15%. The reference data have therefore been adjusted to make the experiments comparable using a correction factor of 0.833 and 0.864 for summer- and wintertime, respectively.

Two different methods to determine NO_2 concentrations have been used at Schauinsland, one monitor (Thermo Environmental Instrument 42c) and one manual based on the Saltzman method. The results obtained by the latter method is reported to EMEP. As expected, the automatic method overestimates the gas concentration, clearly seen in Figure 2. Also the Saltzmann method overestimates NO_2 if concentrations are below 1 µg N/m^3, resulting in a median difference of 28% is observed; the precision is here also poor. When plotting concentrations from the reference and Saltzman methods against each other, one can clearly see that is a good correspondence between the two methods at concentration higher than 1 µg N/m^3, whereas, the fit is poor at lower concentration, Figure 3. It is recommended to change to the NaI method for NO_2, particularly because it has a lower detection limit and lower blank values and is therefore more suitable for the low concentration levels that usually occur at the background stations.

Also for sulphur dioxide, several different methods have been used. In Figure 4, one clearly sees that the SO_2 monitor (Monitor-Labs Fluorescent Model 8850) gives a very poor fit. The data reported for the absorption method TCM, gives surprisingly many low values. Low results for SO_2 by the TCM method seems to be caused by interference of ozone, or some other oxidant. This will particularly affect measured concentration levels in summer. Part of the poor agreement is of course also caused by the very low concentration levels for SO_2 at Schauinsland. The best correspondence is achieved with the new method at this station based on the recommended method, but even here there is an unacceptable difference of 20%. The SO_4 determination is much more satisfactory with an average difference of 10%. Sum nitrate and nitric acid, on the other hand, gives a considerable difference, about 60%. This must be a systematic error because M.MAD is relatively low. The statistical data in Table 5 are given for the best methods together with TCM for SO_2 sampling.

Table 5: Results of co-located sampling at Schauinsland. The values in parenthesis for SO_2 sampling are for the TCM method. Unit: µg S(N)/m^3.

	Schauinsland	Reference	Schauinsland	Reference
	Sulphur dioxide (SO_2-S)		Nitrogen dioxide (NO_2-N)	
Average	0,64 (0,20)	0,54	1,13	1,00
Median	0,38 (0,05)	0,36	1,00	0,77
Number of sample pairs	93		83	
Average difference	0,10 (-0,33)		0,13	
Median difference	0,08 (-0,25)		0,20	
M.MAD	0,08 (0.26)		0,39	
	Sulphate aerosol (SO_4S)		Sum nitrate (NO_3^-+HNO_3)	
Average	0,66	0,61	0,73	0,46
Median	0,53	0,47	0,61	0,33
Number of sample pairs	93		93	
Average difference	0,05		0,28	
Median difference	0,04		0,22	
M.MAD	0,10		0,11	

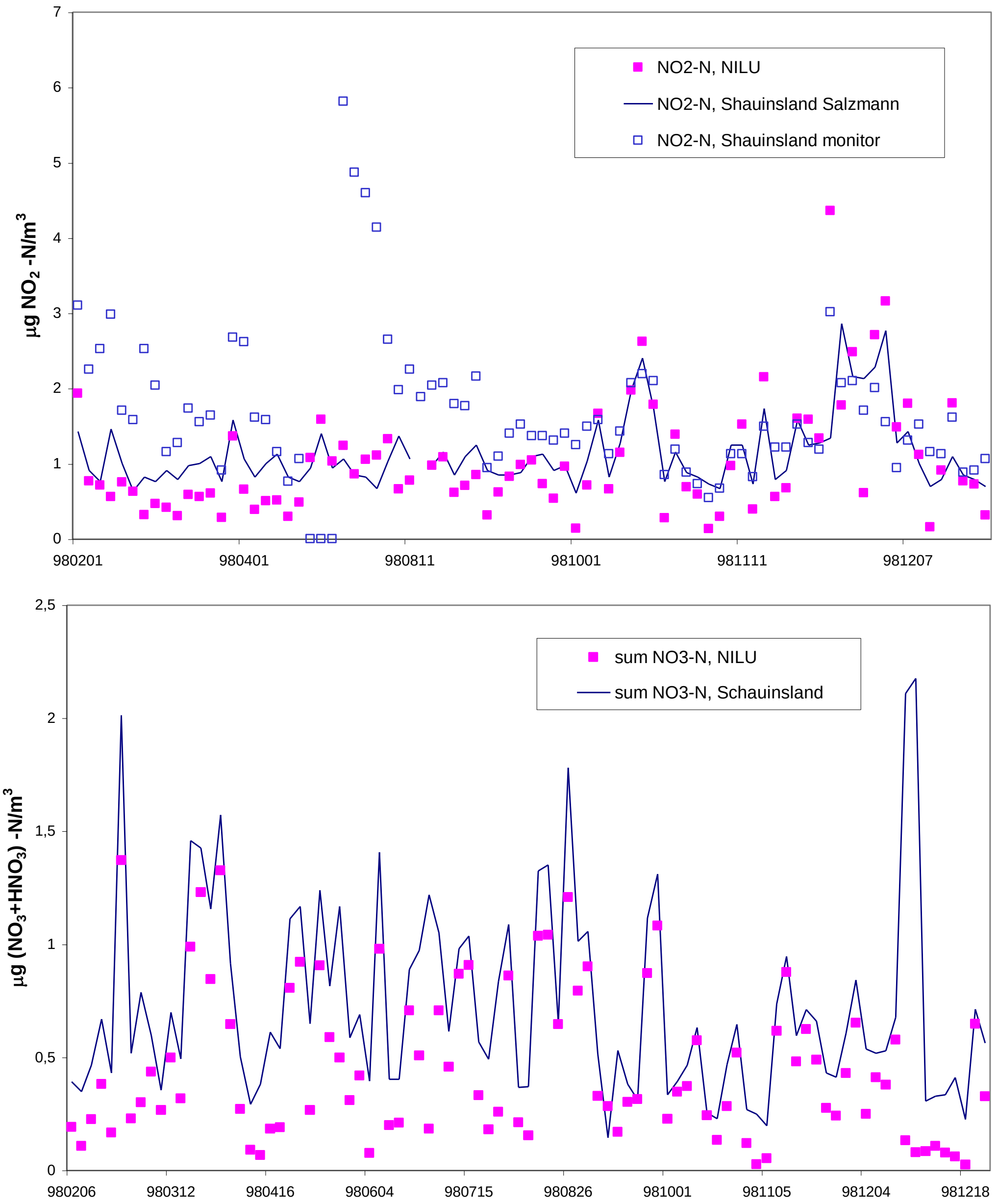


Figure 2: Comparison of measurements at Schauinsland with reference sampler, results for sum nitrate and nitrogen dioxide.

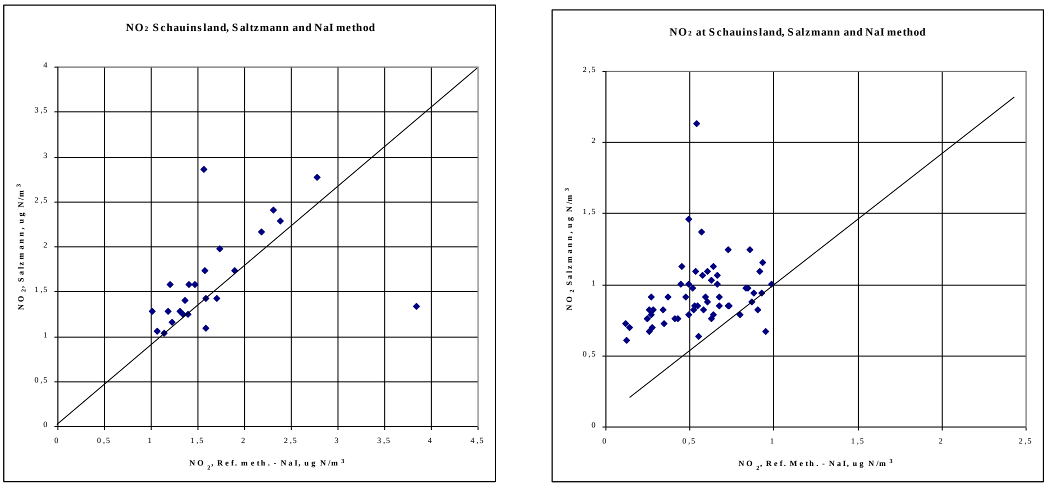


Figure 3: Comparison of reference and Saltzman methods at high and low SO_2 concentration.

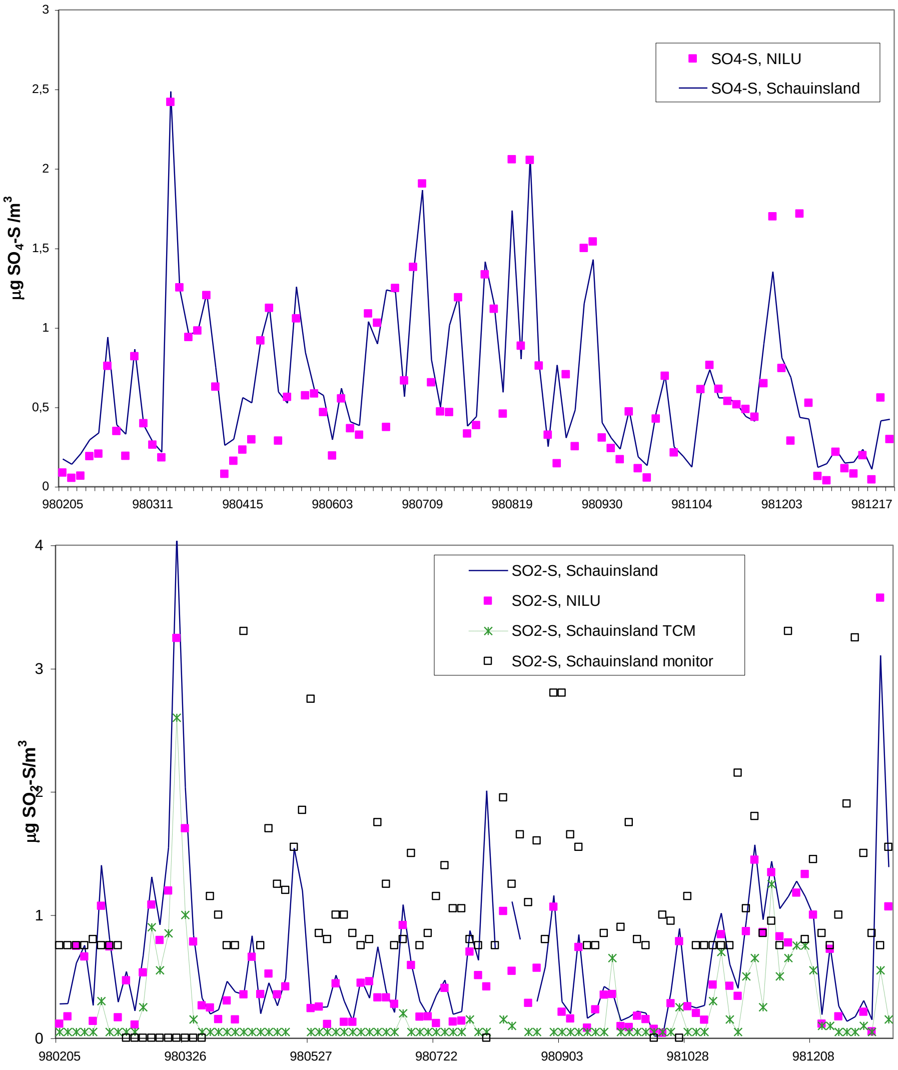


Figure 4: Comparison of measurements at Schauinsland with reference sampler, results for particulate sulphate and sulphur dioxide.

6.5 Comparison at Diabla Gora (PL5)

The field comparison at Diabla Gora started in May 1997. At Diabla Gora the gaseous SO_2 and NO_2 are sampled using absorption method with KOH and TGS, respectively. The SO_2 determination is good even though the average error is slightly above 10%, but the median concentration difference is only 2% indicating that there is problem with the peak concentrations. NO_2 has a very low average and median difference (Table 6); however, the precision is very low, also seen clearly in Figure 5 where there is little correspondence with the two methods. The method should be replaced by the recommended NaI method. The sampling of particulate sulphate and the sum of nitrate and nitric acid give both a difference around 20%, which is not acceptable. The nitrate concentration level is rather low resulting in a relatively high deviation.

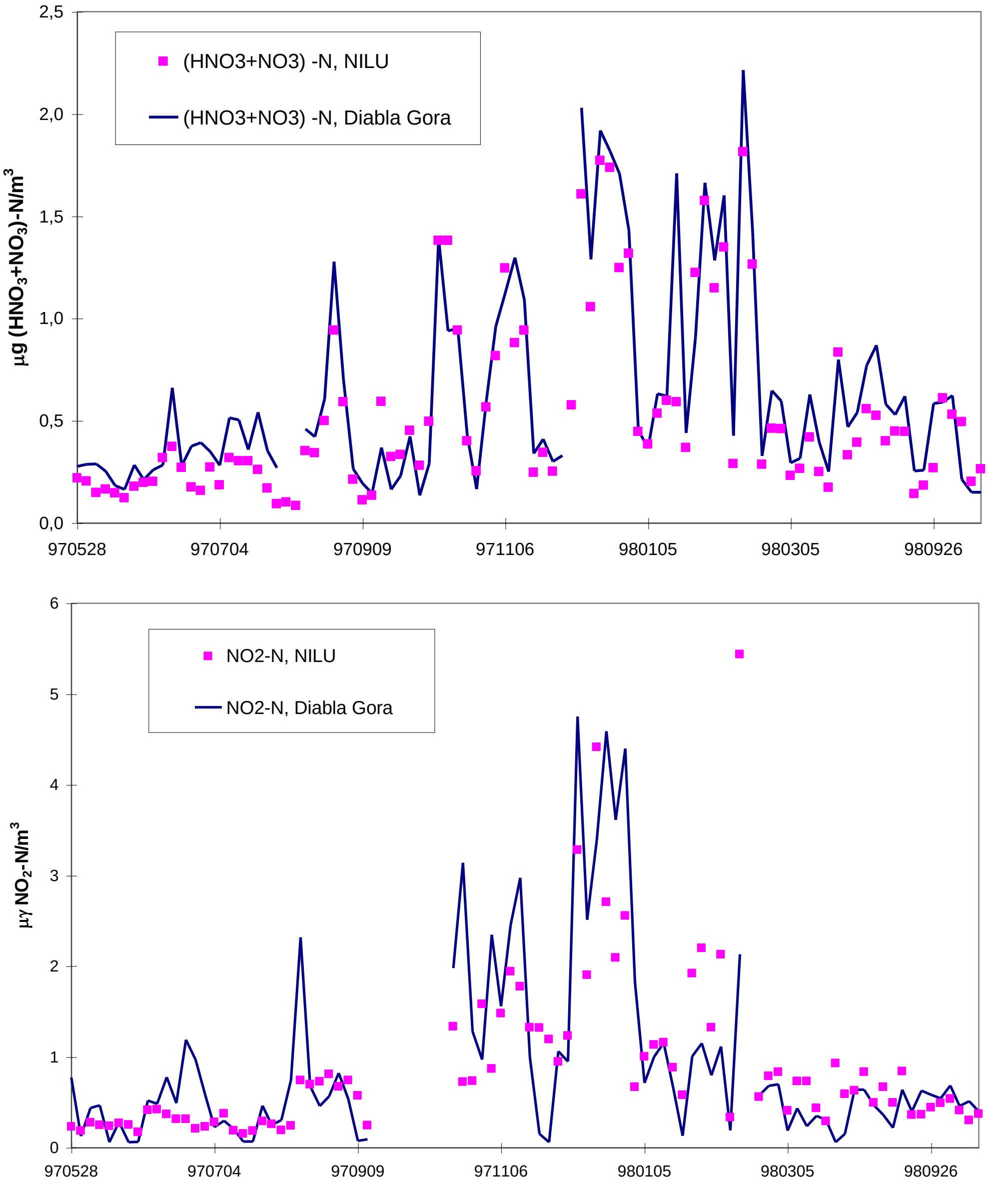


Figure 5: Comparison of measurements at Diabla Gora with reference sampler, results for sum nitrate and nitrogen dioxide.

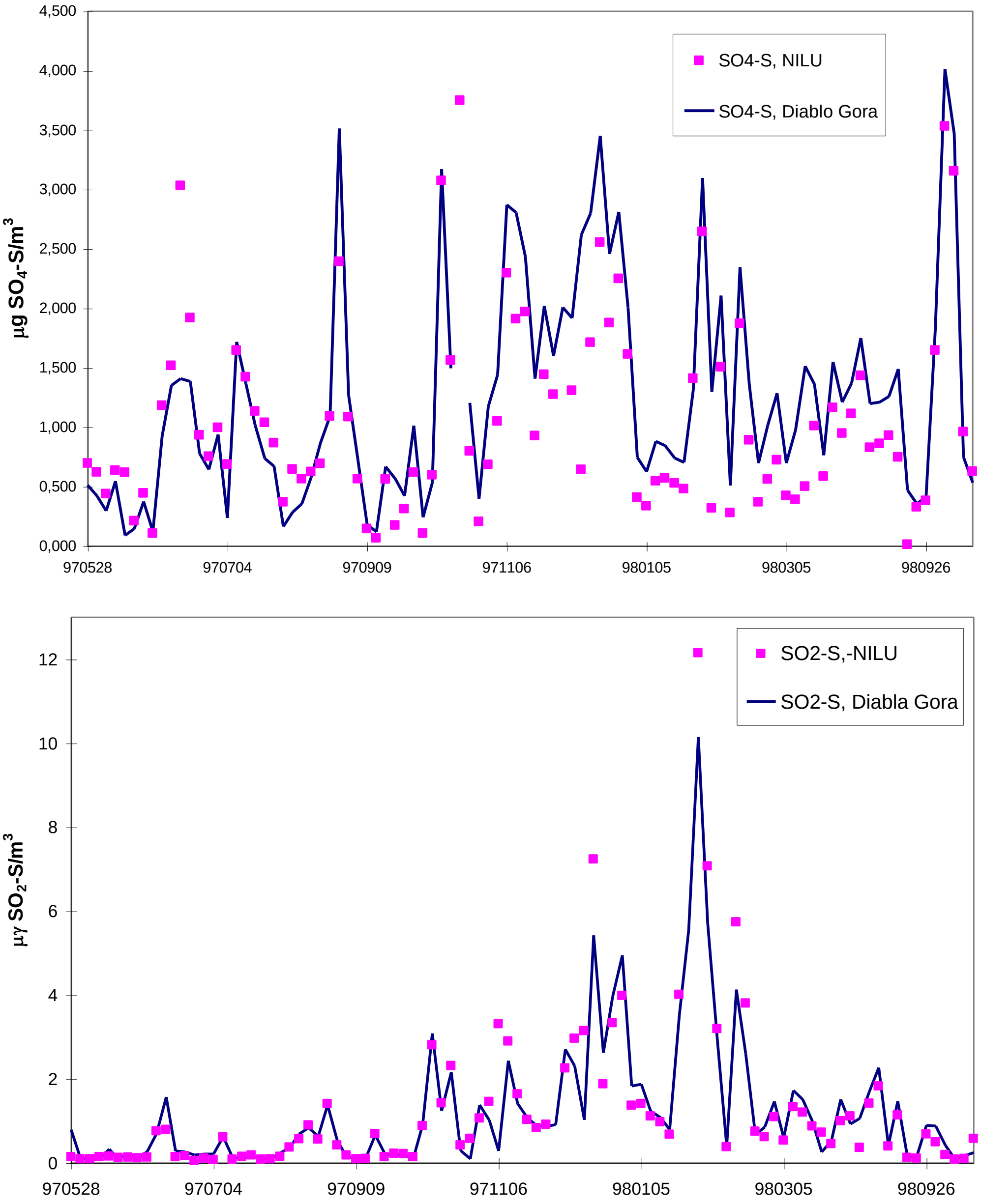


Figure 6: Comparison of measurements at Diabla Gora with reference sampler, results for particulated sulphate and sulphur dioxide.

Table 6: Results of co-located sampling at Diabla Gora. Unit: µg S(N)/m³.

	Diabla Gora	Reference	Diabla Gora	Reference
	Sulphur dioxide (SO_2-S)		Nitrogen dioxide (NO_2-N)	
Average	1.22	1.39	0.94	0.89
Median	0.70	0.68	0.58	0.63
Number of sample pairs	95		87	
Average difference	-0.16		0.05	
Median difference	0.03		0.01	
M.MAD	0.16		0.32	
	Sulphate aerosol (SO_4S)		Sum nitrate (NO_3^-+HNO_3)	
Average	1.24	1.02	0.64	0.54
Median	1.02	0.78	0.45	0.37
Number of sample pairs	94		92	
Average difference	0.22		0.10	
Median difference	0.23		0.09	
M.MAD	0.37		0.11	

6.6 Comparison at Košetice (CS3)

The field comparison in Košetice started in September 1998. The sampling is still continuing, but we chose to present some preliminary results now. SO_2 and NO_2 are sampled by both automatic and manual methods. Both of them are presented in the figures to show the discrepancies of the two methods. The automatic SO_2 and NO_2 methods are done by UV-fluorescence and chemiluminescence, respectively. The manual NO_2 sampling is done by using a guajacol impregnated filter. In addition, SO_4, SO_2 and NO_3+HNO_3 are sampled using filter pack; filters impregnated with KOH and NaCl to collect SO_2 and HNO_3, respectively. This is not a good method to separate gaseous HNO_3 and aerosol NO_3 and the sum of these should therefore be given. But in the comparison, we see that there is a big error between the sum of nitrate at Košetice compared to the reference method at NILU, Figure 7. This is mainly due to problems with the nitric acid determination that can bee seen when also plotting aerosol nitrate in the figure. The difference between average aerosol nitrate is only 10% compared to more than 100% for the sum nitrate! The nitric acid concentration at Košetice is measured to be about 3 times the nitrate concentration, which is not very likely.

Nitrogen dioxide monitors based on chemiluminescence are not specific for nitrogen dioxide, and readings are typically 30-40% too high at rural ”background” sites. This can also be seen in Figure 7. The concentration levels of the manual Košetice and reference methods are more comparable, but the differences between corresponding daily concentration values are too high to be acceptable. We suggest that the method for NO_2 at Košetice should be changed to the EMEP standard reference NaI method. The situations for the sulphur compounds are better, but also here big errors occur: 20 and 35% differences for the SO_4 and the SO_2 comparisons, respectively. These comparisons are done with only few data point and more solid conclusions might be drawn when the field comparison is completed.

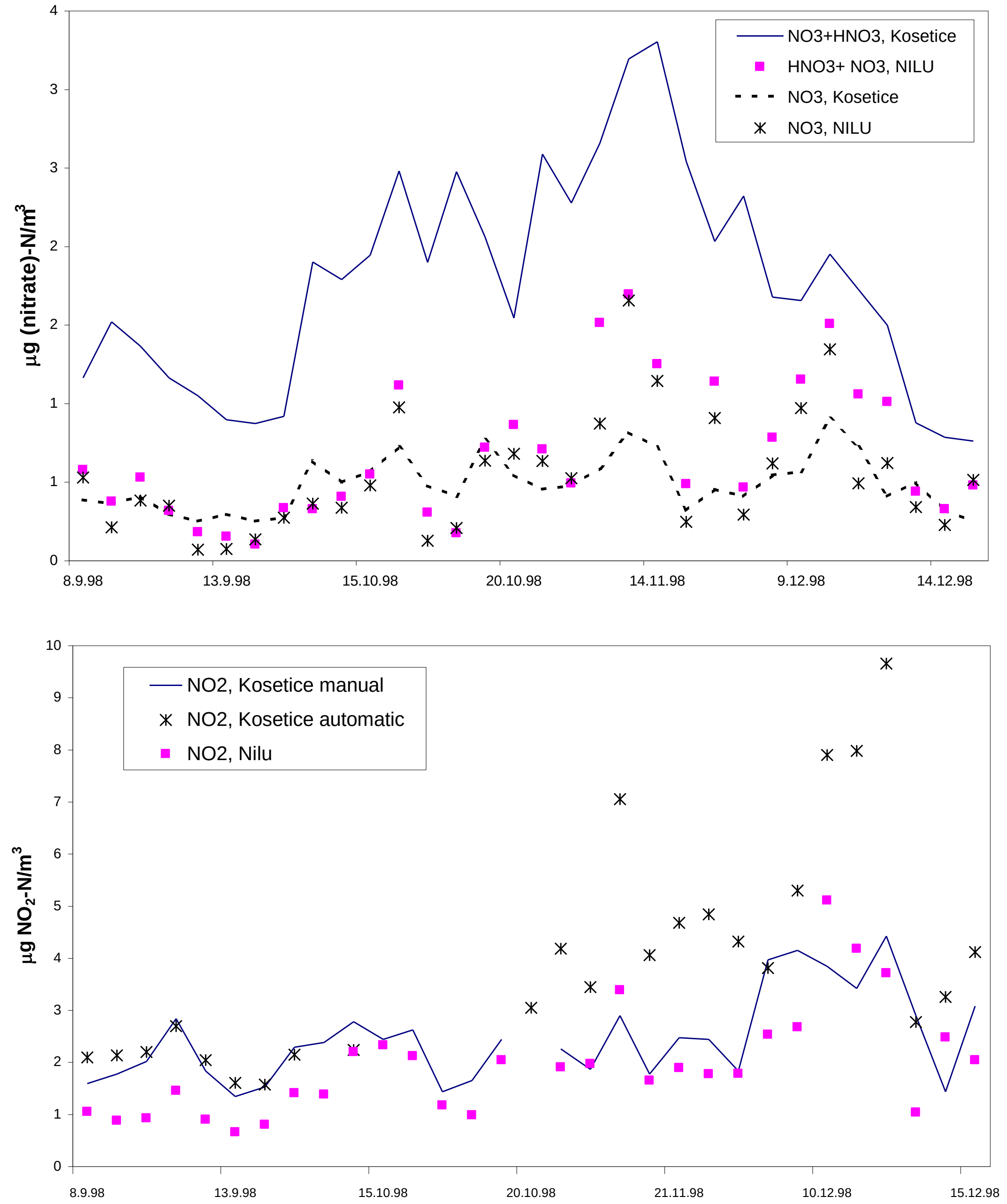


Figure 7: Comparison of measurements at Košetice with reference sampler, results for sum nitrate and nitrogen dioxide.

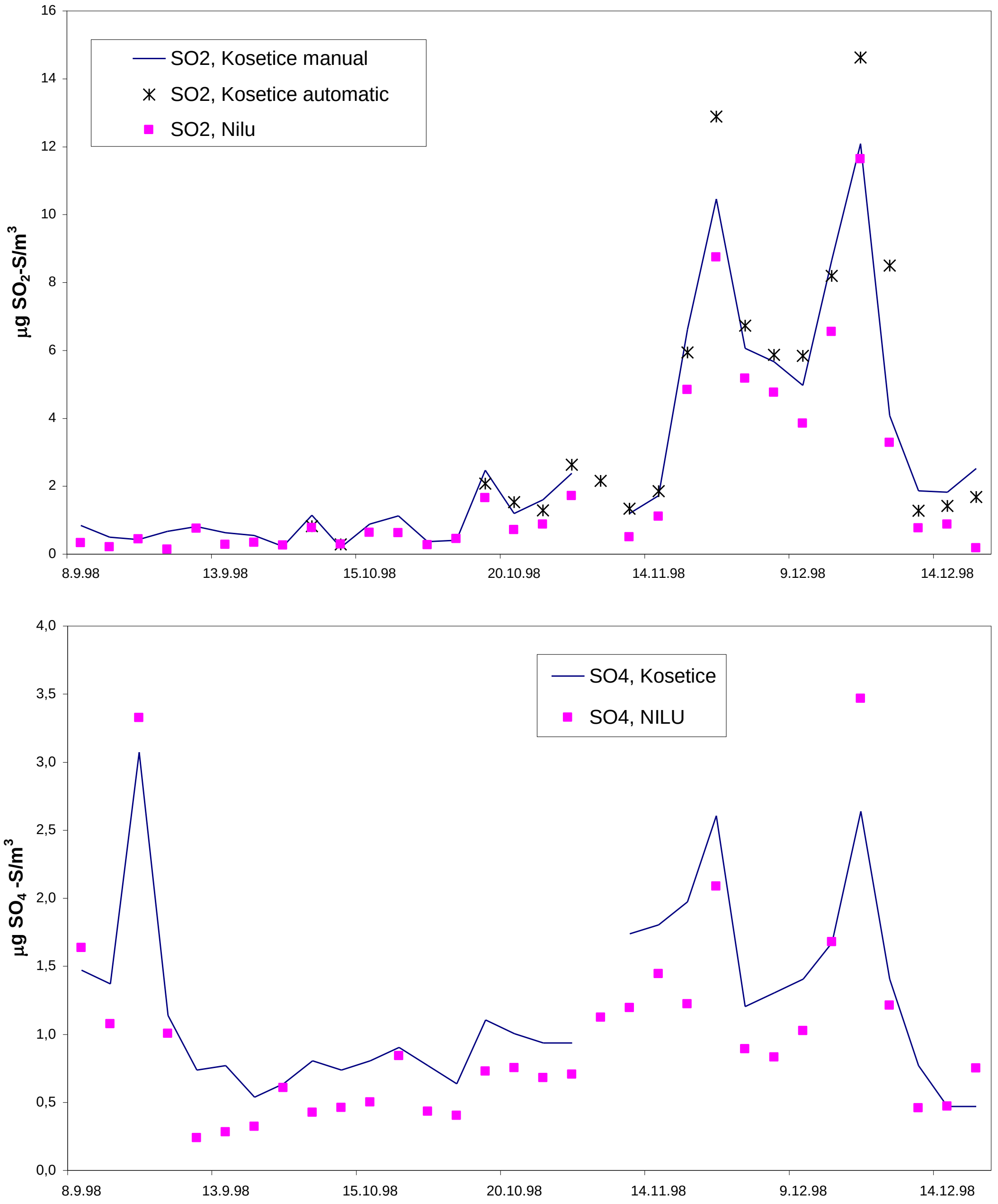


Figure 8: Comparison of measurements at Košetice with reference sampler, results for particulated sulphate and sulphur dioxide.

Table 7: Results of co-located sampling at Košetice. Unit: μg S(N)/m^3.

	Kosetice	Reference	Kosetice	Reference
	Sulphur dioxide (SO_2-S)		Nitrogen dioxide (NO_2-N)	
Average	2.70	2,02	2,45	1,94
Median	1.19	0,74	2,41	1,83
Number of sample pairs	31		30	
Average difference	0,71		0,51	
Median difference	0,58		0,62	
M.MAD	0,49		1,04	
	Sulphate aerosol (SO_4S)		Sum nitrate (NO_3^-+HNO_3)	
Average	1,22	1,00	1,78	0,67
Median	1,00	0,75	1,75	0,51
Number of sample pairs	31		32	
Average difference	0,22		1,10	
Median difference	0,28		0,89	
M.MAD	0,15		0,65	

6.7 Summary and preliminary conclusions

The variability in the individual measurements is considerable. All of the sites that are presented give measurements that are not acceptable. There are problem with gaseous nitrogen dioxide, and generally this is due to use of methods that are not sensitive enough at the background sites. In connection with trend studies, changes in the measurement methods or analysis should generally be avoided. However, when the differences can be quantified, it is generally an advantage to change to a method that is more reproducible and avoids systematic errors that are difficult to explain. For this reason, the use of the more sensitive NaI method is strongly recommended.

The biggest problems seem to be the determination of sum of nitrate. Differences of 20, 60 and 100% are seen at DE3, PL5 and CS3, respectively. This might be a problem with the methodology or problems with field blanks. In the filterpack method one can’t separate nitrate and nitric acid because volatile ammonium nitrate collected on the aerosol filter will be migrating to the alkaline impregnated filter leading to an overestimation of nitric acid. One should therefore also measure the sum of ammonia to see whether high nitric acid concentration could be caused by high ambient air concentrations of nitric acid or evaporated ammonium nitrate. Preferably, denuders are wanted to obtain separate concentrations of gasses and particles

Also the concentration of particulate sulphate is rather poorly estimated at all sites, except at Schauinsland. For gaseous sulphur dioxide the situation is slightly better with acceptable data at Donon and Diabla Gora.

7. Methods and data quality

7.1 Introduction

In order to easier comment and improve the data quality, all the sites' precipitation and air data have been classified into different quality groups. The intention with this evaluation is to give an estimate of the expected errors in annual averages from 1997, the reason for this choice being that arithmetic averages are used for many purposes, e.g. comparisons between measurements and model results. The summary of the data quality at all operating stations in 1997 is found in Annex 4. Errors in single measurements are expected to be larger than errors in long-term arithmetic averages. The reason for this being that random errors in single measurements are assumed to cancel each other when data are aggregated, therefore adding to near-zero errors in long-term averages. Systematic errors, however, will be retained and copied into the averages. Data from other years than 1997 may have different qualities than those estimated below.

The averages have been classified in four quality groups:
expected error 10 per cent or better: **A,**
expected error 25 per cent or better: **B,**
expected error 30 per cent or better: **C**
expected error worse that 30 per cent or unknown: **D**
In a few cases even "unknown" has been used in the classification.

Besides giving a quality classification, references to the sampling methods and chemical analytical methods have been given. More information about the methods can be found, e.g. in the annual data reports (Hjellbrekke, 1999). The tables below also contain comments to the data when that was felt necessary and brief recommendations for the further work.

7.2 Recommended EMEP methods

EMEP's recommended methods for sampling and analysis have been presented in two manuals, most recently in the EMEP/CCC-Report 1/95 from 1996. Full harmonisation of methods has not been achieved and many participants still use different methods, and some laboratories even outdated methods. The use of a different methodology creates a comparability problem within the network. When other methods than the recommended ones are used by a laboratory, "then that laboratory should be responsible to document to the CCC their accuracy, precision and comparability to the methods described in the Manual" (EMEP Workshop on data handling, analysis and quality assurance, 1986, Freiburg in Breisgau, Federal Republic of Germany). This is, however, seldom done. The recommended sampling and analysing procedures are listed in Table 8.

Table 8: EMEP monitoring requirements for acidification.

Component	**Sampling frequency**	**Sampling period**	**Methods in field**	**Methods in laboratory**
Precipitation:				
amount	daily	24 hours	rain gauge	by weight
SO4	daily	24 hours	wet only	IC
H	daily	24 hours	wet only	titration
pH	daily	24 hours	wet only	pH meter
NH4	daily	24 hours	wet only	IC/indophenol
NO3	daily	24 hours	wet only	IC/Griess
Na	daily	24 hours	wet only	IC/AES
Mg	daily	24 hours	wet only	IC/AAS
Cl	daily	24 hours	wet only	IC/Thiocyanate
Ca	daily	24 hours	wet only	IC/AAS
K	daily	24 hours	wet only	IC/AES
κ	daily	24 hours	wet only	Cond-meter
Air:				
SO2(g)	daily	24 hours	filter –3 pack	IC
NO2(g)	daily	24 hours	KI impr. glass fritt	IC/Griess
HNO3(g)	daily	24 hours	denuder	IC/Griess
NH3(g)	daily	24 hours	denuder	IC/Indophenol
SO4(p)	daily	24 hours	filter –3 pack	IC
NO3(p)	daily	24 hours	denuder	IC/Griess
NH4(p)	daily	24 hours	denuder	IC/Indophenol
HNO3(g)+NO3(p)	daily	24 hours	filter –3 pack	IC/Griess
NH3(g)+NH4(p)	daily	24 hours	filter –3 pack	IC/Indophenol

Comments:
IC: ion chromatography, AES: atomic emission spectroscopy, AAS: atomic absorption spectroscopy.
Filter-3-pack: aerosol filter + KOH impregnated filter + oxalic acid impregnated filter.

7.3 Data used for the quality estimates

Three sources of data have been used in the estimates which follows,

- The sixteenth intercomparison of analytical methods within EMEP (Hanssen and Skjelmoen, 1997),
- results from field comparisons contained in (EMEP/CCC-Report 6/98) as well as the recent results from comparisons in Germany, France, Poland, and the Czech Republic,
- calculations on ion balances.

The laboratory comparison gives information about laboratory performance in tests of this type. The weakness in these tests is that laboratories may put more effort into analysing the comparison samples, which arrive once every year, than in the large number of routine samples they receive every week. The comparison results may for this reason give a lower estimate of the accuracy than the real one of routine samples. The laboratory comparison results have been used as a basis for the quality classification when results from field comparisons were not available.

The ion balances for samples with pH less than 5 units give separate indications on the quality of the results, and they have been used to modify the quality classification based on the laboratory comparison results. It should be noted that different handling of routine and comparison samples is not the only reason for a lower quality in routine results; this can also be due to other things, for example generally low concentrations or contamination.

Field comparisons are the best way to quantify errors and differences to reference methods. As far as possible such information has been used below. For some methods the data have been rather scarce and more comparisons are needed. For this reason the UV spectrometry for sulphur dioxide is classified as “D” (expected error worse that 30 per cent or unknown). A chemiluminescence measurement of nitrogen dioxide has been classified as, “C” (expected error 30 per cent or better). In general monitors are convenient and well suited for many locations, but not at the low concentration levels at EMEP sites, except for ozone which has sufficiently high concentrations.

Generally, in order to obtain good routine results, it should again be emphasised that adequate equipment in field and laboratory are imperative, and that strict quality assurance procedures are of extreme importance. It must again be stressed that it is the obligation of the Parties to the Convention to see that the necessary funding to meet EMEP’s requirements and data quality objectives is provided for the participating institutions.

8. References

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Granby, K., Egeløv, A.H., Nielsen, T., Lohse, C. (1997) Carboxylic acids: Seasonal variation and relation to chemical and meteorological parameters. *J. Atm. Chem., 28,* 195-207.

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Sirois, A. and Vet, R.J. (1994) The comparability of precipitation chemistry measurements between the Canadian air and precipitation monitoring network (CAPMoN) and three other North American networks. In: *EMEP Workshop on the Accuracy of Measurements*. *Passau*, *1993*. Edited by T. Berg and J. Schaug. Kjeller, Norwegian Institute for Air Research (EMEP/CCC-Report 2/94). pp. 88-114.

Annex 1

Data quality objectives

10 % accuracy or better for oxidised sulphur and oxidised nitrogen in single analysis in the laboratory,

15 % accuracy or better for other components in the laboratory,

0.1 units for pH,

15–25% uncertainty for the combined sampling and chemical analysis (components to be specified later),

90 % data completeness of the daily values.

The targets, with respect to accuracy in the laboratory, for the very lowest concentrations of the main components in precipitation follow the WMO GAW (1992) recommendations for regional stations:

	Accuracy	
SO_4^{2-}	0.032 mg S/l	(1 µmol/l)
NO_3^-	0.014 mg N/l	(1 µmol/l)
NH_4^+	0.028 mg N/l	(2 µmol/l)
Cl^-	0.107 mg Cl/l	(3 µmol/l)
Ca^{2+}	0.012 mg Ca/l	(0.3 µmol/l)
K^+	0.012 mg K/l	(0.3 µmol/l)
Mg^{2+}	0.007 mg Mg/l	(0.3 µmol/l)
Na^+	0.007 mg Na/l	(0.3 µmol/l)

The targets for the wet analysis of components extracted from air filters are the same as for precipitation. For SO_2 the limit above for sulphate is valid for the medium volume method with impregnated filter. For NO_2 determined as NO_2^- in solution the accuracy for the lowest concentrations is 0.01 mg N/l.

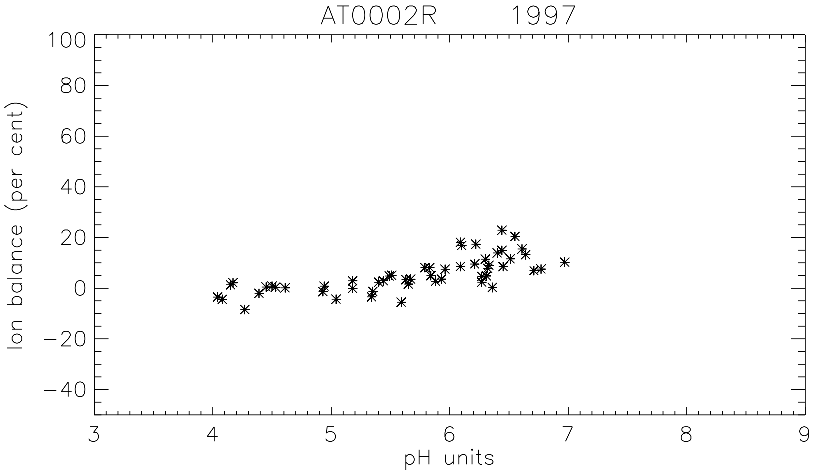
The aim for data completeness is valid for the current definition used by the CCC. This definition will, however, be harmonised with the WMO GAW definition and modified.

It is understood that there is a need to investigate additional uncertainty caused by local influence on the measurements at the sites (not representative siting).

It may be necessary to reconsider the DQO for volatile organic components (VOC), persistent organic pollutants (POP), and trace metals (HM).

Annex 2

Ion balances in precipitation samples 1997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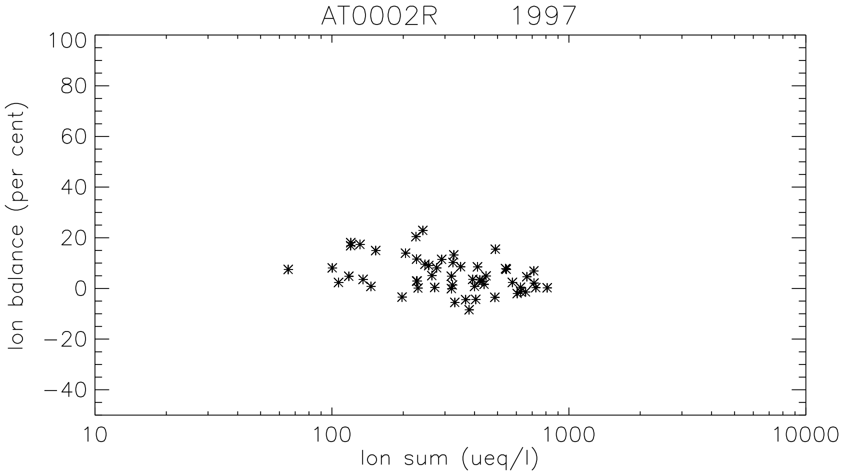
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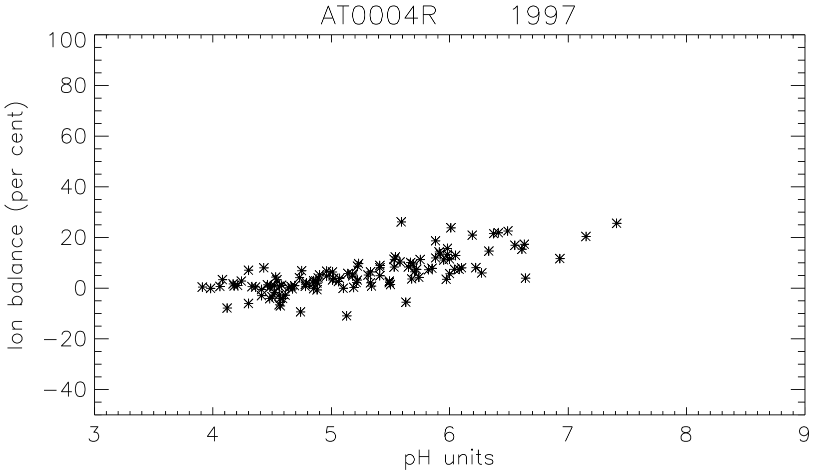
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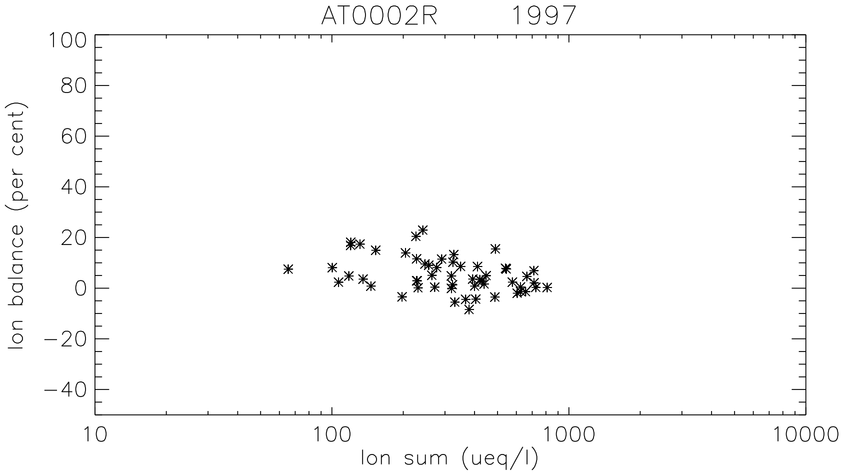
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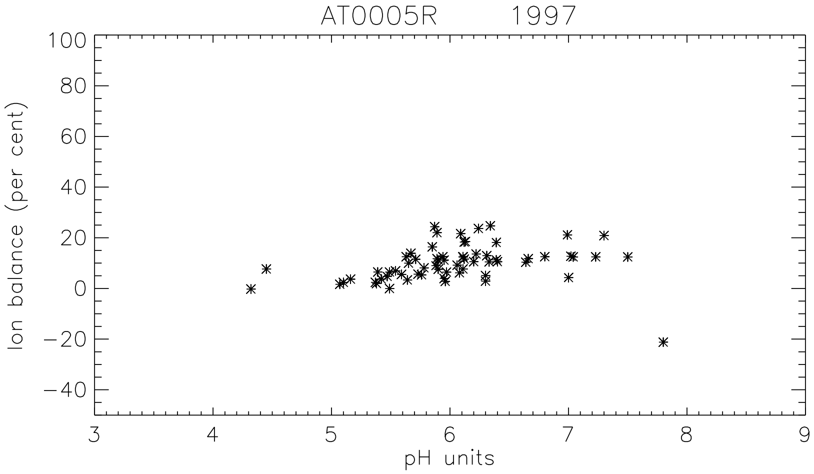
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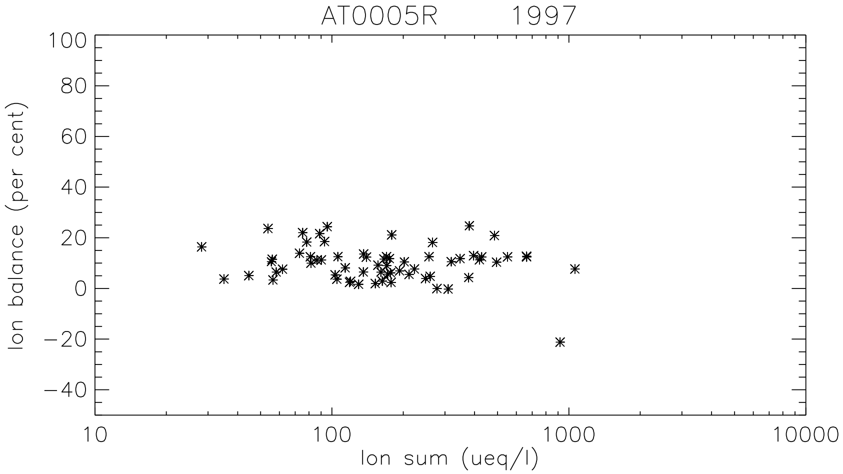
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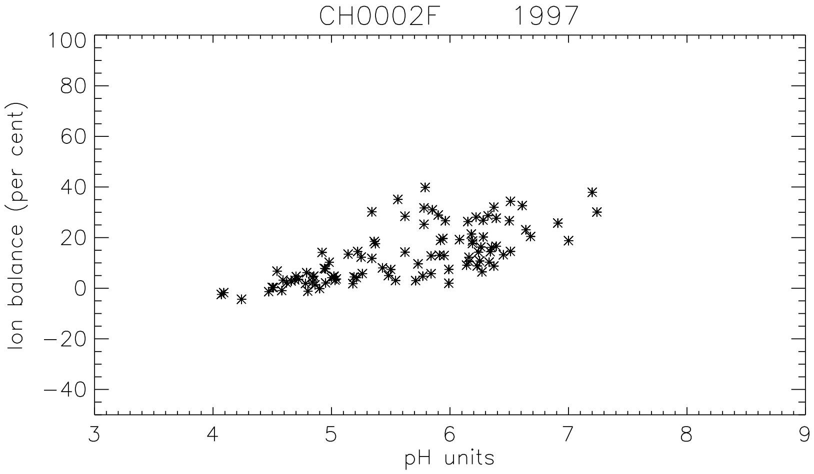
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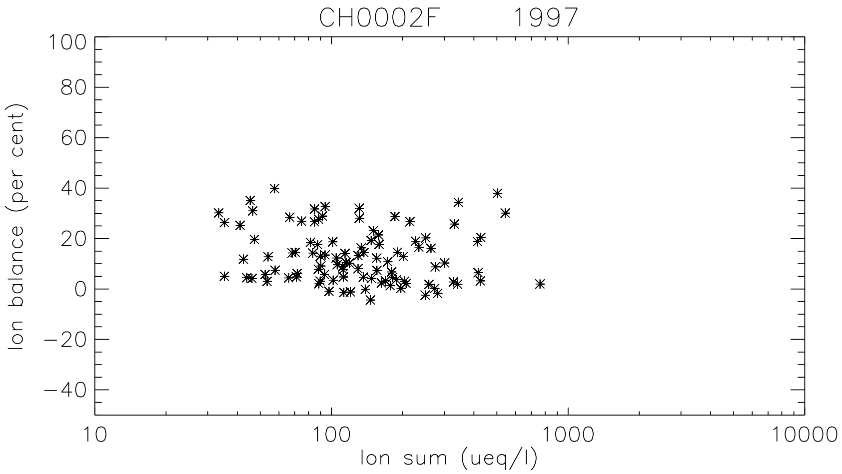
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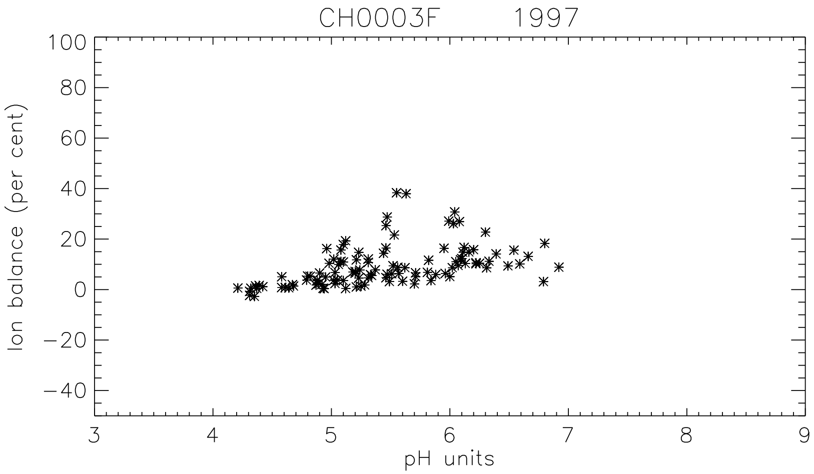
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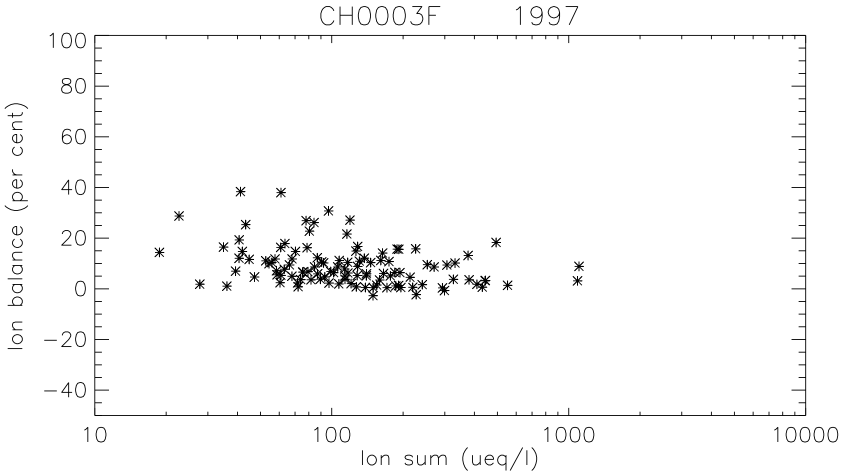
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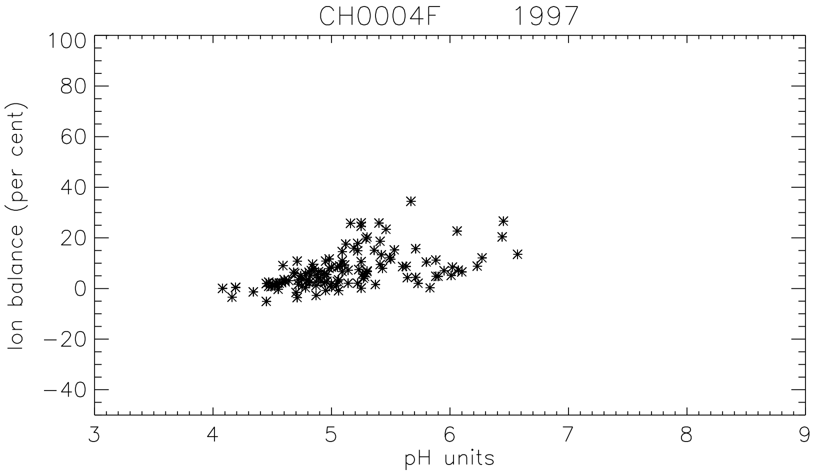
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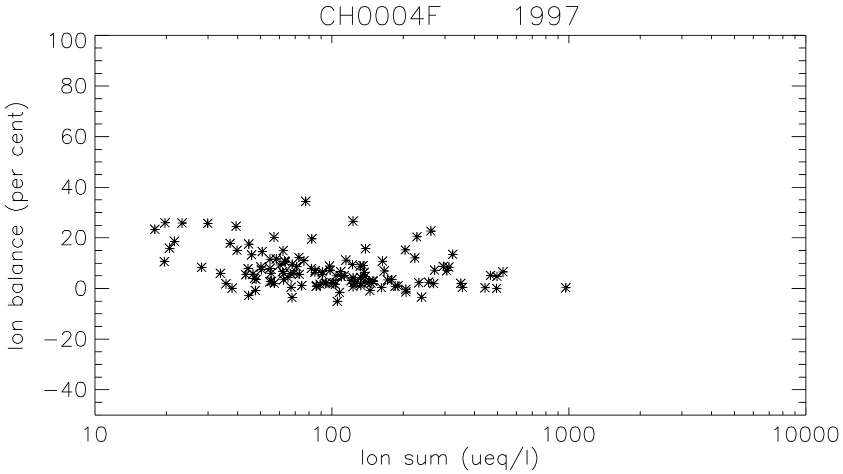
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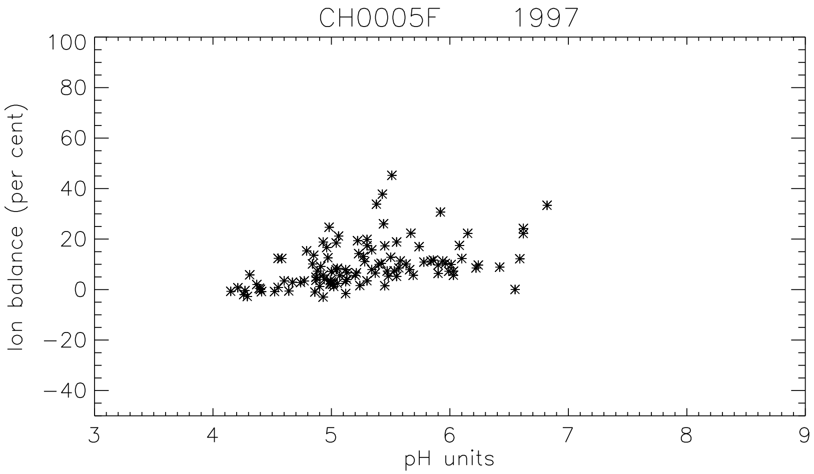
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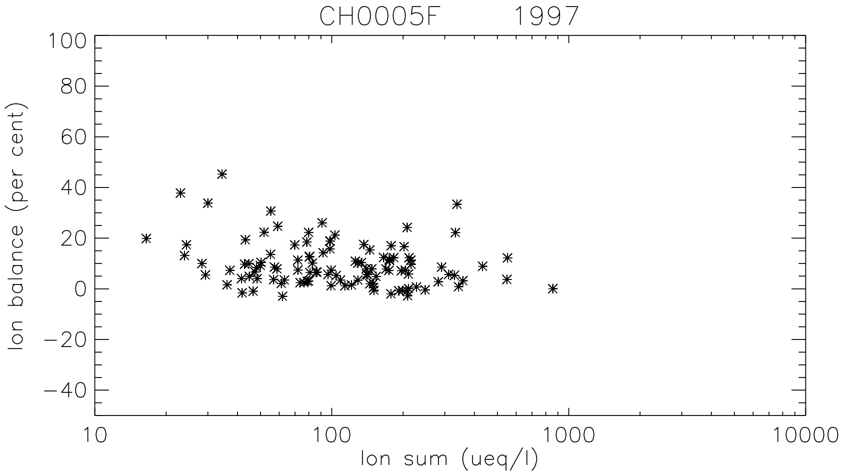
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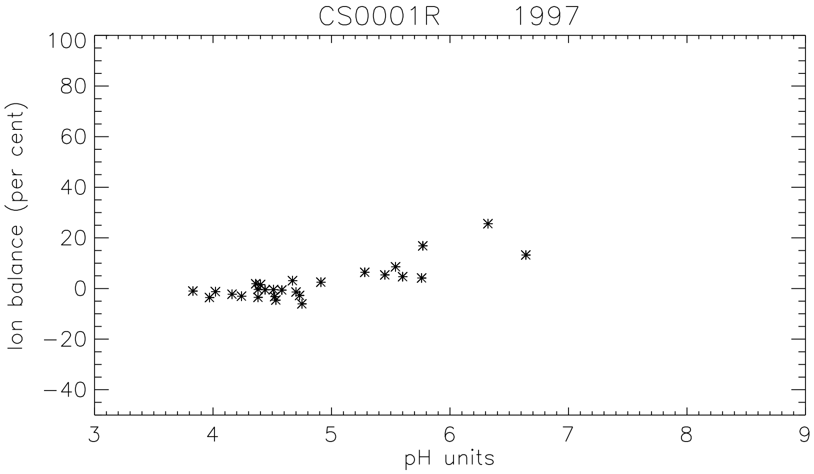
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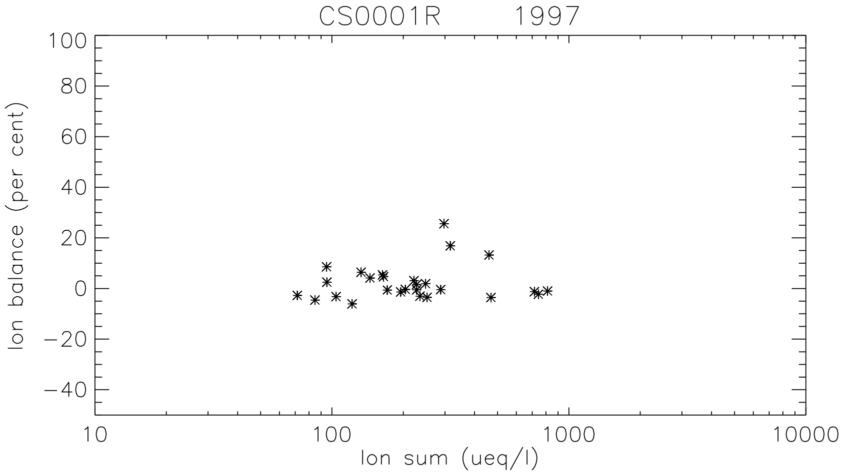
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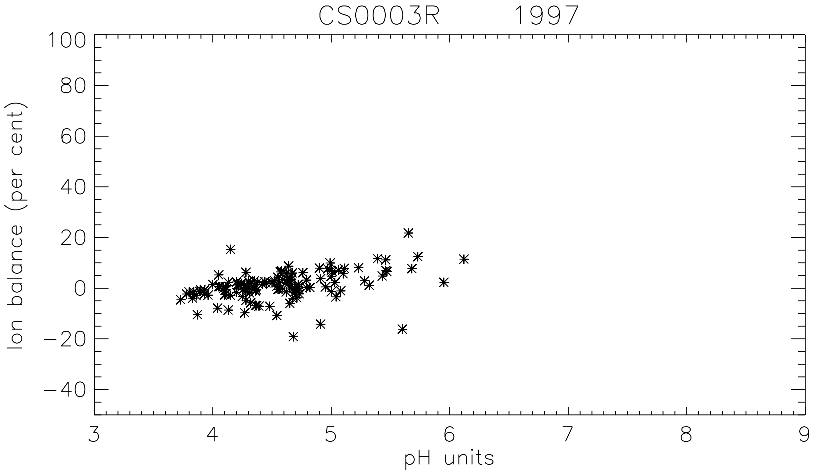
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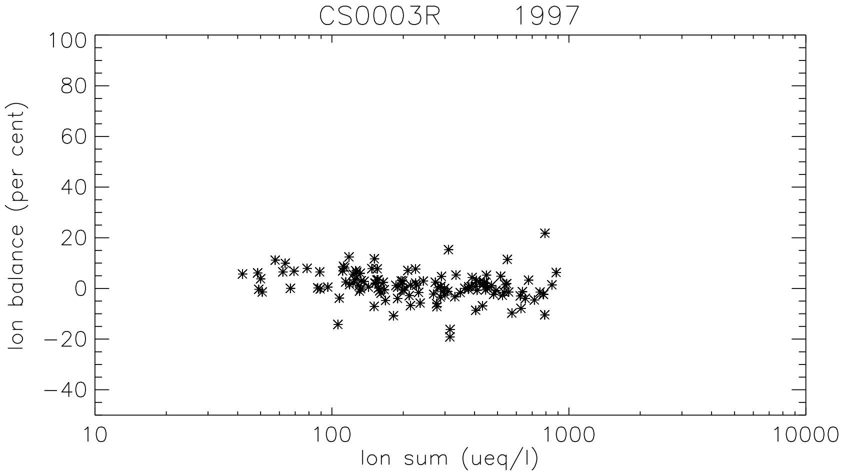
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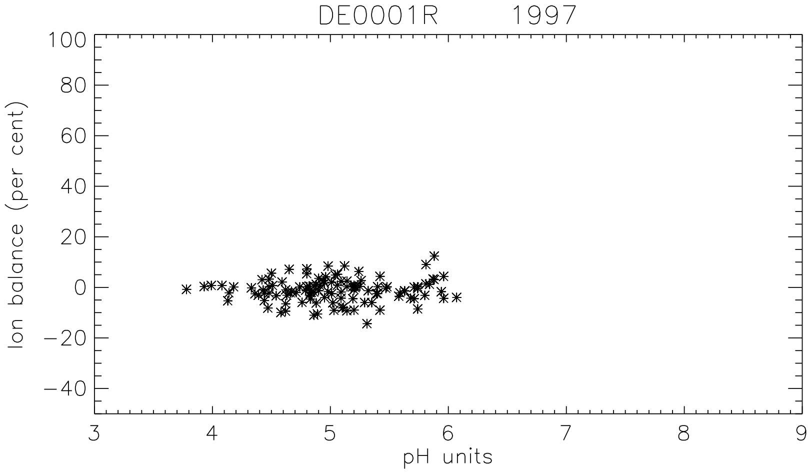
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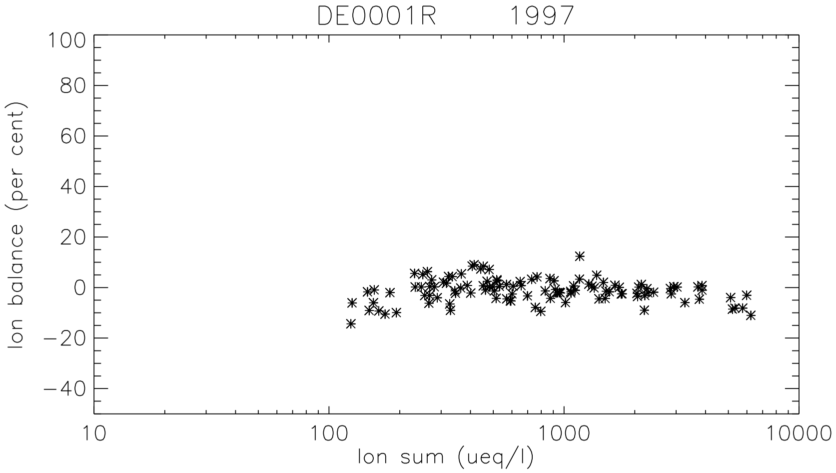
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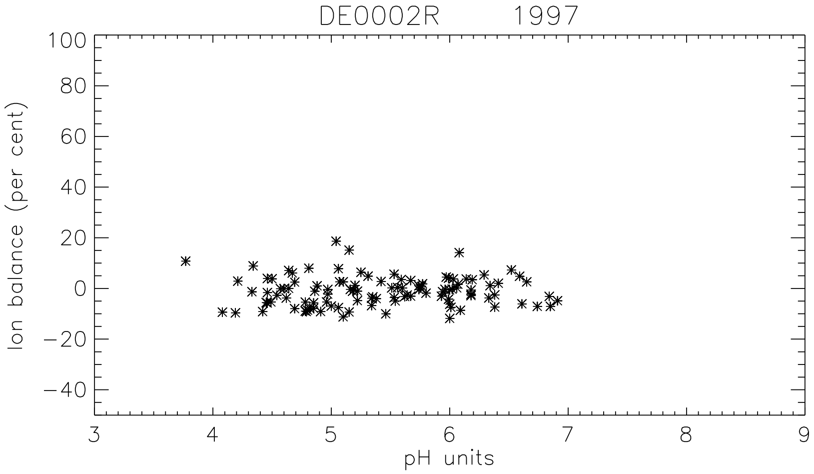
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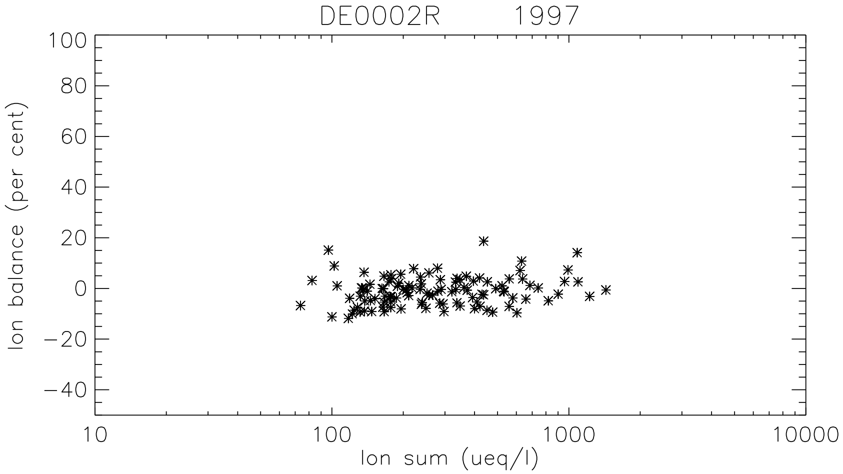
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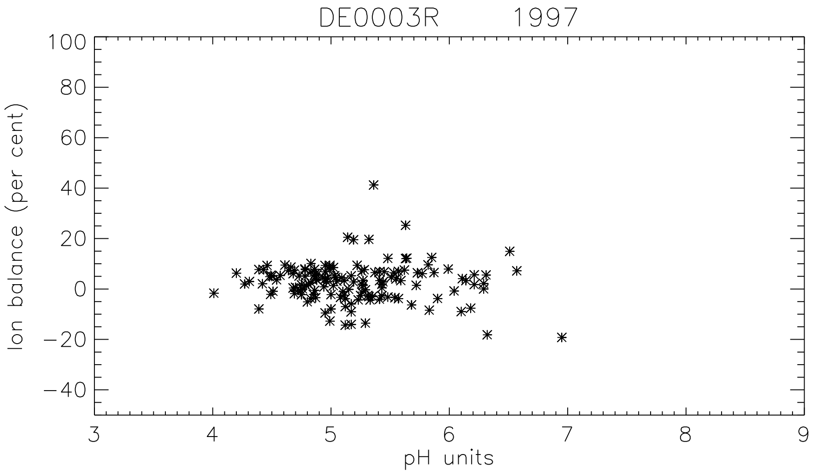
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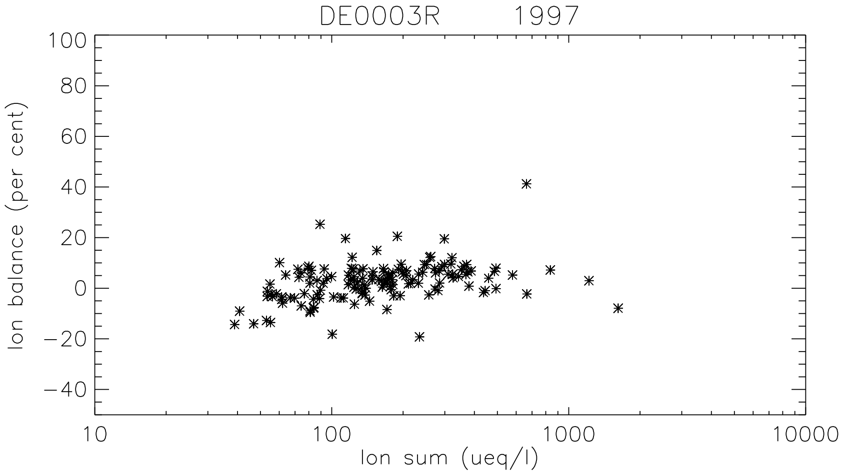
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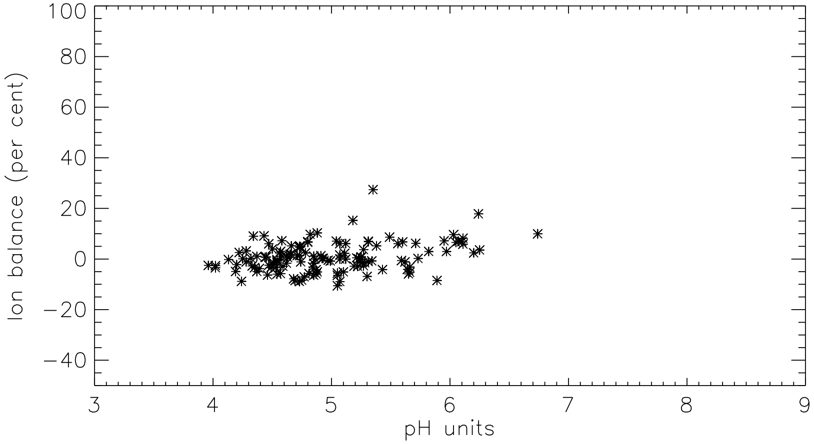
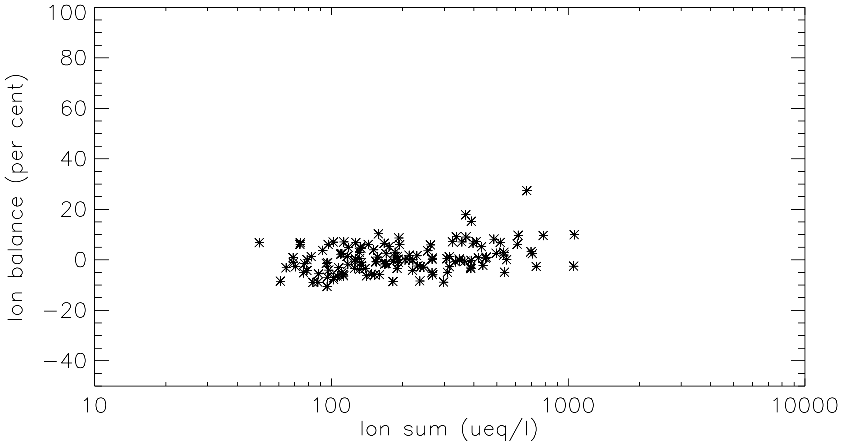
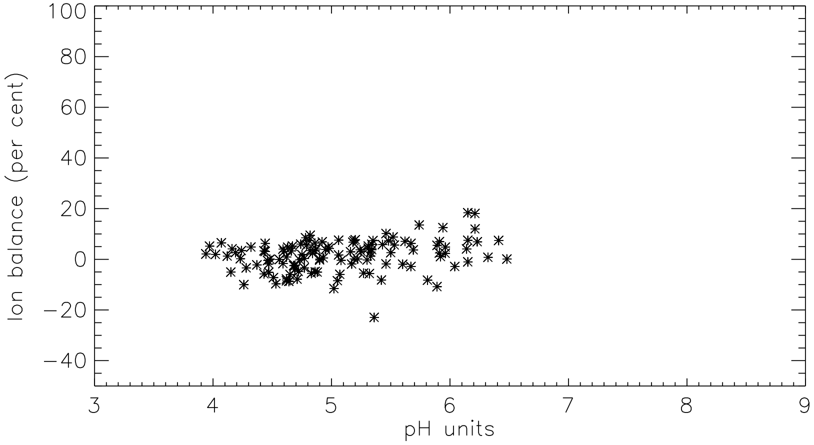


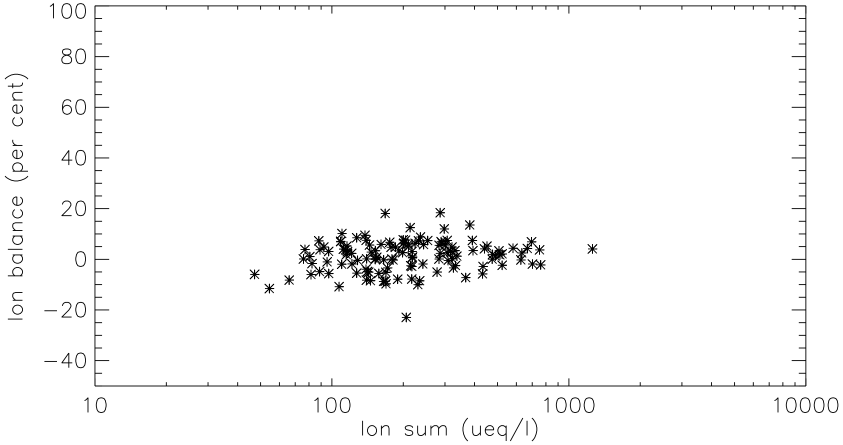
DE0004R 1997

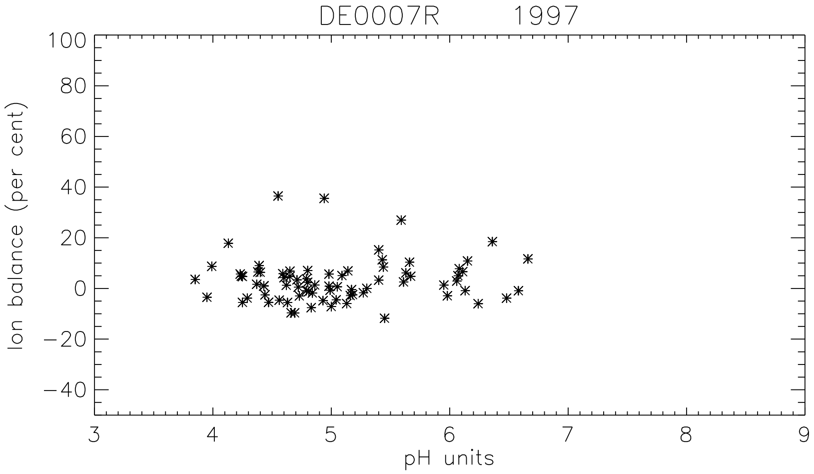


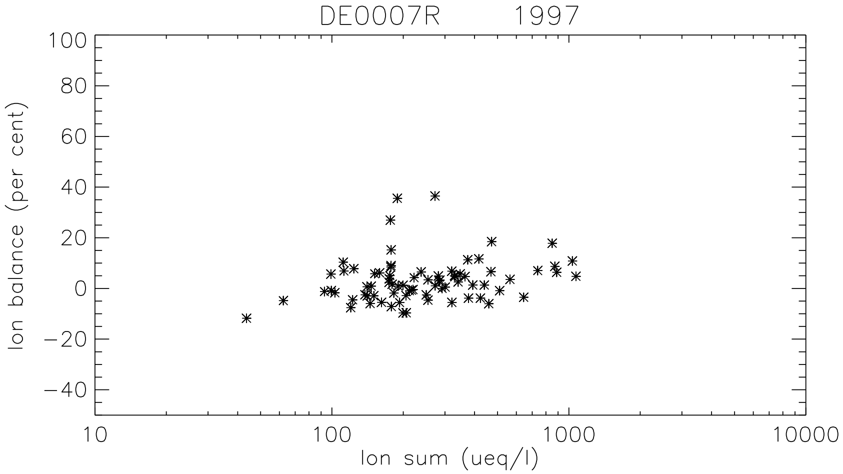
DE0005R 1997

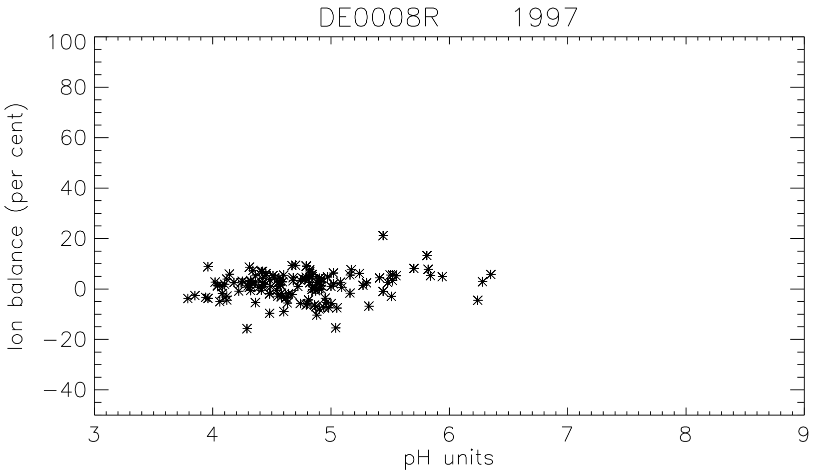


DE0005R 1997




DE0007R 1997
Ion balance (per cent)
100
80
60
40
20
0
−20
−40
3
4
5
6
7
8
9
pH units


DE0007R 1997
Ion balance (per cent)
100
80
60
40
20
0
−20
−40
10
100
1000
10000
Ion sum (ueq/l)


DE0008R 1997
Ion balance (per cent)
100
80
60
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0
−20
−40
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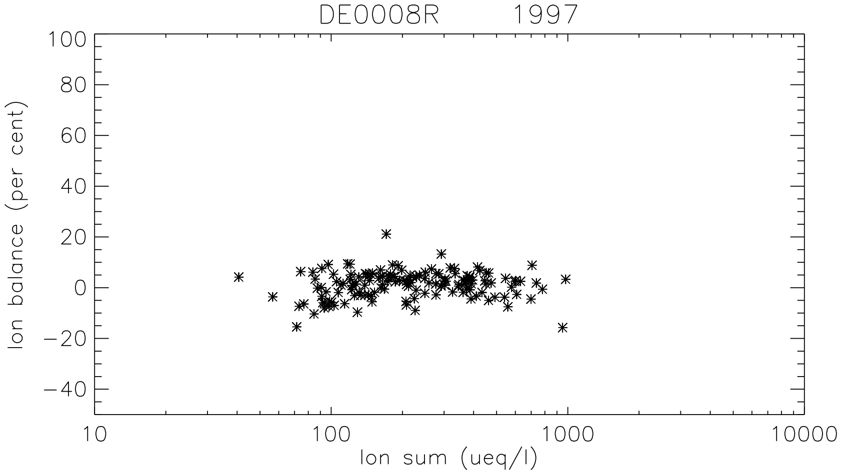
8
9
pH units


DE0008R 1997
Ion balance (per cent)
100
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20
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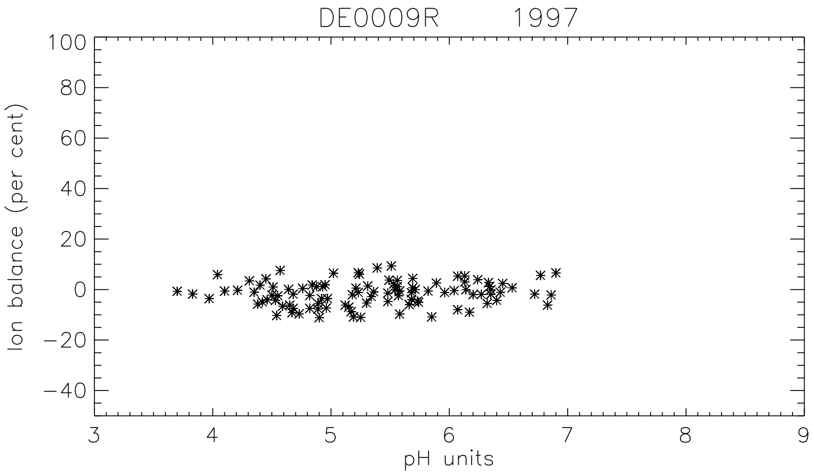
−20
−40
10
100
1000
10000
Ion sum (ueq/l)


DE0009R 1997
Ion balance (per cent)
pH units
100
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0
−20
−40
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8
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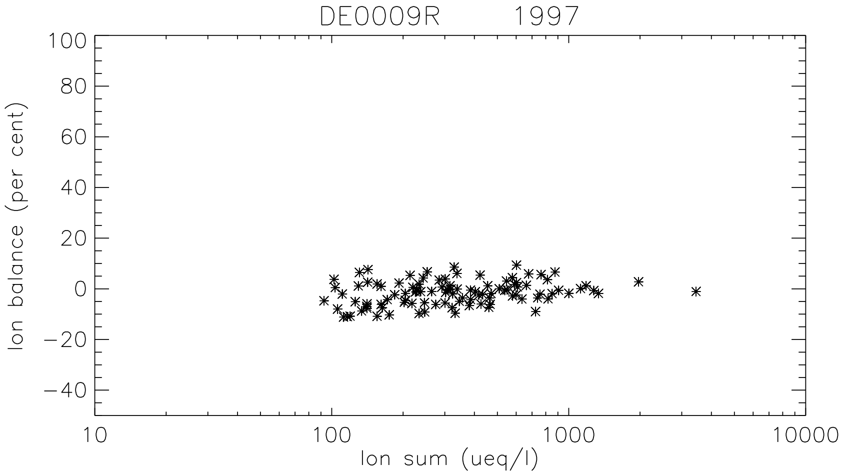
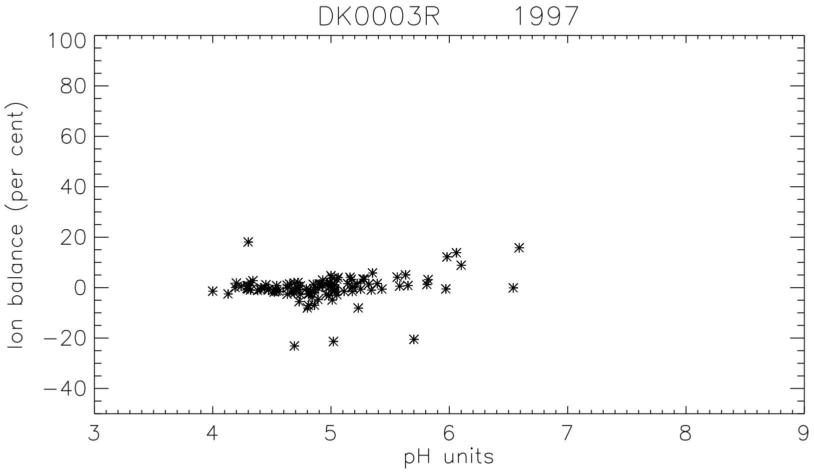

DE0009R 1997
Ion balance (per cent)
Ion sum (ueq/l)
100
80
60
40
20
0
−20
−40
10
100
1000
10000


DK0003R 1997
Ion balance (per cent)
pH units
100
80
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−20
−40
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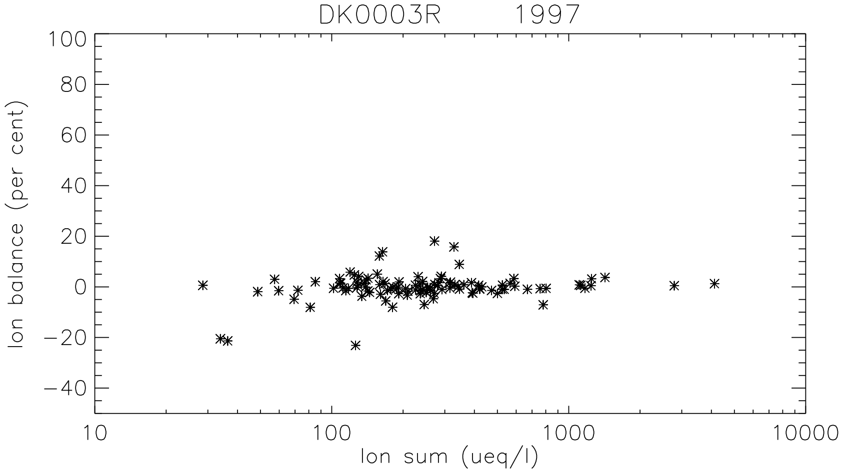
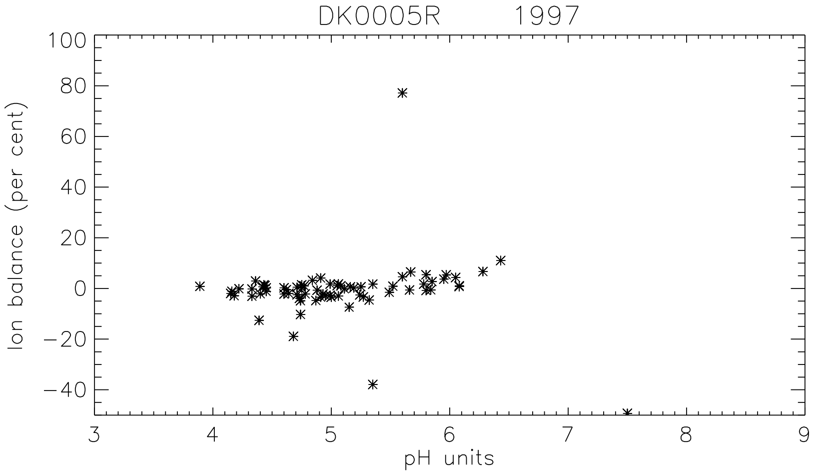

DK0003R 1997
Ion balance (per cent)
Ion sum (ueq/l)
100
80
60
40
20
0
−20
−40
10
100
1000
10000


DK0005R 1997
Ion balance (per cent)
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80
60
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−20
−40
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8
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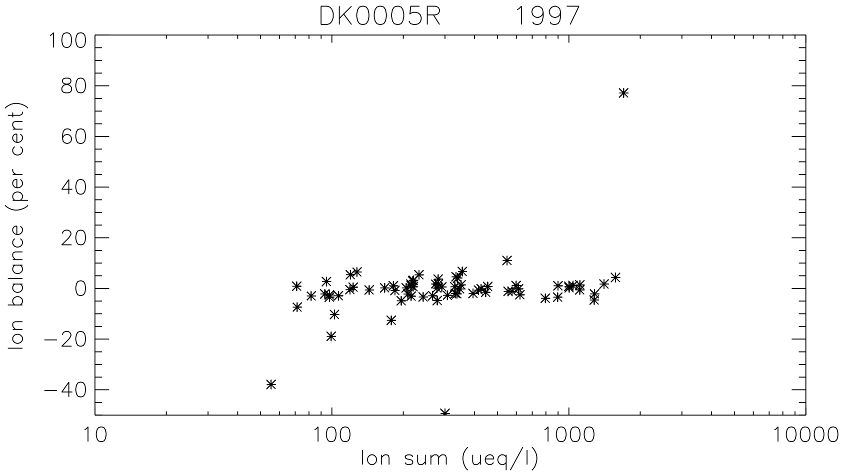
pH units


DK0005R 1997
Ion balance (per cent)
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−20
−40
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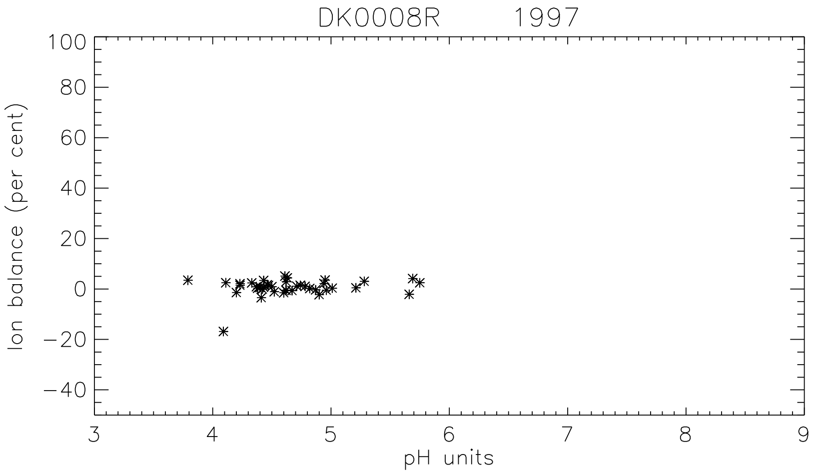
100
1000
10000
Ion sum (ueq/l)


DK0008R 1997
Ion balance (per cent)
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−40
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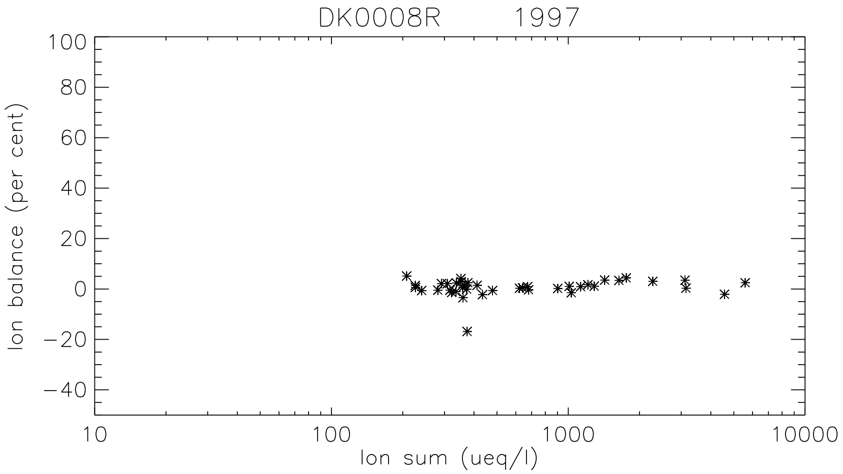
pH units


DK0008R 1997
Ion balance (per cent)
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−40
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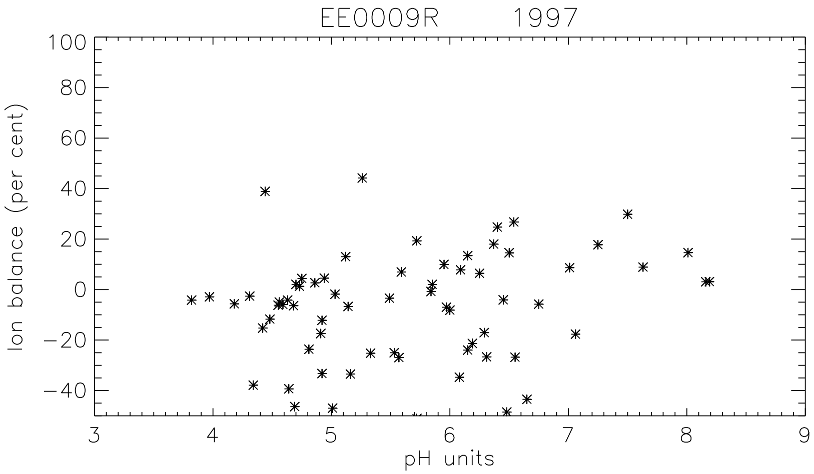
100
1000
10000
Ion sum (ueq/l)


EE0009R 1997
Ion balance (per cent)
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20
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−40
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4
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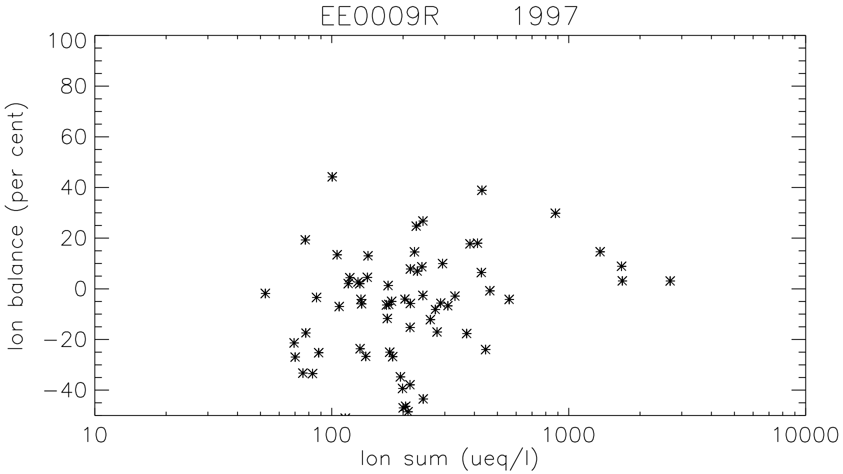
8
9
pH units


EE0009R 1997
Ion balance (per cent)
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−40
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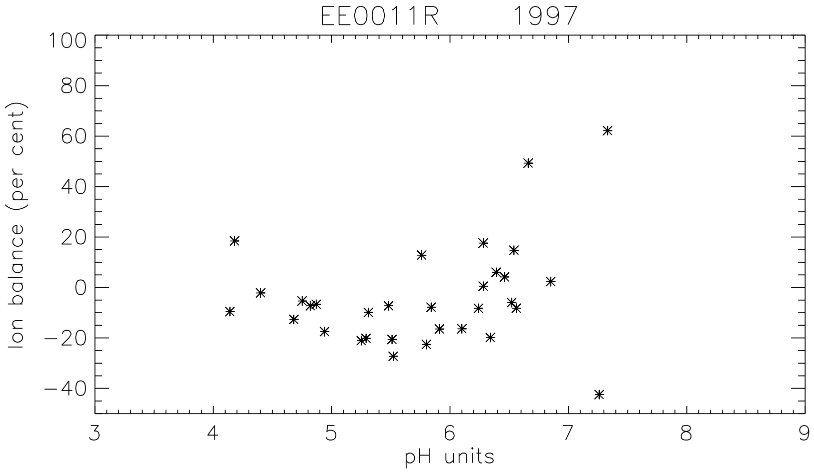
100
1000
10000
Ion sum (ueq/l)


EE0011R 1997
Ion balance (per cent)
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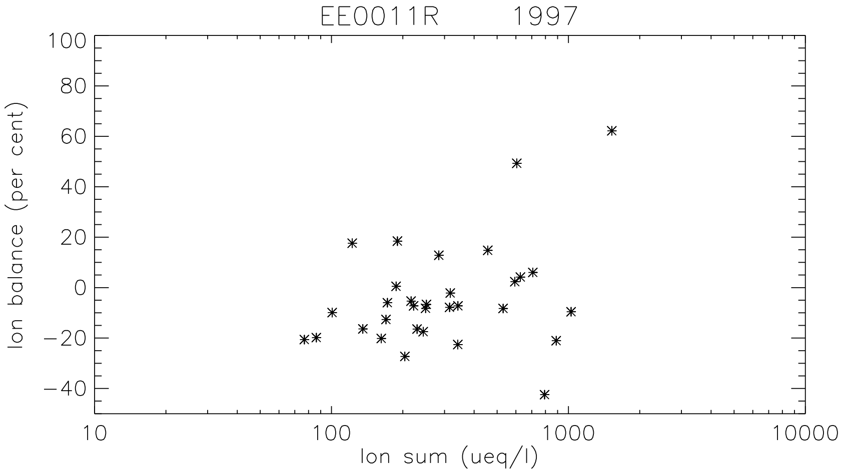
pH units


EE0011R 1997
Ion balance (per cent)
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−40
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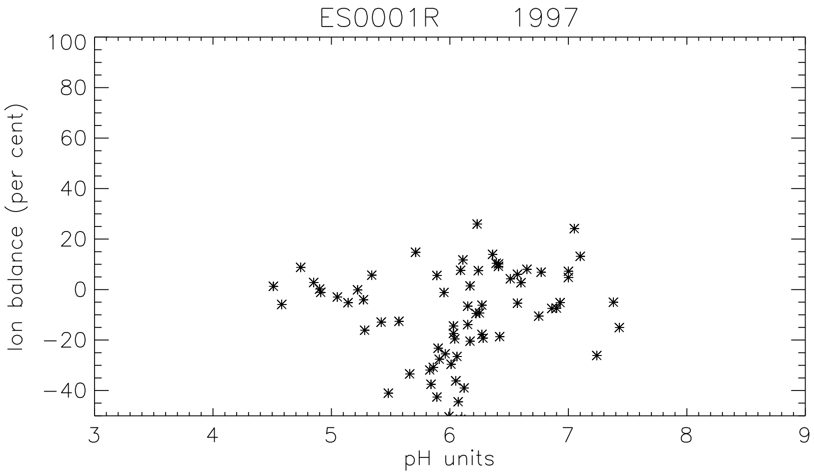
100
1000
10000
Ion sum (ueq/l)


ES0001R 1997
Ion balance (per cent)
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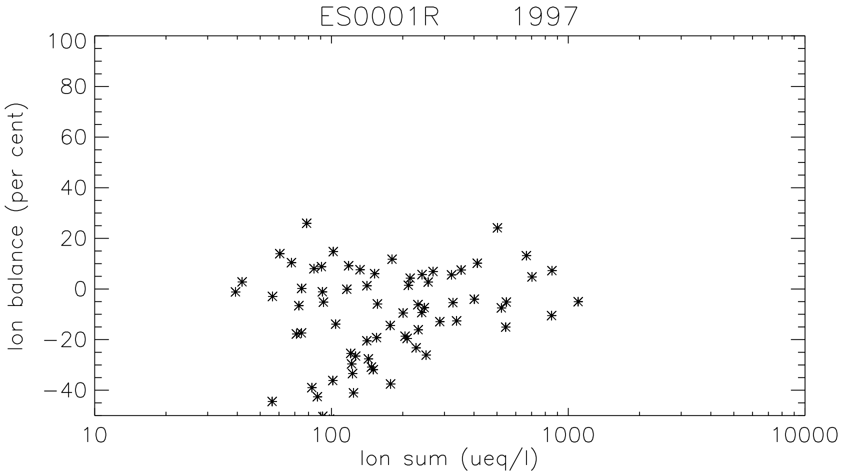
pH units


ES0001R 1997
Ion balance (per cent)
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−20
−40
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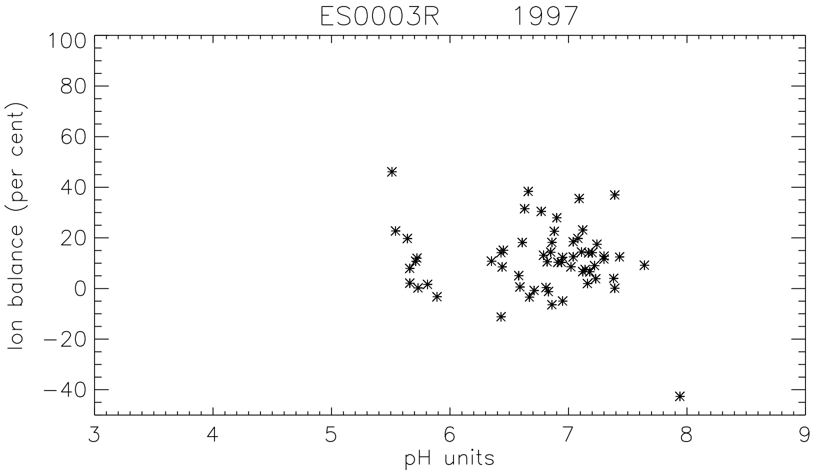
100
1000
10000
Ion sum (ueq/l)


ES0003R 1997
Ion balance (per cent)
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0
−20
−40
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8
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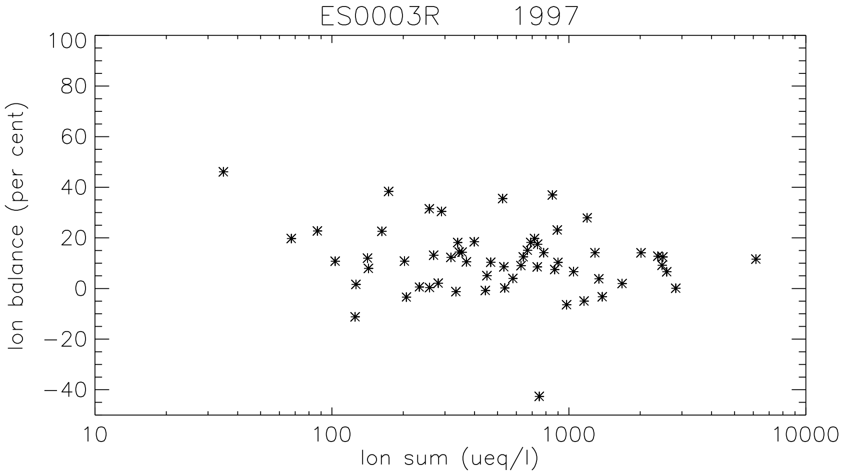
pH units


ES0003R 1997
Ion balance (per cent)
100
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−20
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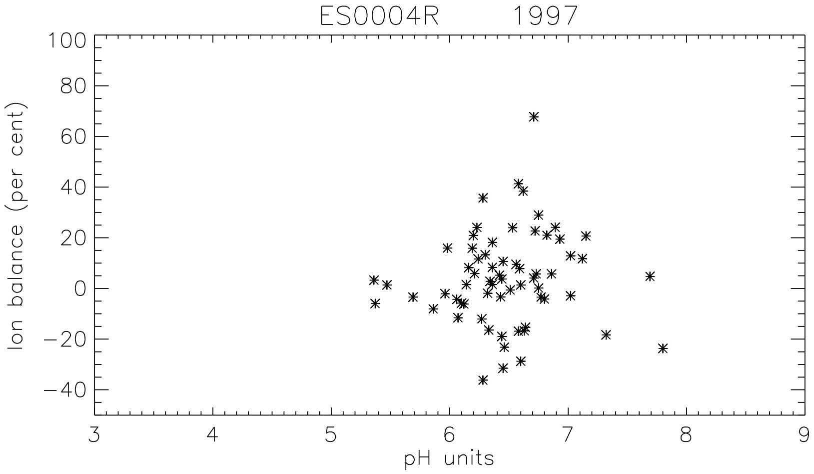
100
1000
10000
Ion sum (ueq/l)


ES0004R 1997
Ion balance (per cent)
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80
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0
−20
−40
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8
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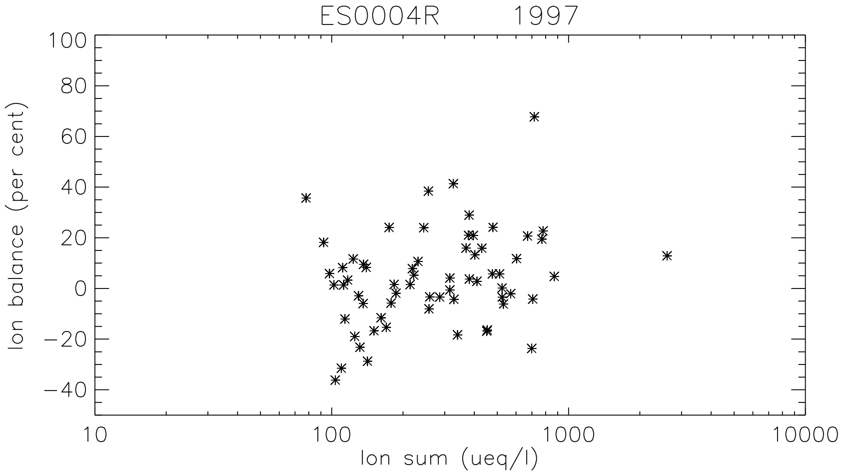
pH units


ES0004R 1997
Ion balance (per cent)
100
80
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0
−20
−40
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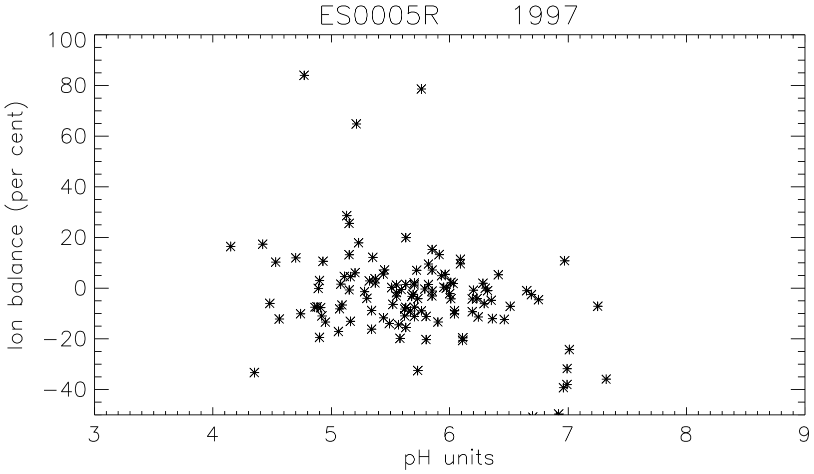
100
1000
10000
Ion sum (ueq/l)


ES0005R 1997
Ion balance (per cent)
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80
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0
−20
−40
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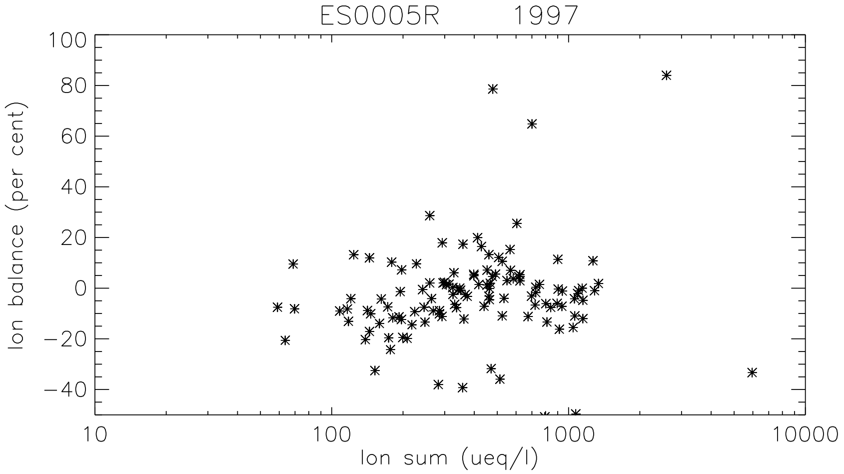
pH units


ES0005R 1997
Ion balance (per cent)
100
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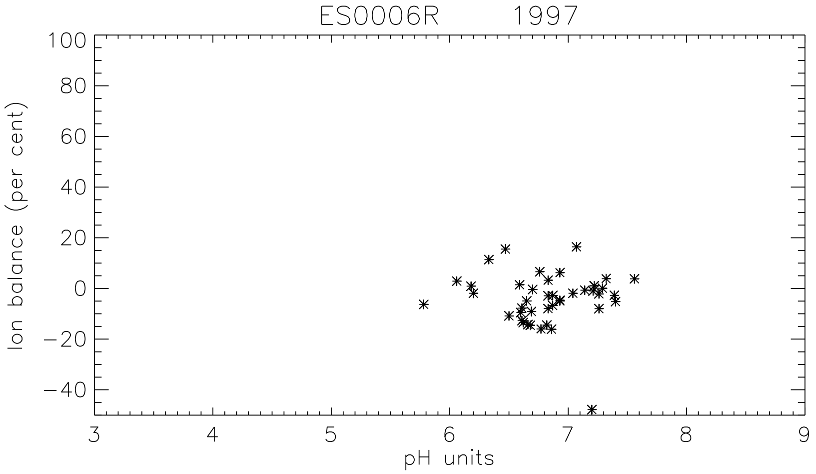
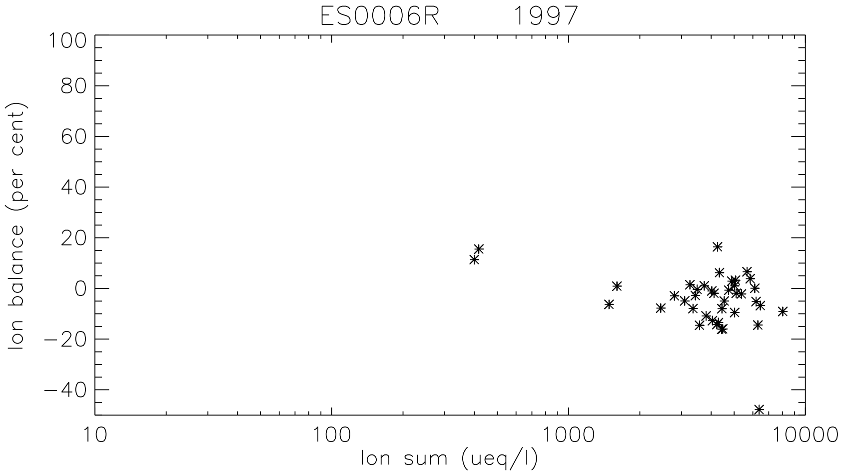
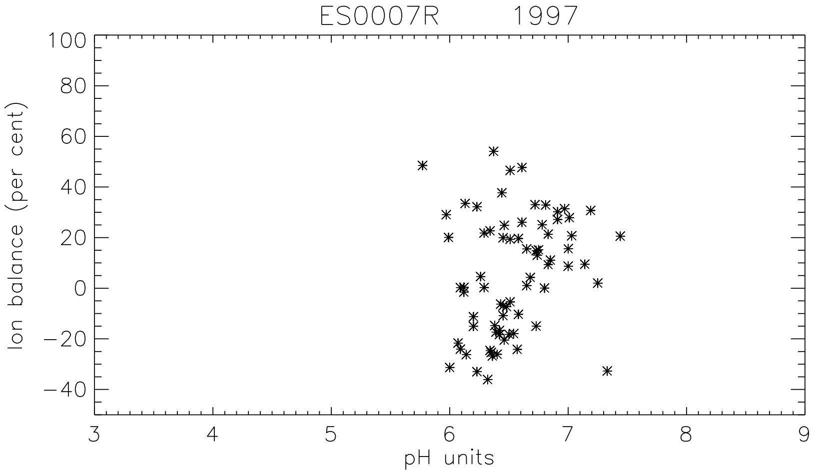
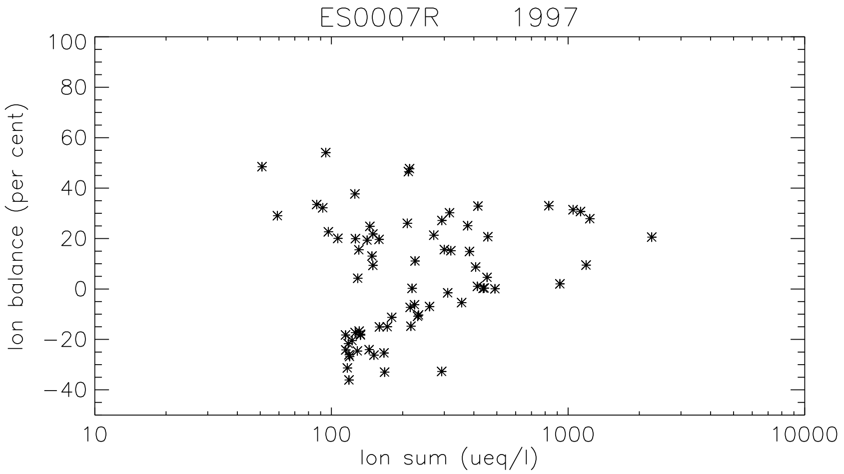
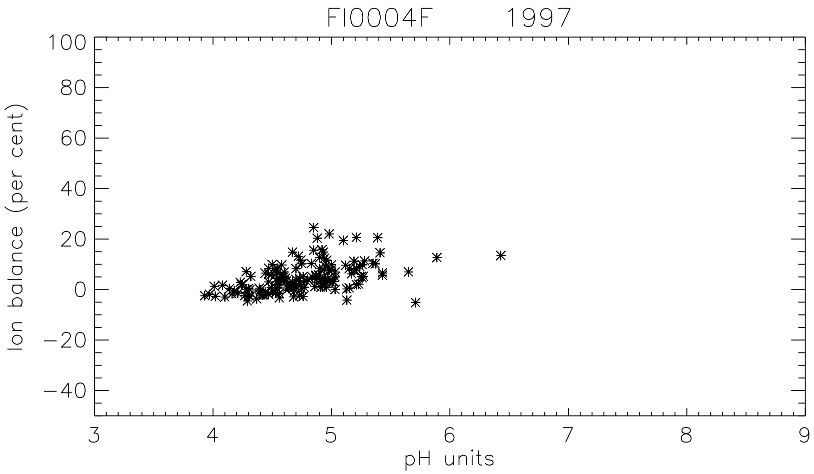
100
1000
10000
Ion sum (ueq/l)


ES0006R 1997


ES0006R 1997


ES0007R 1997


ES0007R 1997


FI0004F 1997
Ion balance (per cent)
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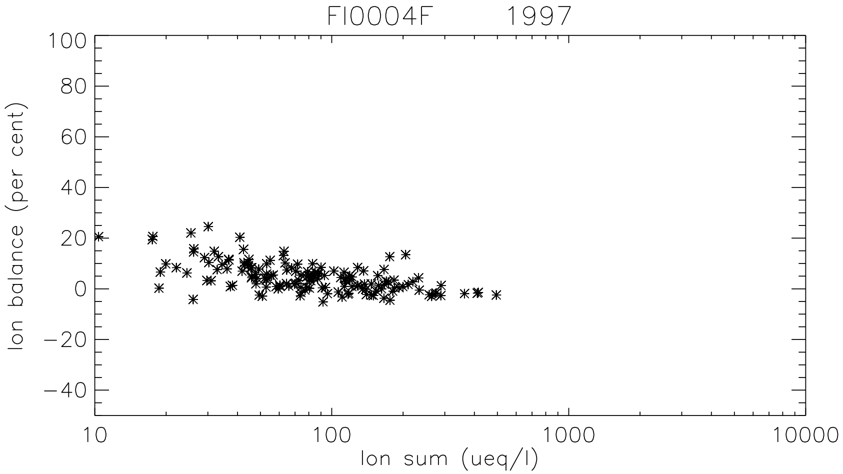
80
60
40
20
0
−20
−40
3
4
5
6
7
8
9
pH units


FI0004F 1997
Ion balance (per cent)
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−40
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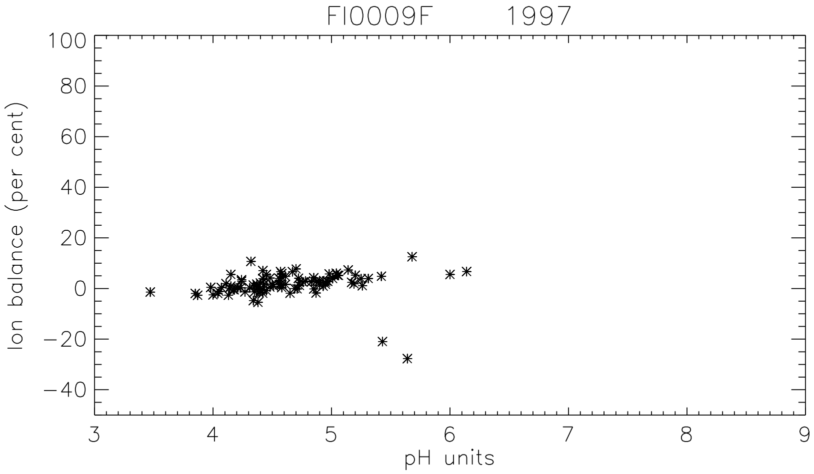
100
1000
10000
Ion sum (ueq/l)


FI0009F 1997
Ion balance (per cent)
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0
−20
−40
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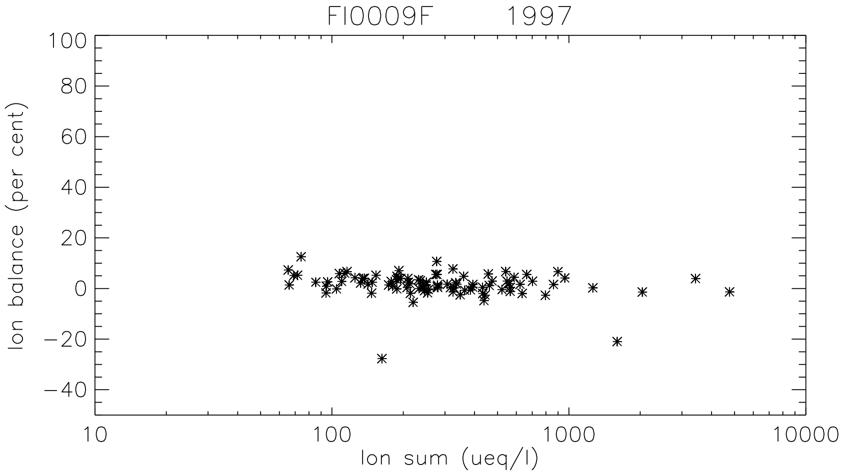
4
5
6
7
8
9
pH units


FI0009F 1997
Ion balance (per cent)
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20
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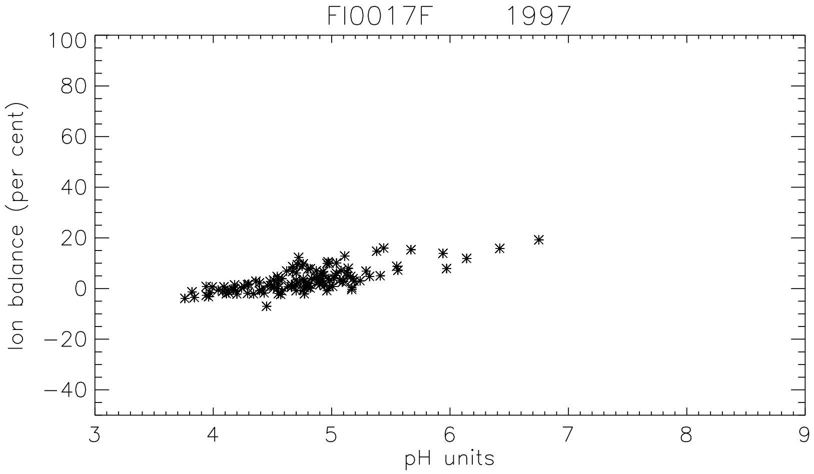
−20
−40
10
100
1000
10000
Ion sum (ueq/l)


FI0017F 1997
Ion balance (per cent)
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−40
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4
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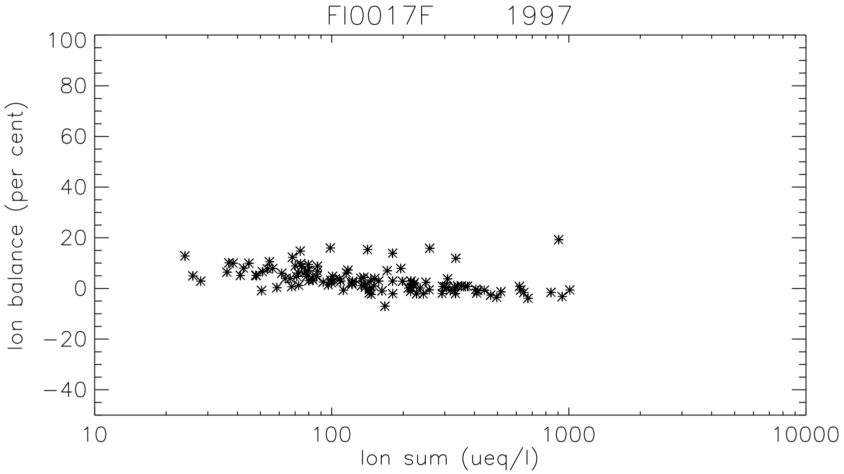
6
7
8
9
pH units


FI0017F 1997
Ion balance (per cent)
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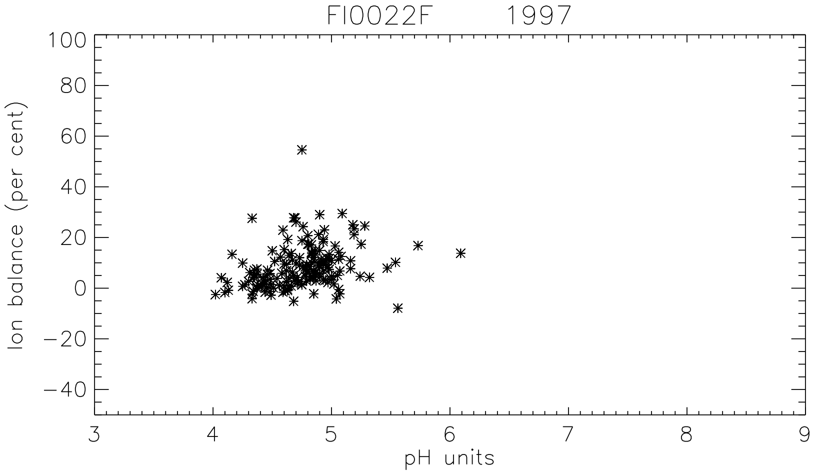
100
1000
10000
Ion sum (ueq/l)


FI0022F 1997
Ion balance (per cent)
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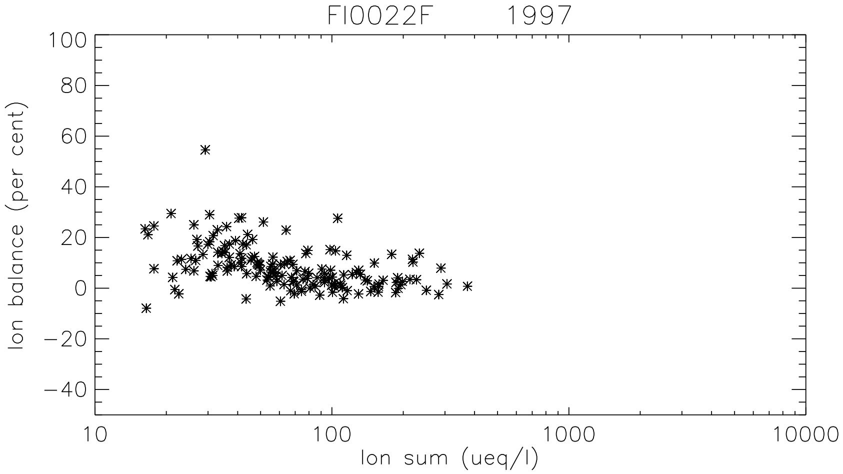
7
8
9
pH units


FI0022F 1997
Ion balance (per cent)
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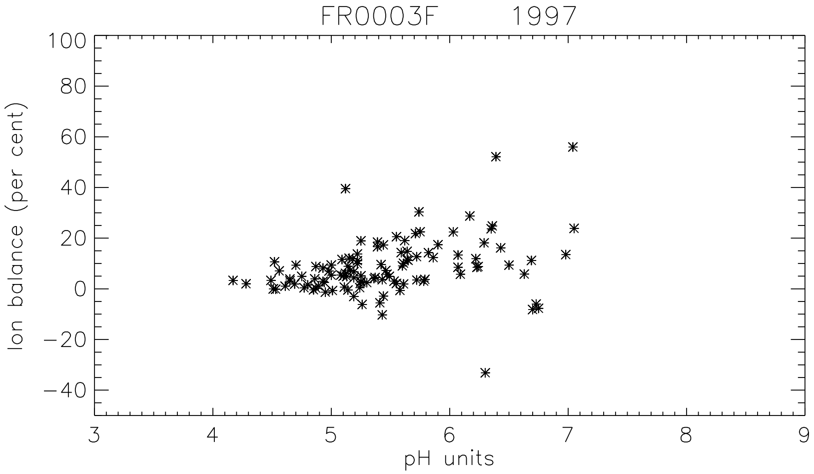
1000
10000
Ion sum (ueq/l)


FR0003F 1997
Ion balance (per cent)
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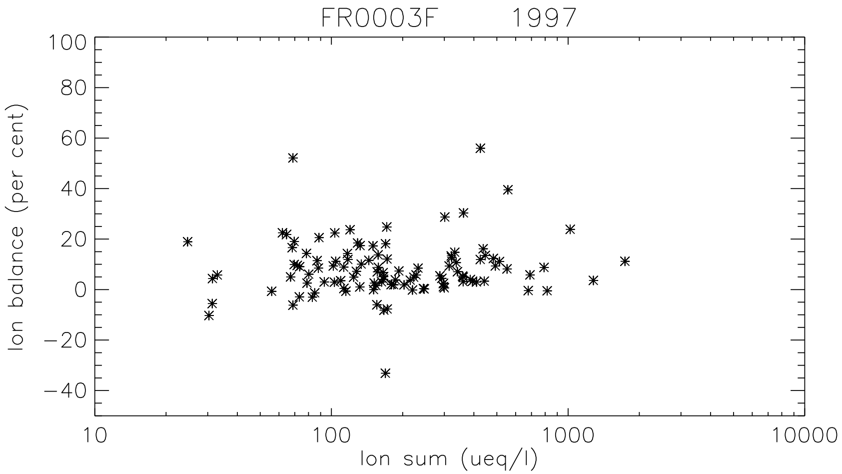
pH units


FR0003F 1997
Ion balance (per cent)
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100
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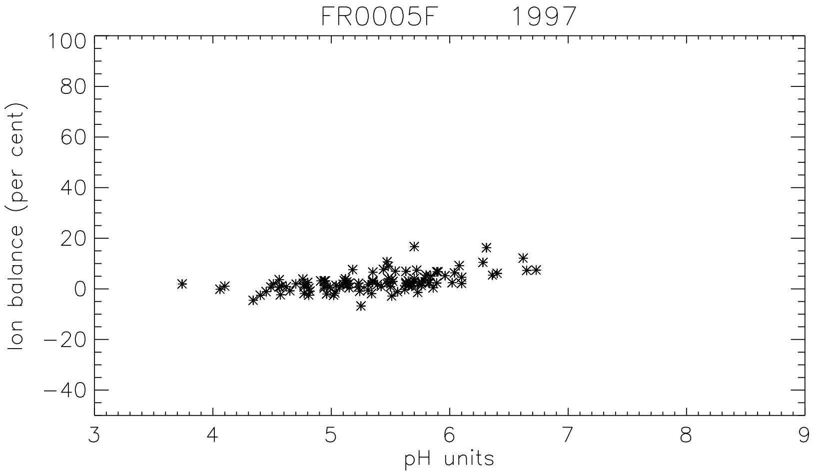
Ion sum (ueq/l)


FR0005F 1997
Ion balance (per cent)
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8
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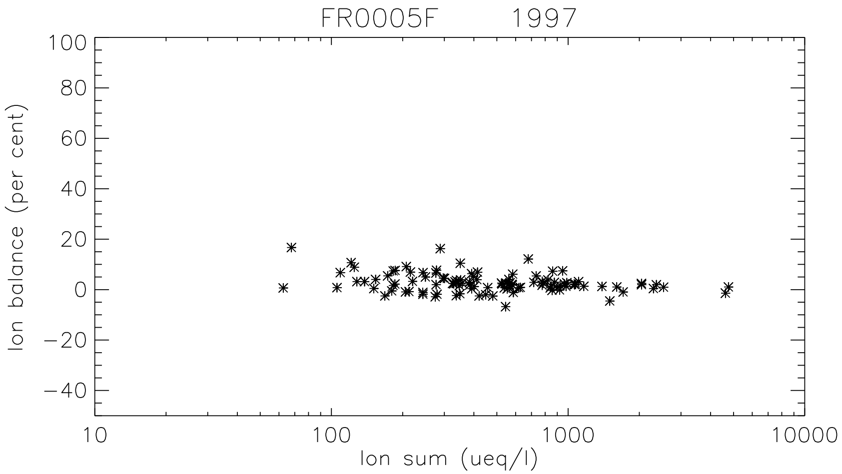
pH units


FR0005F 1997
Ion balance (per cent)
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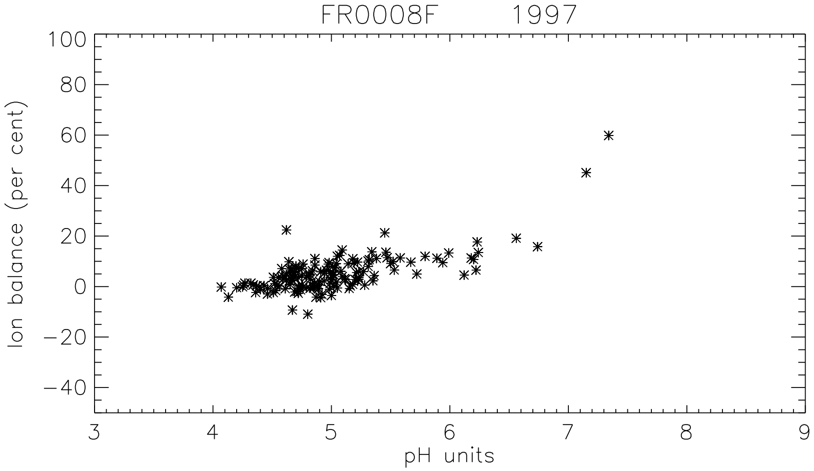
1000
10000
Ion sum (ueq/l)


FR0008F 1997
Ion balance (per cent)
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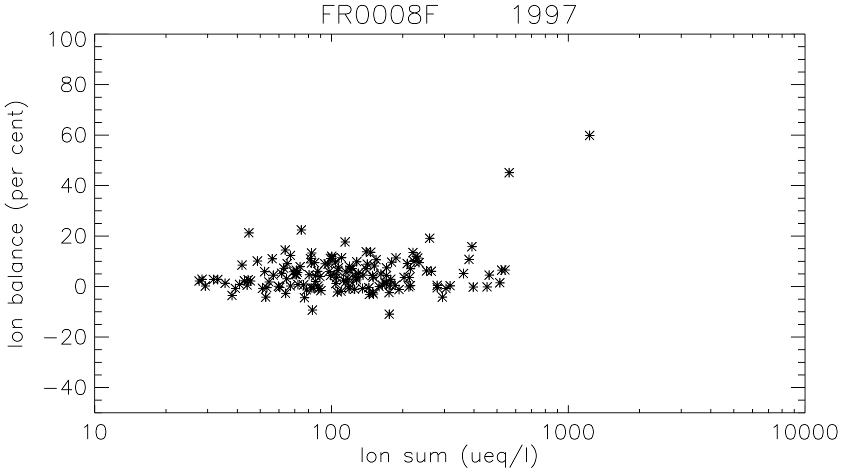
pH units


FR0008F 1997
Ion balance (per cent)
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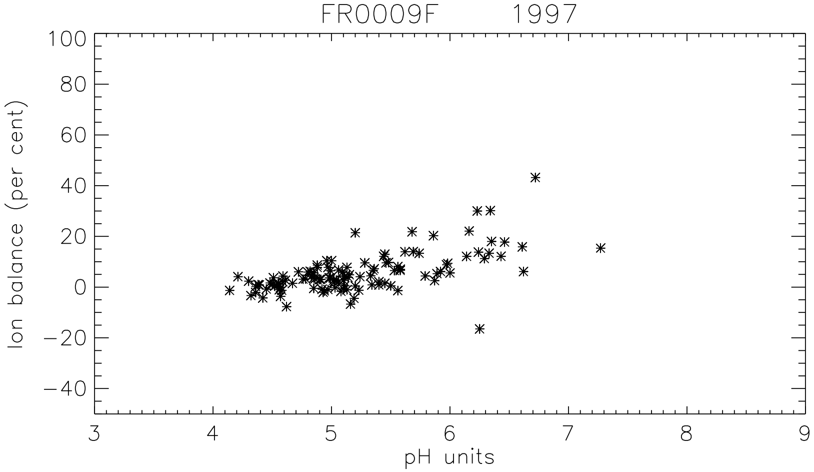
1000
10000
Ion sum (ueq/l)


FR0009F 1997
Ion balance (per cent)
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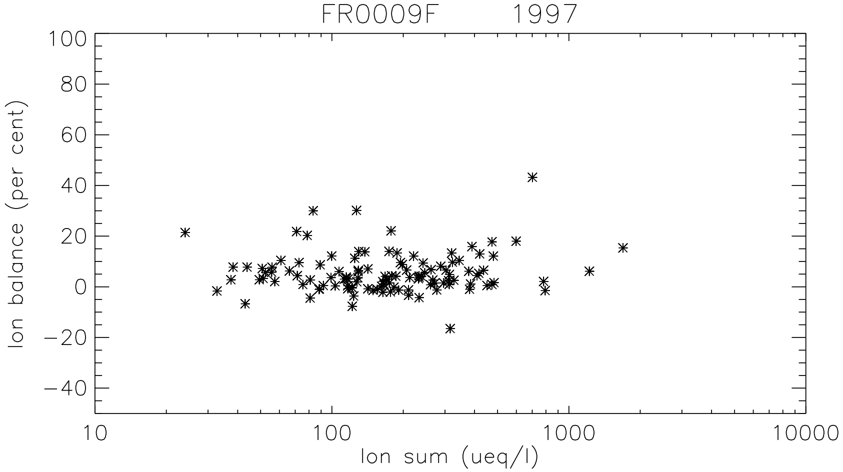
pH units


FR0009F 1997
Ion balance (per cent)
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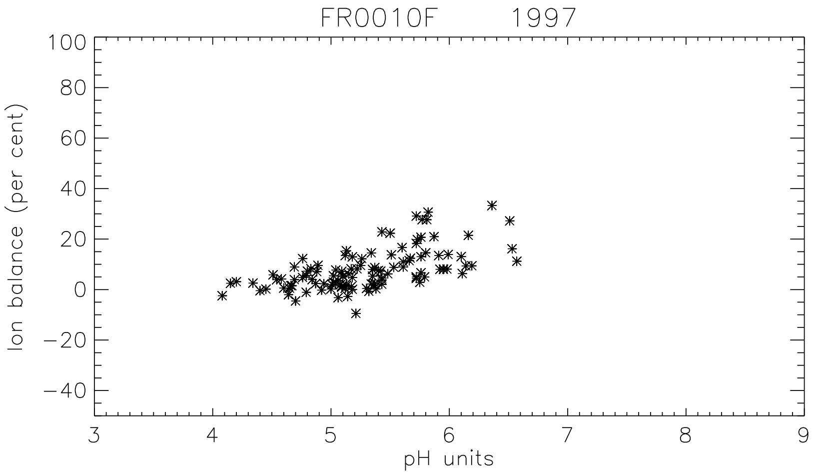
100
1000
10000
Ion sum (ueq/l)


FR0010F 1997
Ion balance (per cent)
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8
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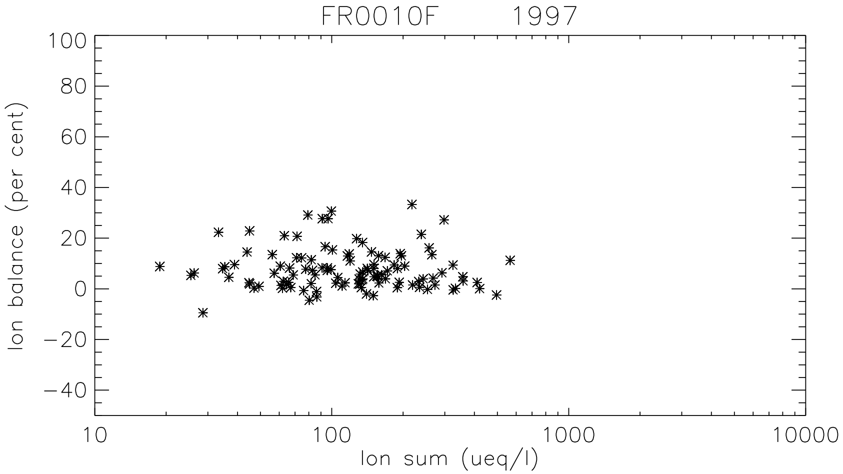
pH units


FR0010F 1997
Ion balance (per cent)
100
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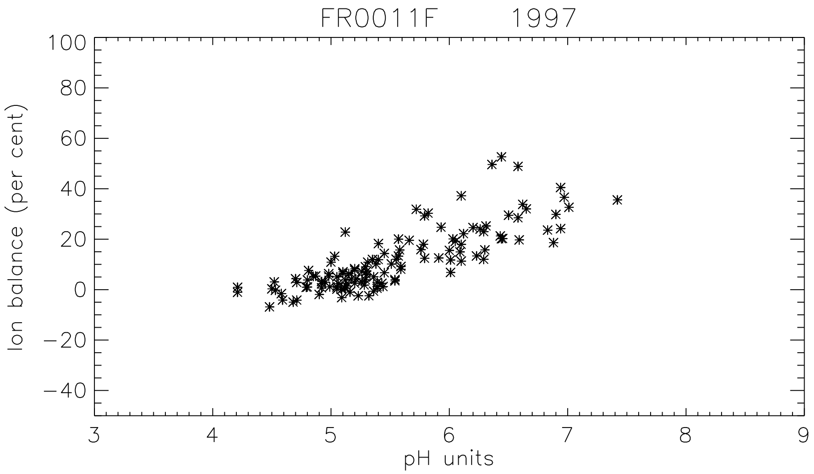
−20
−40
10
100
1000
10000
Ion sum (ueq/l)


FR0011F 1997
Ion balance (per cent)
100
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0
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−40
3
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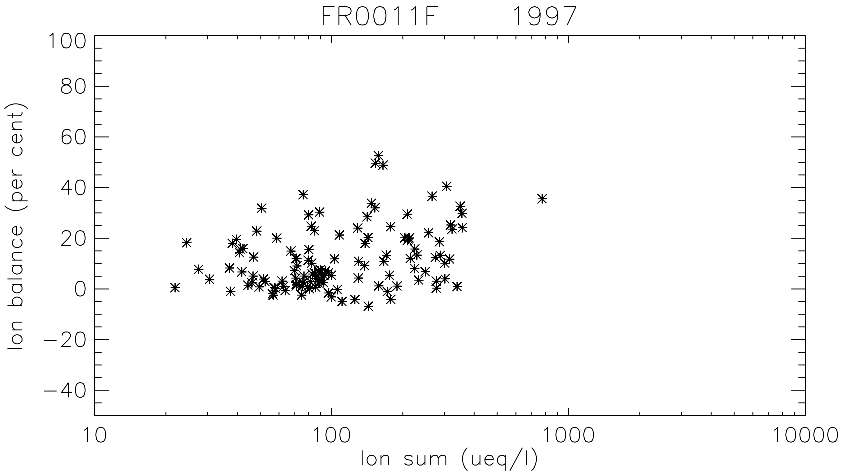
6
7
8
9
pH units


FR0011F 1997
Ion balance (per cent)
100
80
60
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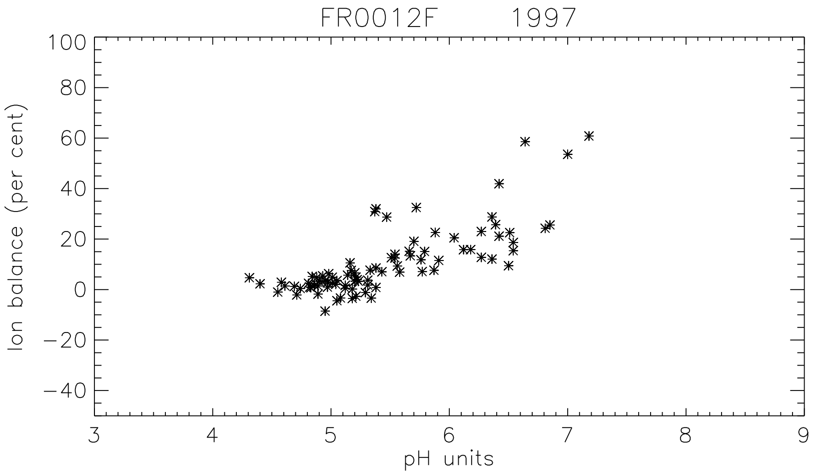
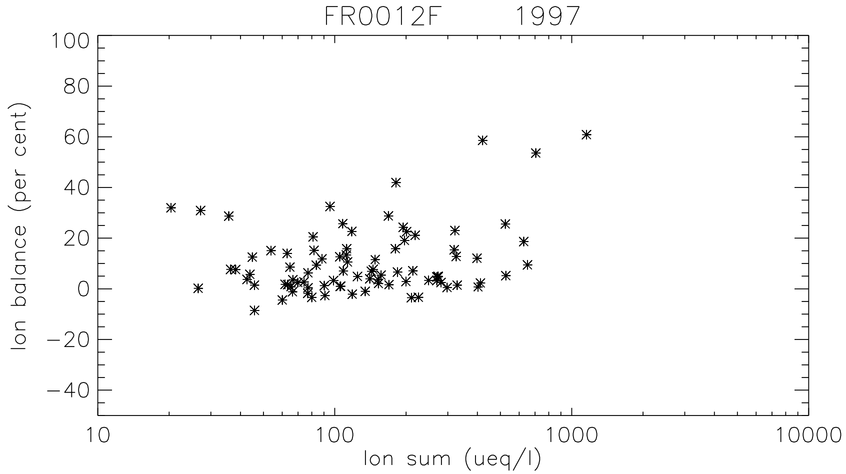
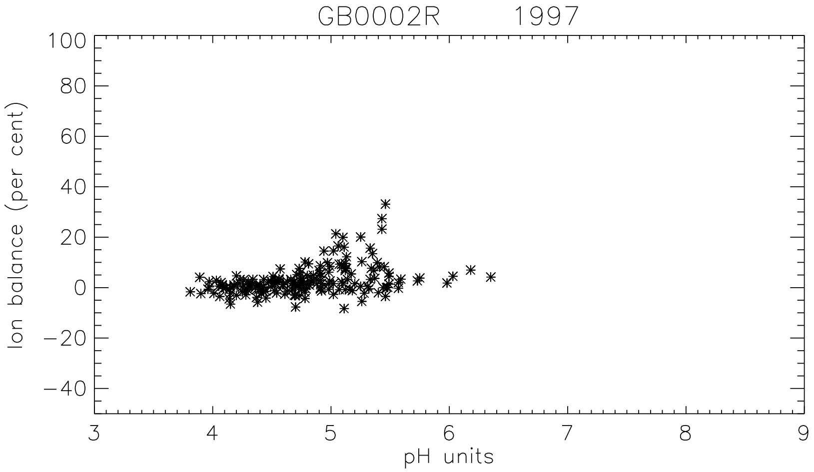
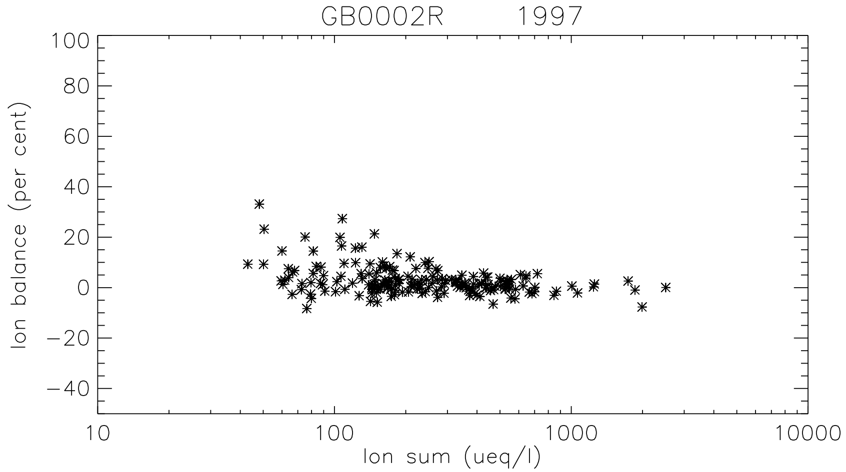
20
0
−20
−40
10
100
1000
10000
Ion sum (ueq/l)


FR0012F 1997
Ion balance (per cent)
100
80
60
40
20
0
−20
−40
3
4
5
6
7
8
9
pH units


FR0012F 1997
Ion balance (per cent)
100
80
60
40
20
0
−20
−40
10
100
1000
10000
Ion sum (ueq/l)


GB0002R 1997
Ion balance (per cent)
100
80
60
40
20
0
−20
−40
3
4
5
6
7
8
9
pH units


GB0002R 1997
Ion balance (per cent)
100
80
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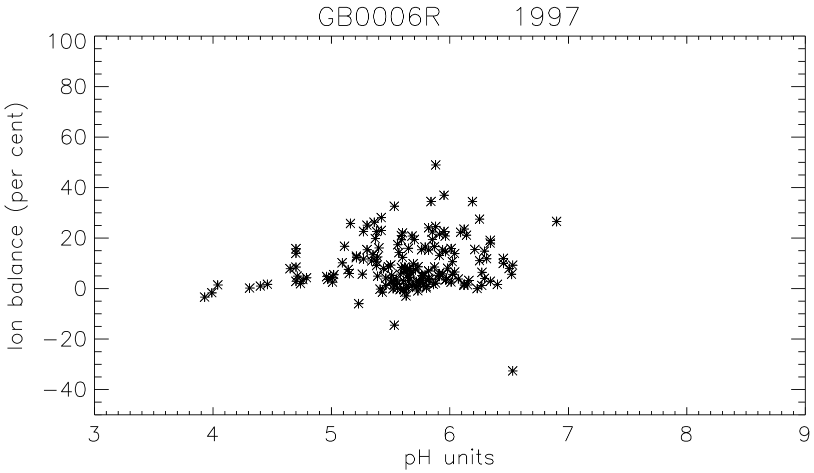
20
0
−20
−40
10
100
1000
10000
Ion sum (ueq/l)


GB0006R 1997
Ion balance (per cent)
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80
60
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0
−20
−40
3
4
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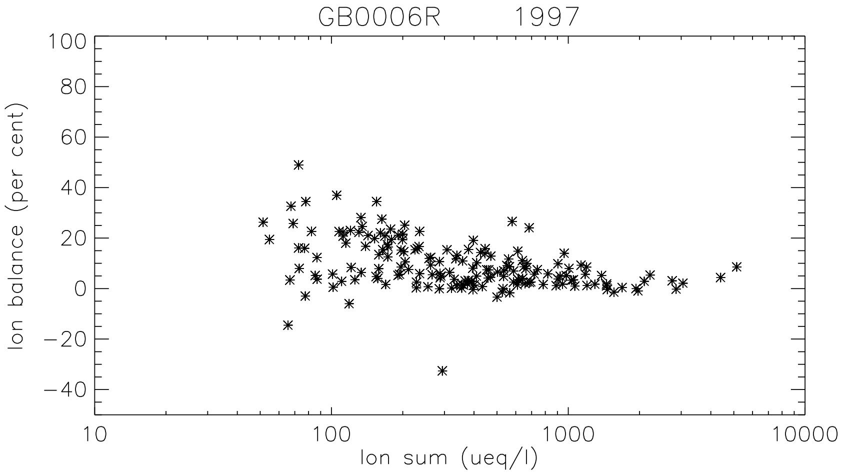
7
8
9
pH units


GB0006R 1997
Ion balance (per cent)
100
80
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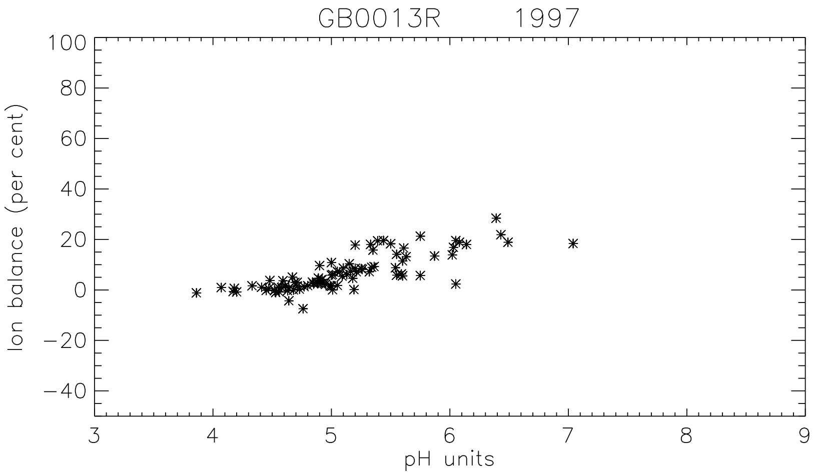
40
20
0
−20
−40
10
100
1000
10000
Ion sum (ueq/l)


GB0013R 1997
Ion balance (per cent)
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80
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20
0
−20
−40
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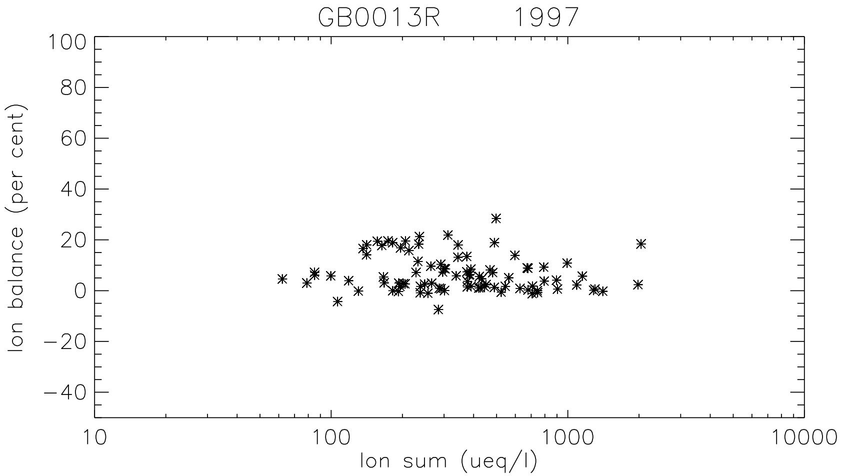
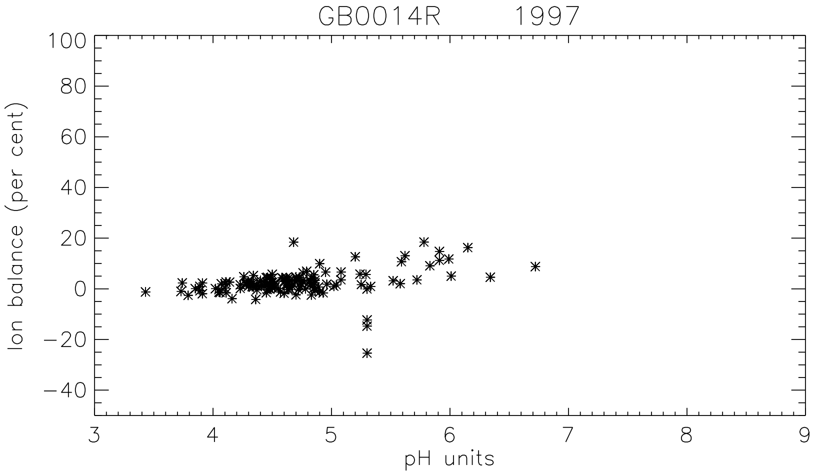
4
5
6
7
8
9
pH units


GB0013R 1997
Ion balance (per cent)
100
80
60
40
20
0
−20
−40
10
100
1000
10000
Ion sum (ueq/l)


GB0014R 1997
Ion balance (per cent)
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60
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0
−20
−40
3
4
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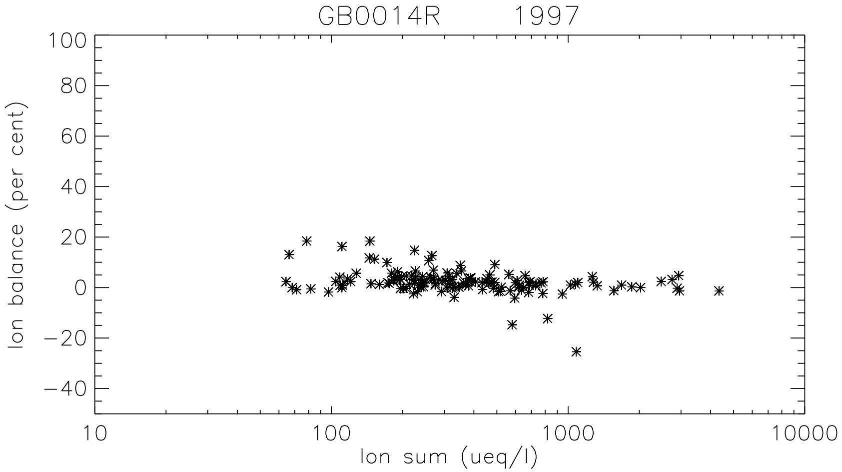
7
8
9
pH units


GB0014R 1997
Ion balance (per cent)
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40
20
0
−20
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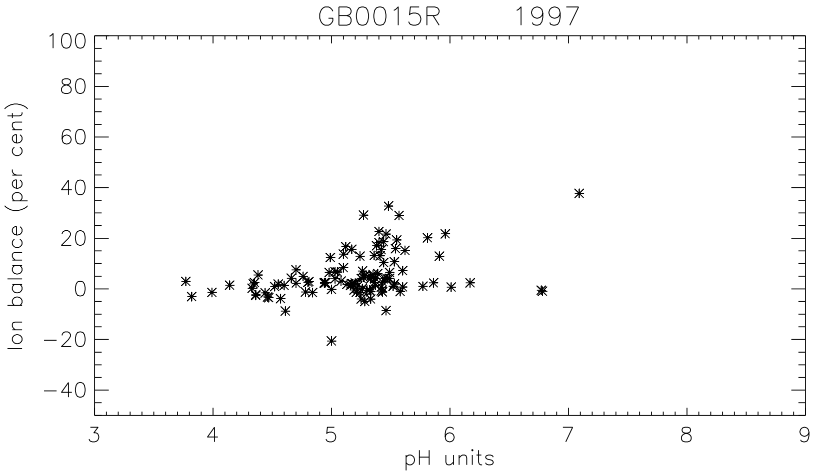
10
100
1000
10000
Ion sum (ueq/l)


GB0015R 1997
Ion balance (per cent)
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0
−20
−40
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4
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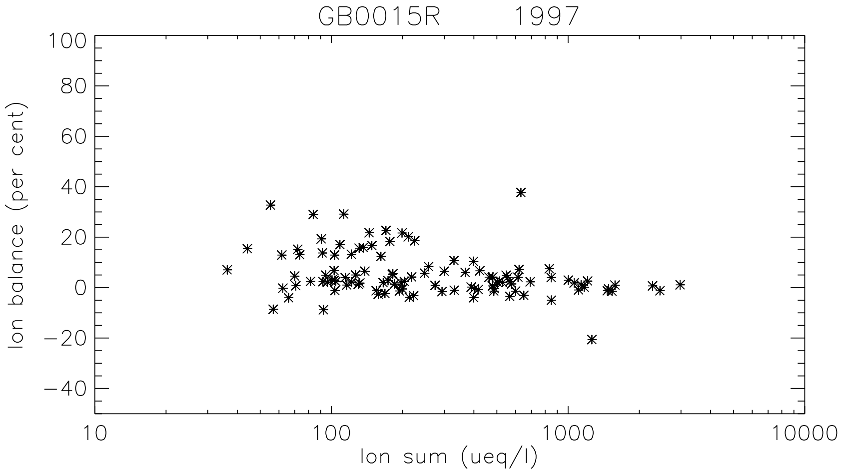
6
7
8
9
pH units


GB0015R 1997
Ion balance (per cent)
100
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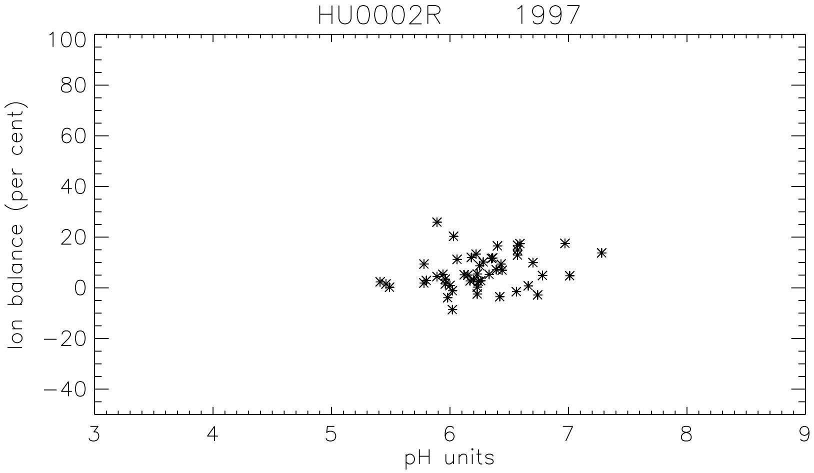
40
20
0
−20
−40
10
100
1000
10000
Ion sum (ueq/l)


HU0002R 1997
Ion balance (per cent)
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80
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40
20
0
−20
−40
3
4
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6
7
8
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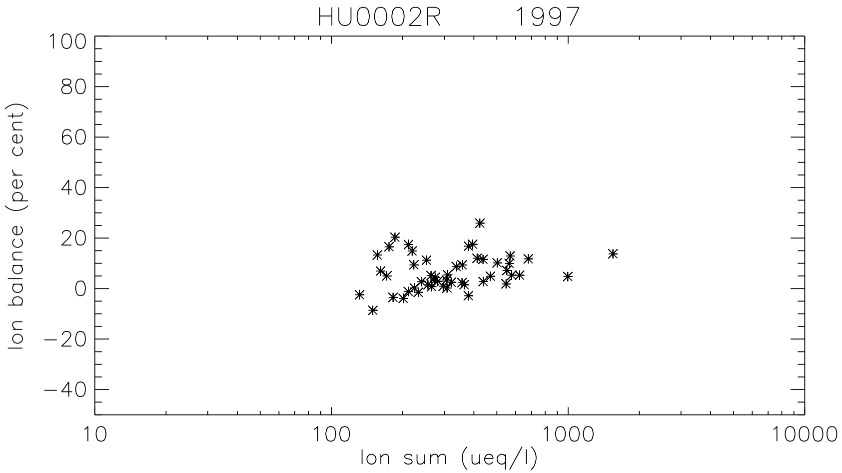
pH units


HU0002R 1997
Ion balance (per cent)
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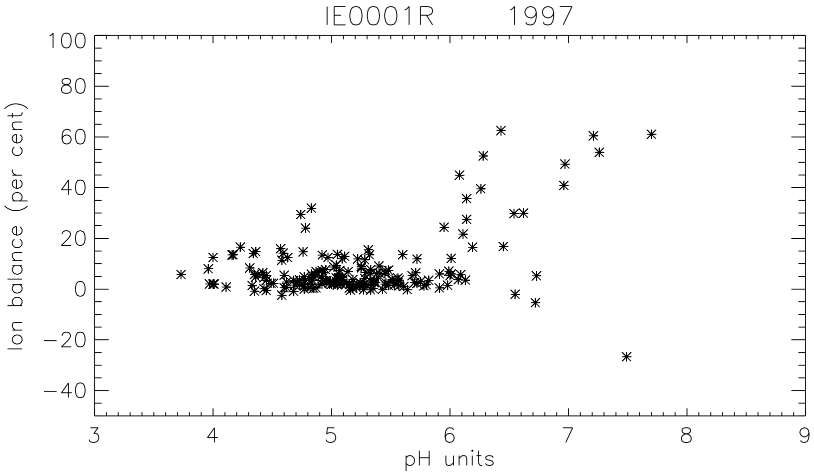
40
20
0
−20
−40
10
100
1000
10000
Ion sum (ueq/l)


IE0001R 1997
Ion balance (per cent)
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80
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40
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0
−20
−40
3
4
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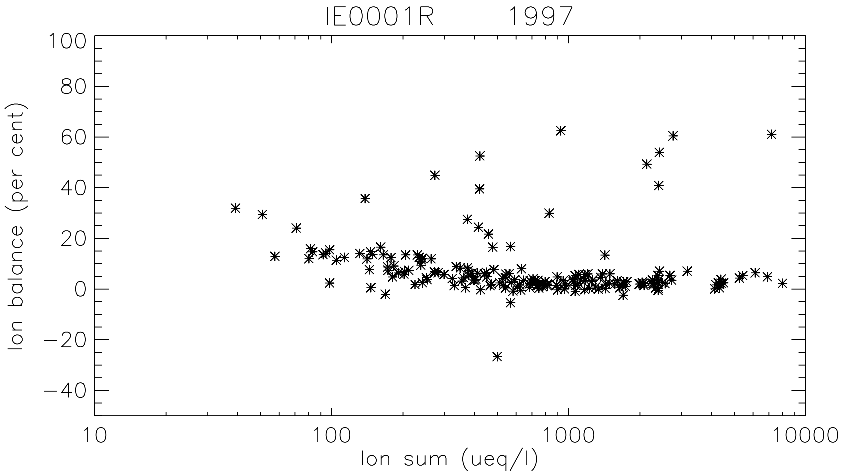
6
7
8
9
pH units


IE0001R 1997
Ion balance (per cent)
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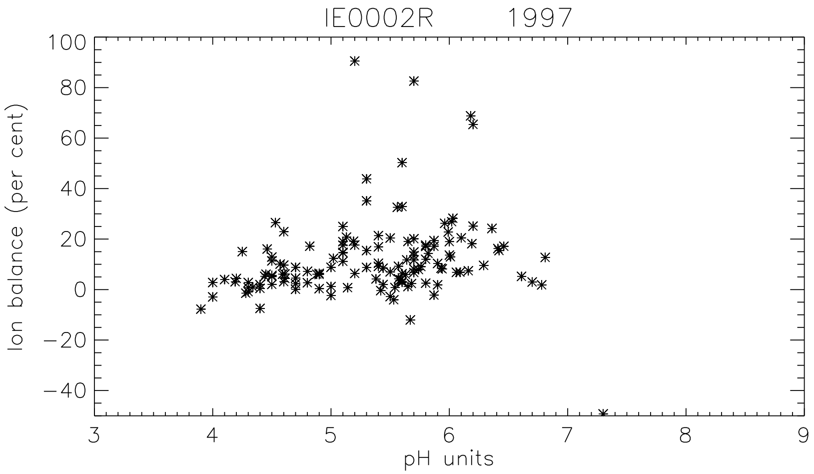
100
1000
10000
Ion sum (ueq/l)


IE0002R 1997
Ion balance (per cent)
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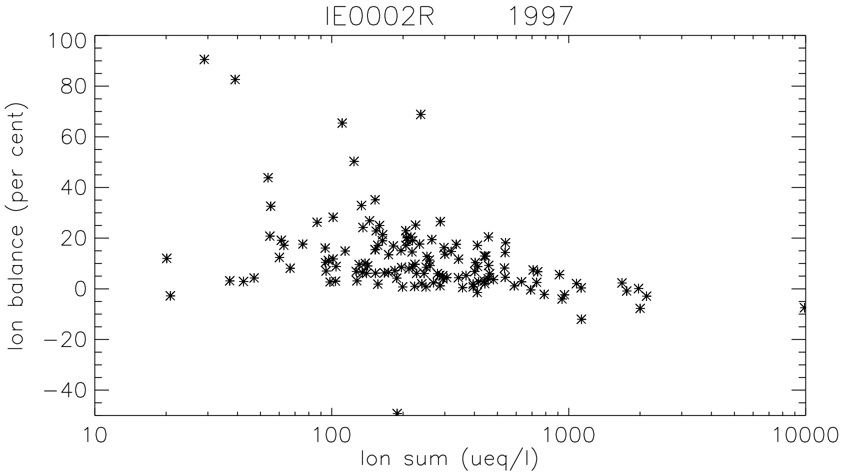
pH units


IE0002R 1997
Ion balance (per cent)
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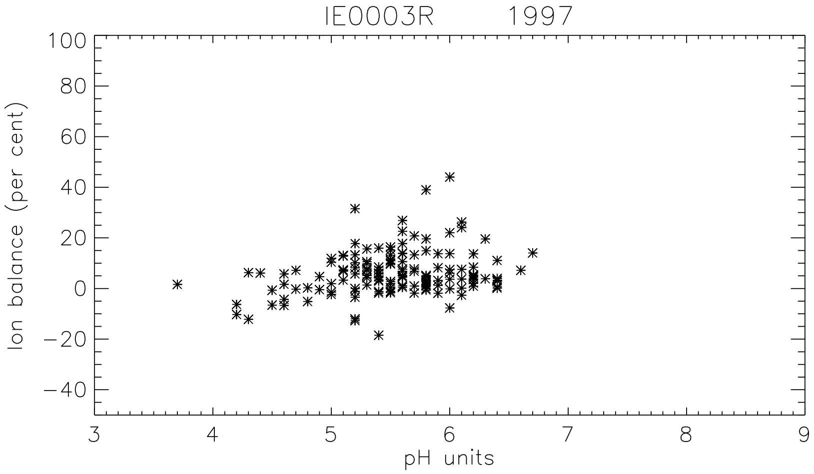
100
1000
10000
Ion sum (ueq/l)


IE0003R 1997
Ion balance (per cent)
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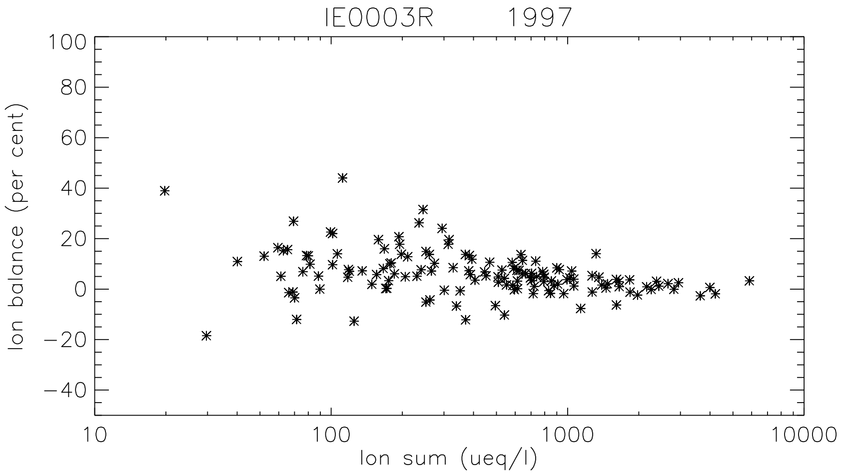
9
pH units


IE0003R 1997
Ion balance (per cent)
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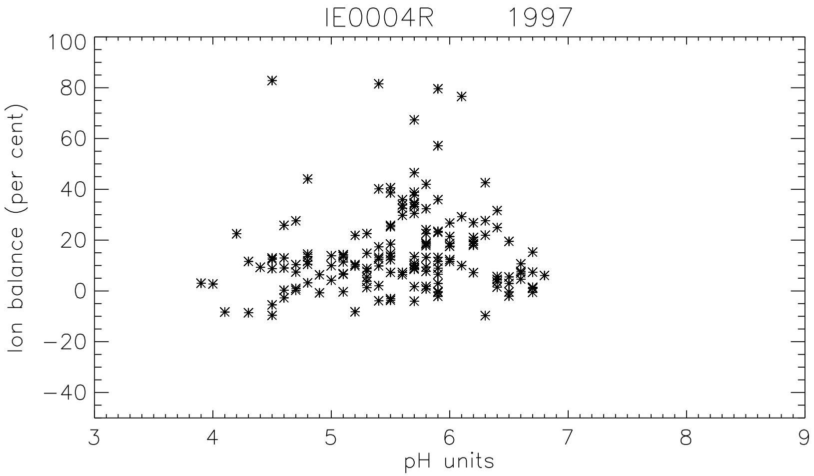
100
1000
10000
Ion sum (ueq/l)


IE0004R 1997
Ion balance (per cent)
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80
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−20
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4
5
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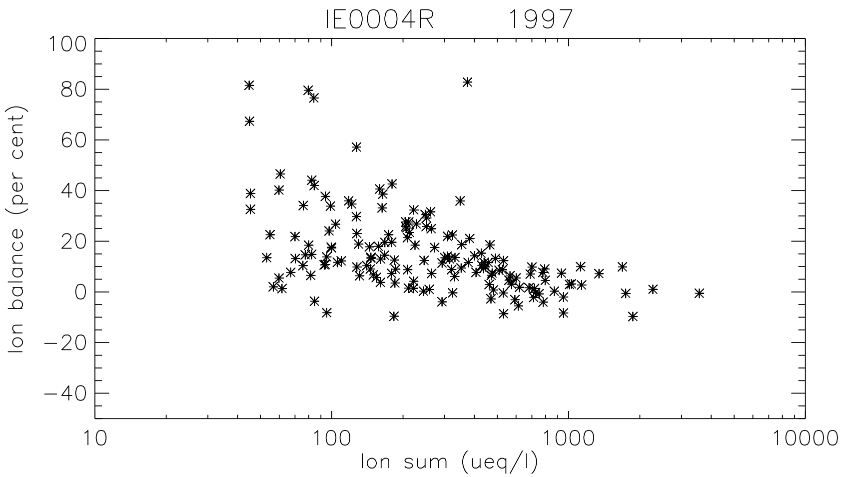
7
8
9
pH units


IE0004R 1997
Ion balance (per cent)
100
80
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20
0
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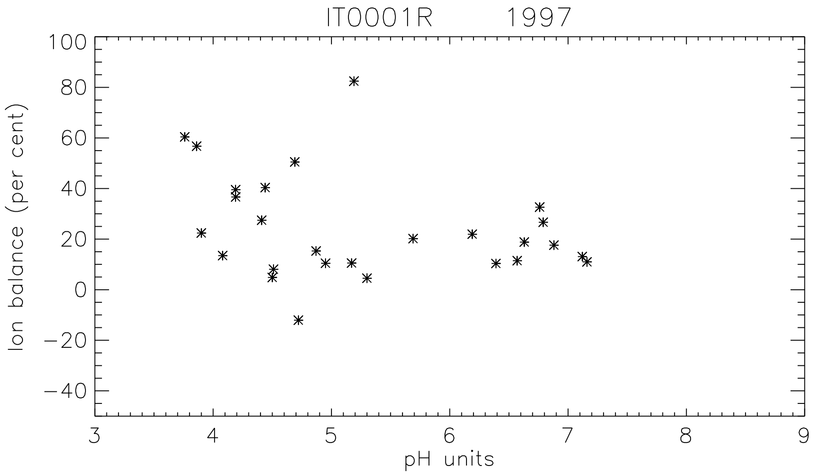
−40
10
100
1000
10000
Ion sum (ueq/l)


IT0001R 1997
Ion balance (per cent)
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0
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4
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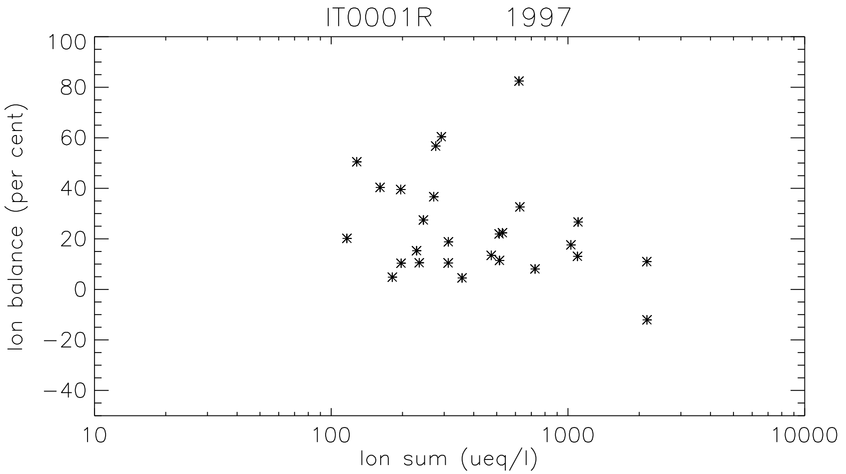
8
9
pH units


IT0001R 1997
Ion balance (per cent)
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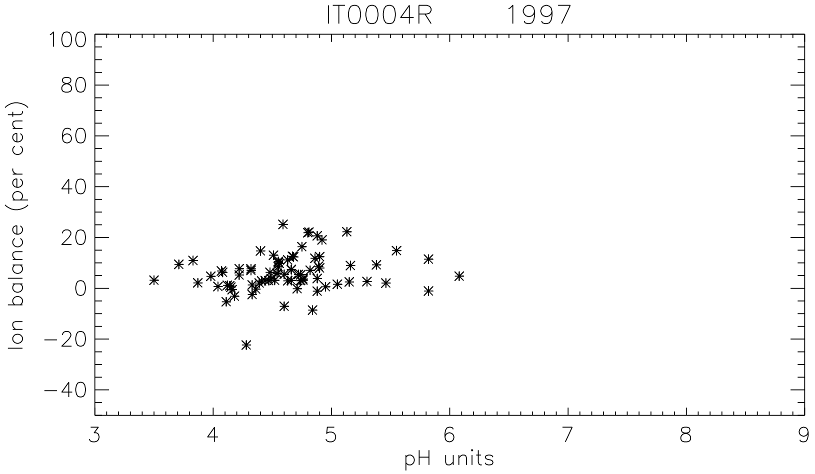
40
20
0
−20
−40
10
100
1000
10000
Ion sum (ueq/l)


IT0004R 1997
Ion balance (per cent)
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0
−20
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3
4
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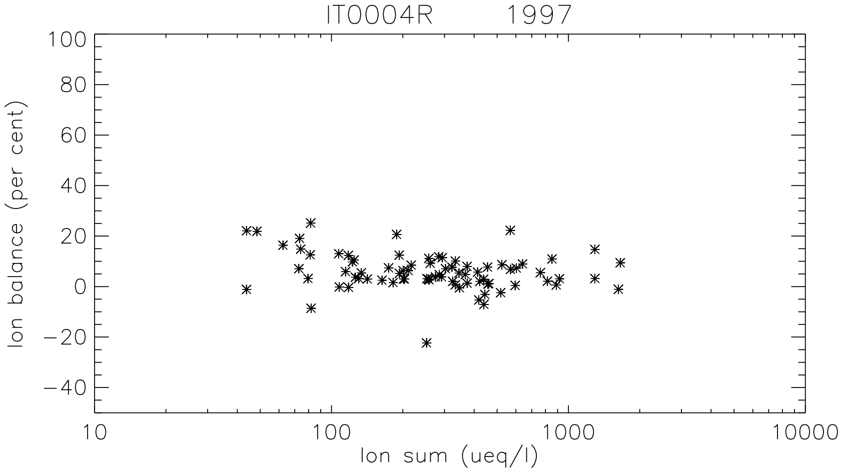
7
8
9
pH units


IT0004R 1997
Ion balance (per cent)
100
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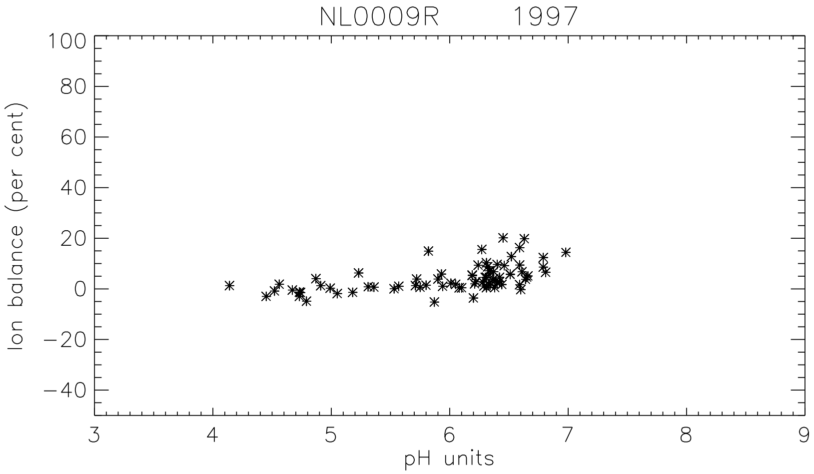
20
0
−20
−40
10
100
1000
10000
Ion sum (ueq/l)


NL0009R 1997
Ion balance (per cent)
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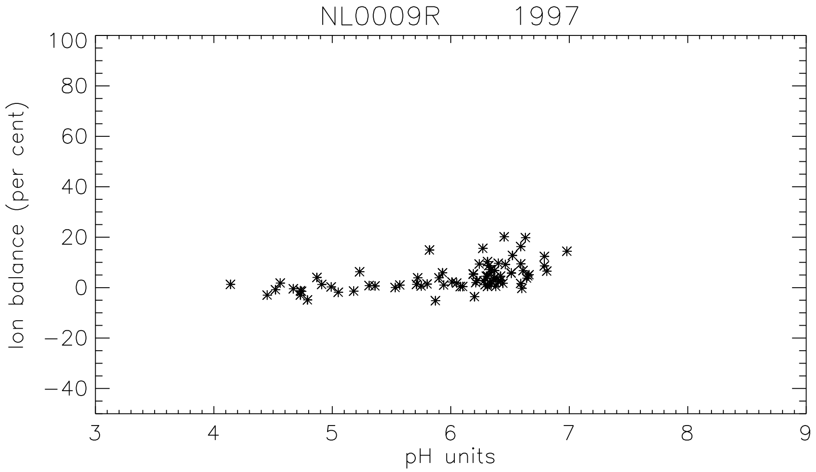
7
8
9
pH units


NL0009R 1997
Ion balance (per cent)
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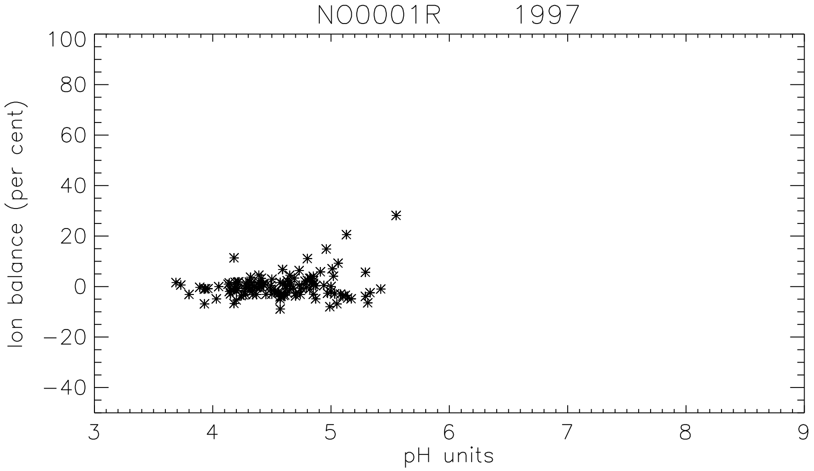
4
5
6
7
8
9
pH units


NO0001R 1997
Ion balance (per cent)
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−20
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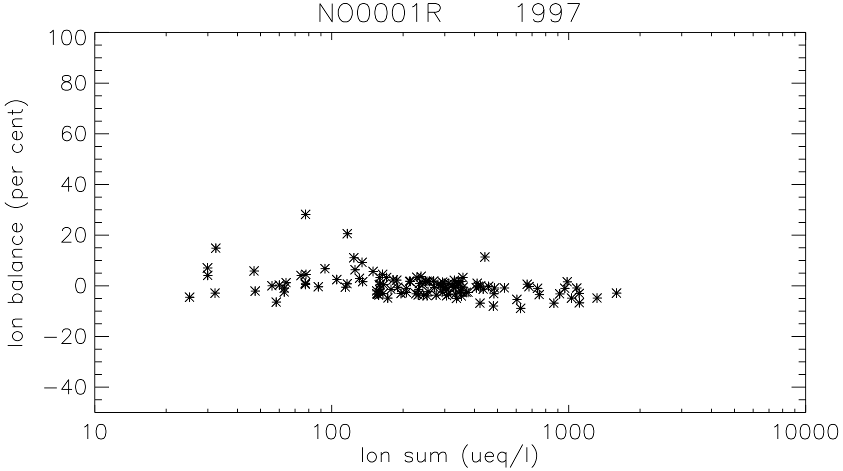
3
4
5
6
7
8
9
pH units


NO0001R 1997
Ion balance (per cent)
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−20
−40
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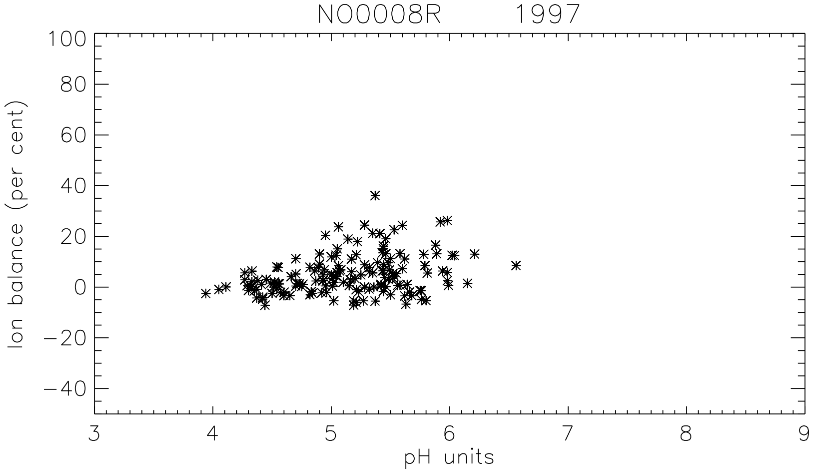
100
1000
10000
Ion sum (ueq/l)


NO0008R 1997
Ion balance (per cent)
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4
5
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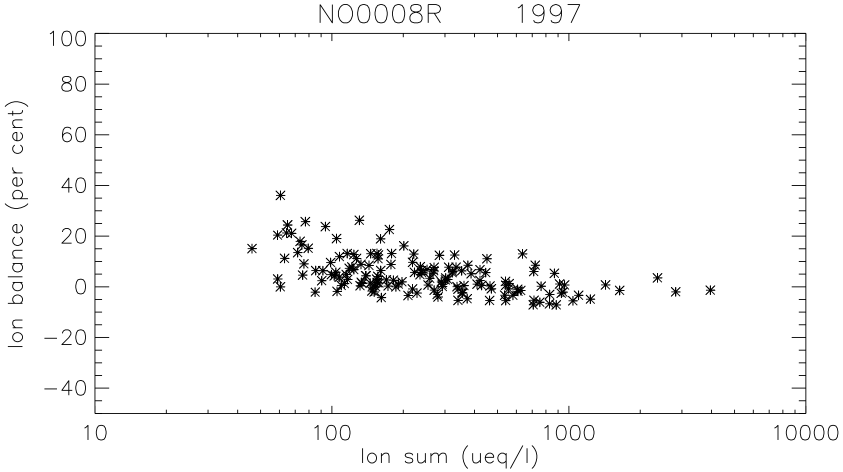
8
9
pH units


NO0008R 1997
Ion balance (per cent)
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−20
−40
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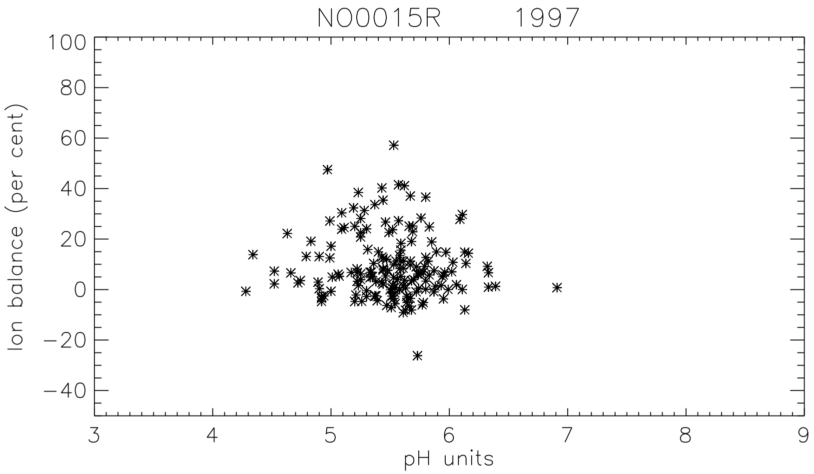
100
1000
10000
Ion sum (ueq/l)


NO0015R 1997
Ion balance (per cent)
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−20
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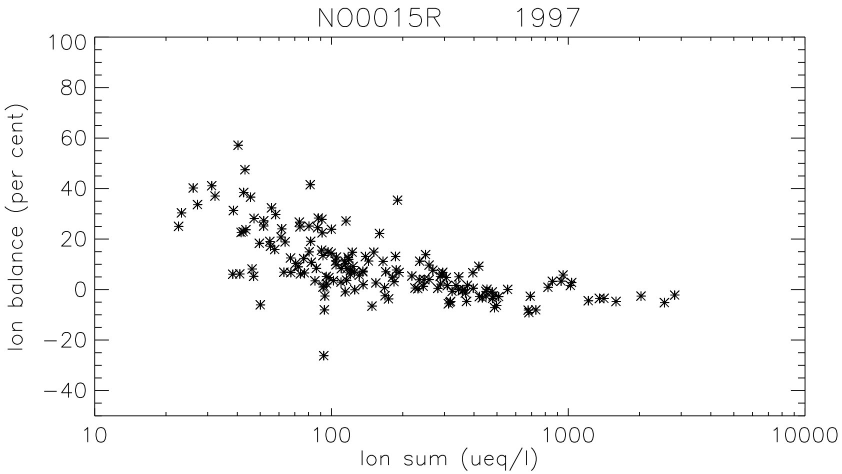
4
5
6
7
8
9
pH units


NO0015R 1997
Ion balance (per cent)
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20
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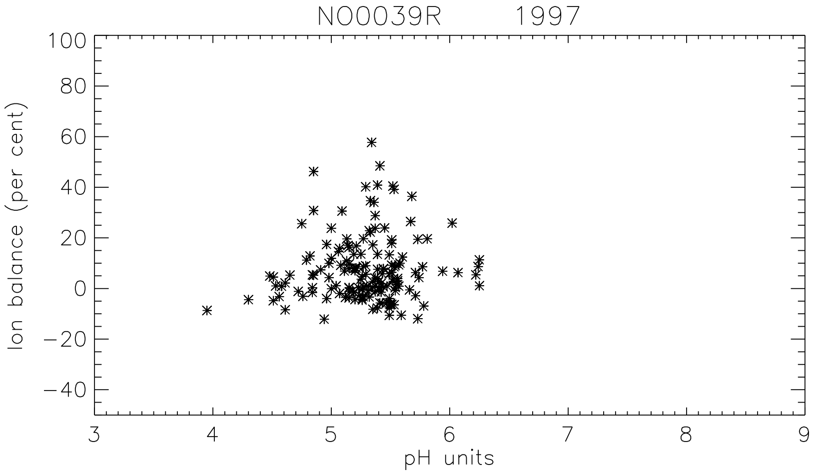
−20
−40
10
100
1000
10000
Ion sum (ueq/l)


NO0039R 1997
Ion balance (per cent)
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8
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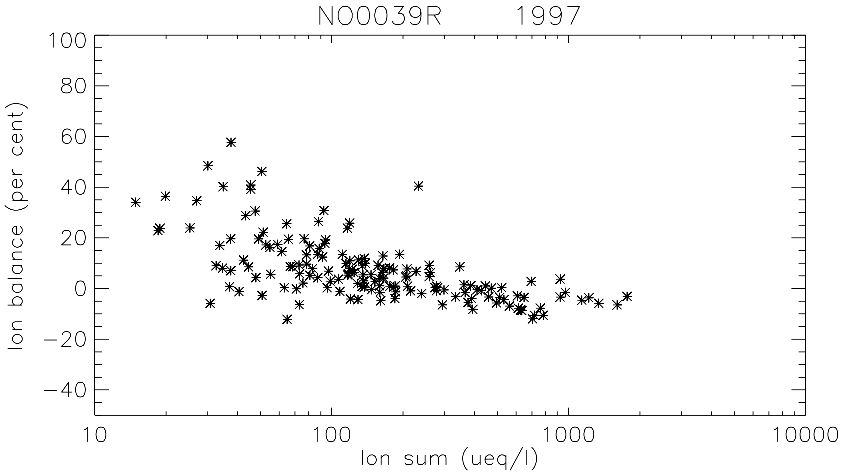
pH units


NO0039R 1997
Ion balance (per cent)
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−40
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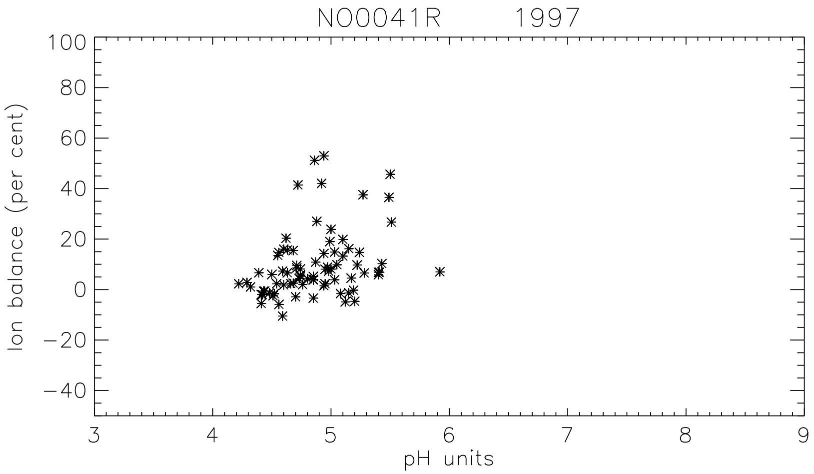
100
1000
10000
Ion sum (ueq/l)


NO0041R 1997
Ion balance (per cent)
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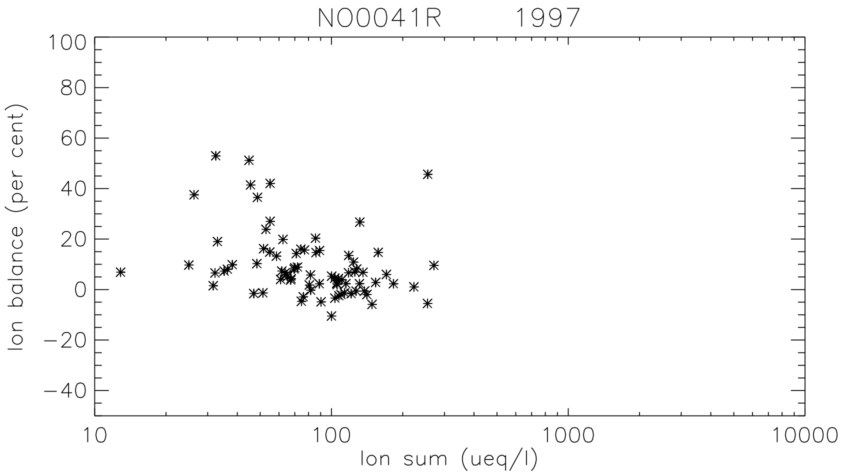
9
pH units


NO0041R 1997
Ion balance (per cent)
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−20
−40
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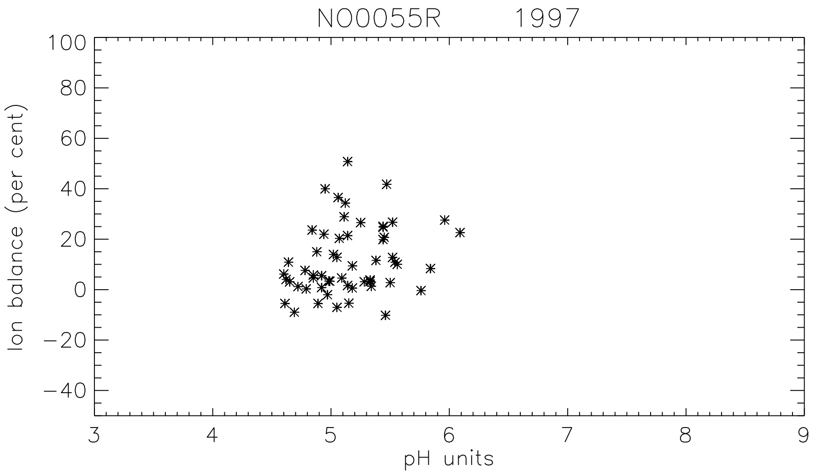
100
1000
10000
Ion sum (ueq/l)


NO0055R 1997
Ion balance (per cent)
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−40
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4
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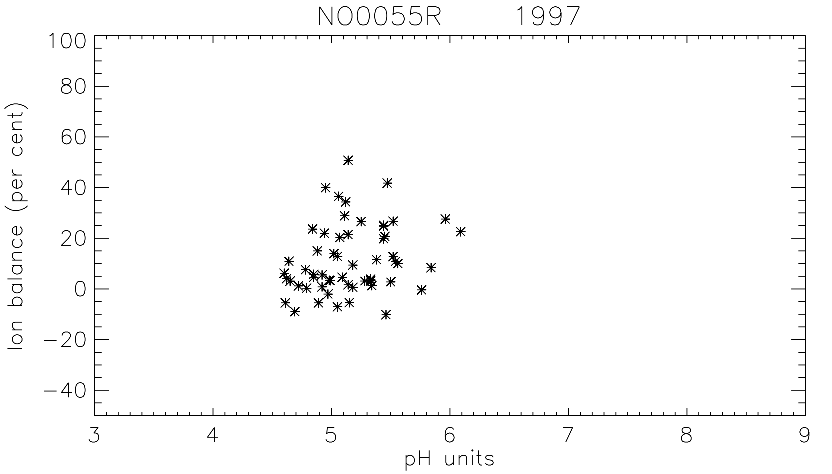
6
7
8
9
pH units


NO0055R 1997
Ion balance (per cent)
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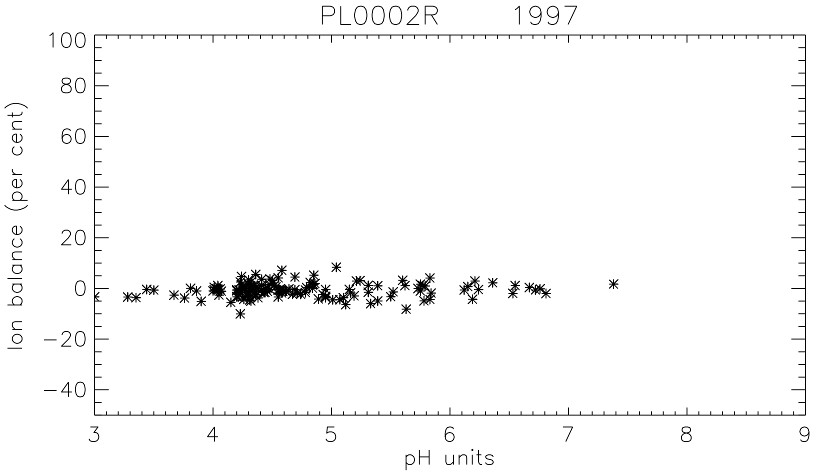
0
−20
−40
3
4
5
6
7
8
9
pH units


PL0002R 1997
Ion balance (per cent)
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40
20
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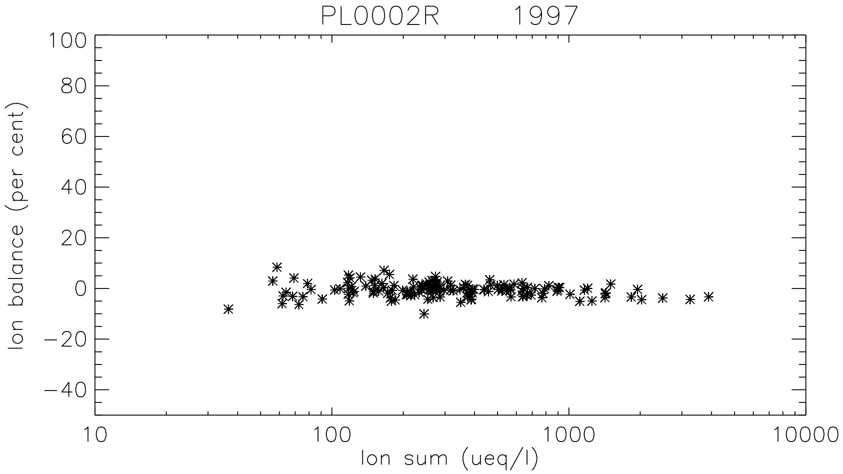
−20
−40
3
4
5
6
7
8
9
pH units


PL0002R 1997
Ion balance (per cent)
100
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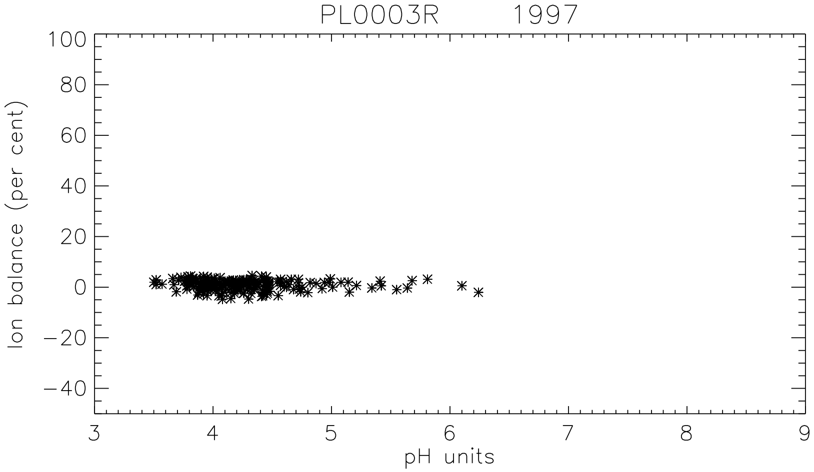
40
20
0
−20
−40
10
100
1000
10000
Ion sum (ueq/l)


PL0003R 1997
Ion balance (per cent)
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−20
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4
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8
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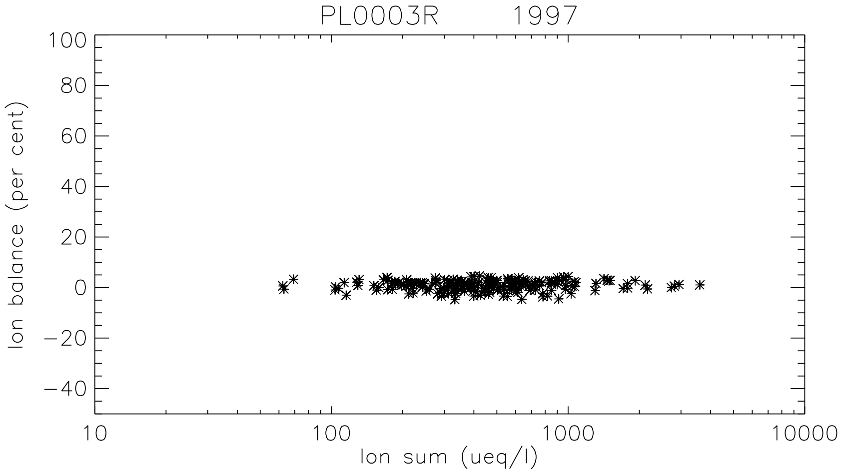
pH units


PL0003R 1997
Ion balance (per cent)
100
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−20
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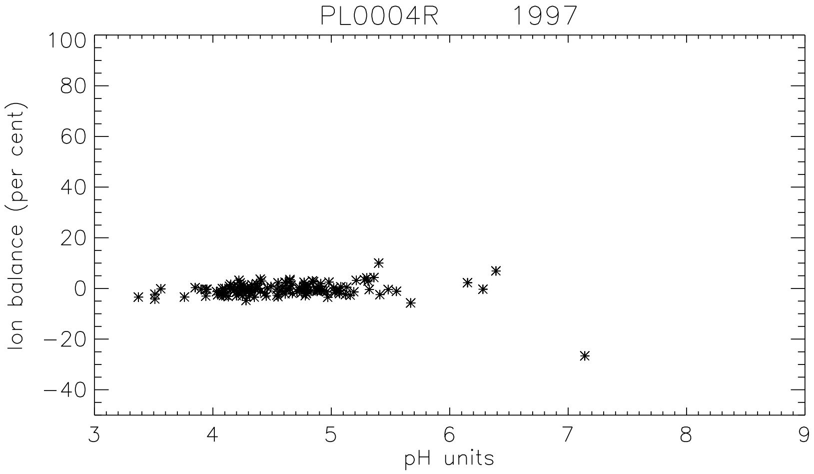
100
1000
10000
Ion sum (ueq/l)


PL0004R 1997
Ion balance (per cent)
100
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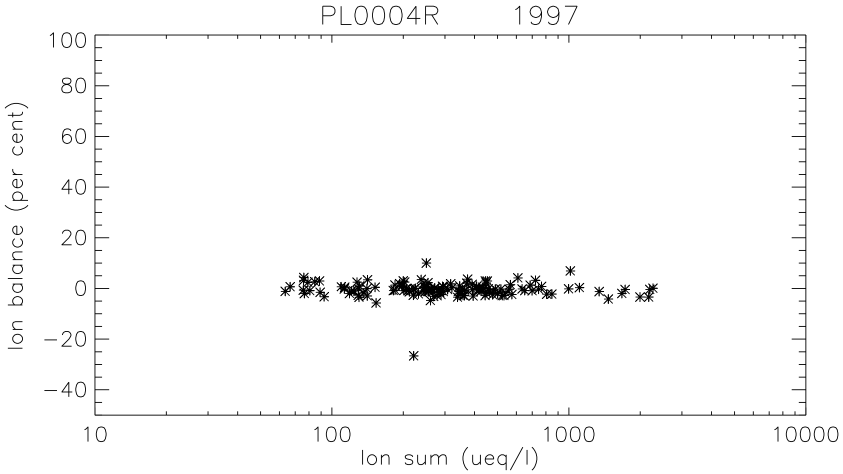
pH units


PL0004R 1997
Ion balance (per cent)
100
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−20
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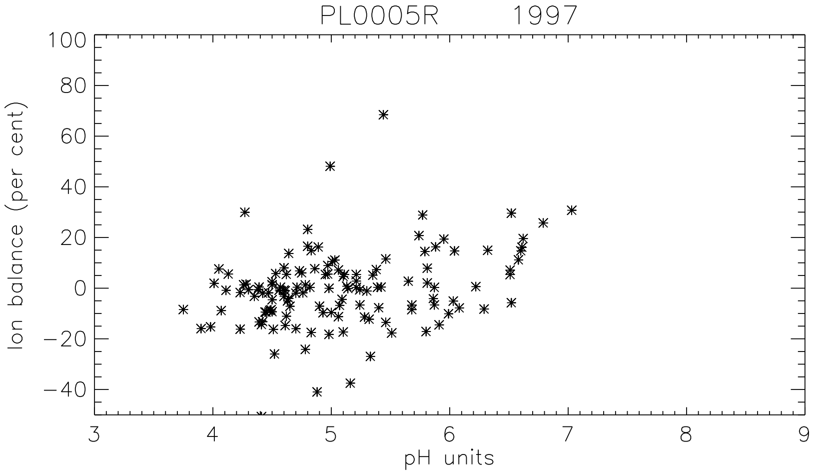
100
1000
10000
Ion sum (ueq/l)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Ion balance (per cent)
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80
60
40
20
0
−20
−40
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4
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6
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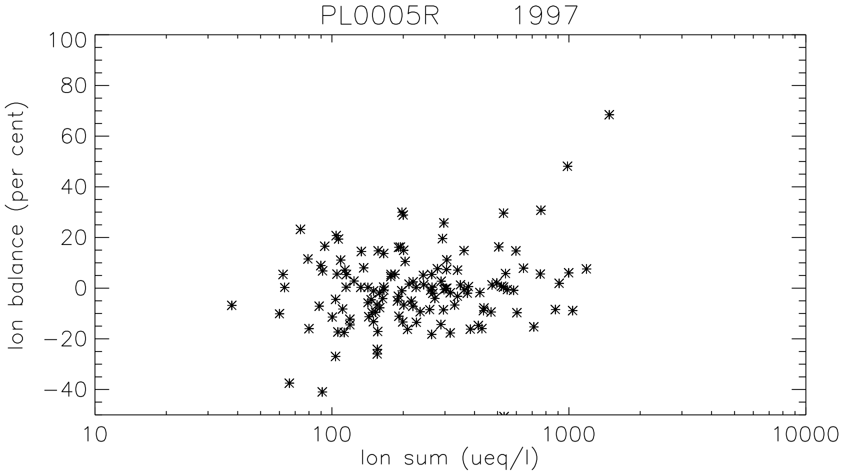
8
9
pH units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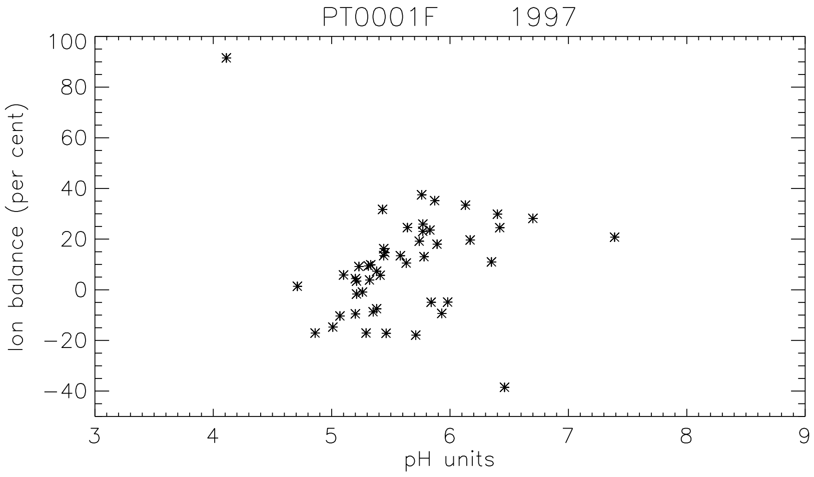
Ion sum (ueq/l)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Ion balance (per cent)
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80
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40
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0
−20
−40
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4
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8
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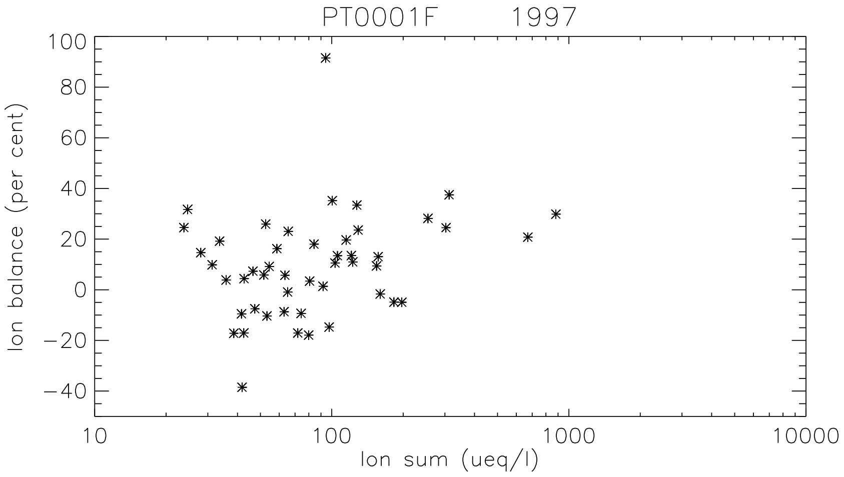
pH units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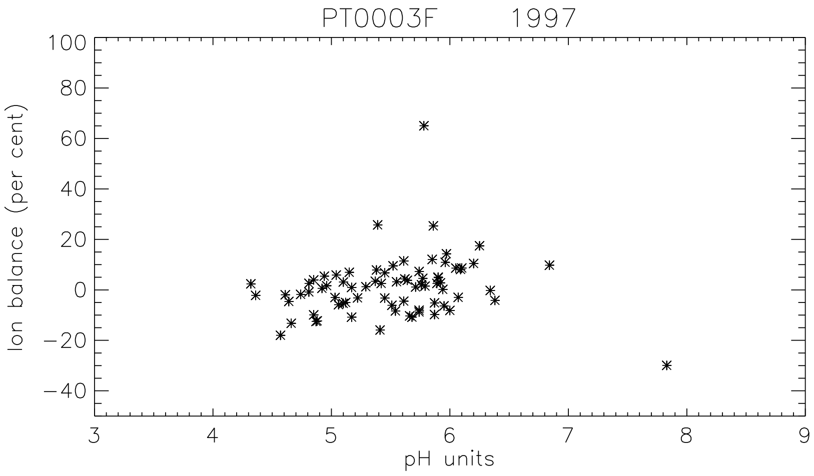
1000
10000
Ion sum (ueq/l)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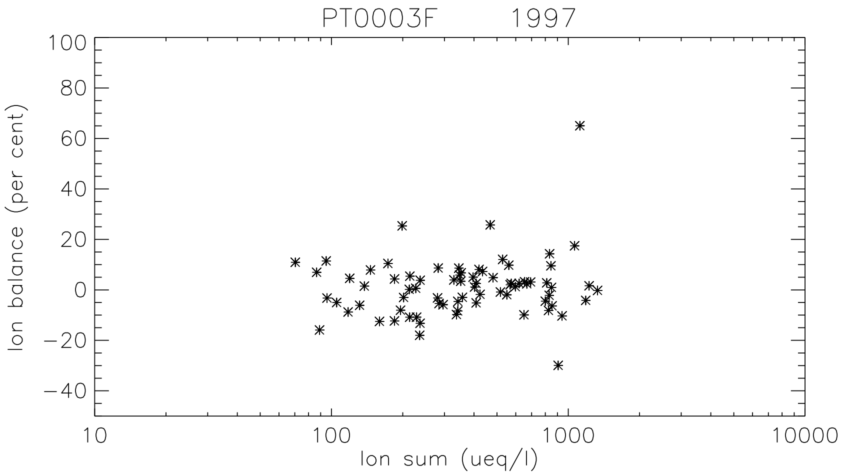
pH units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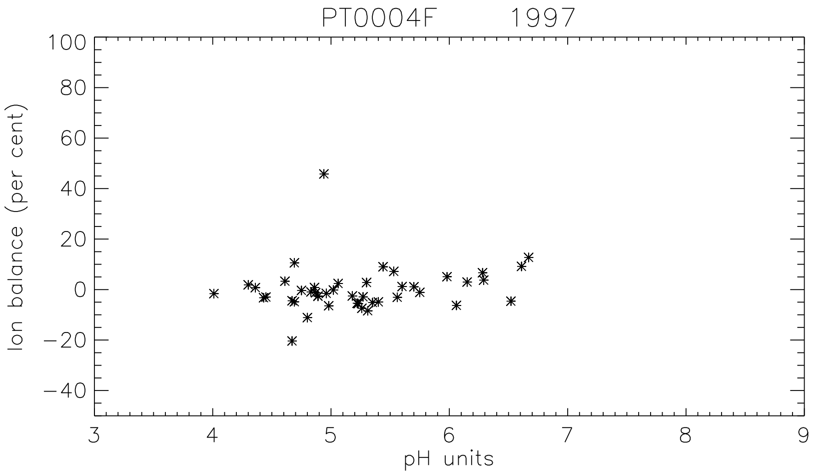
10000
Ion sum (ueq/l)


PT0004F 1997
Ion balance (per cent)
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−20
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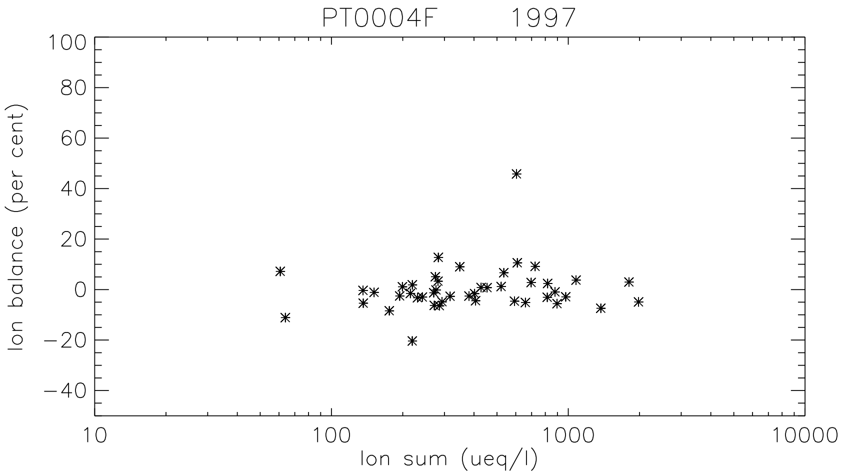
pH units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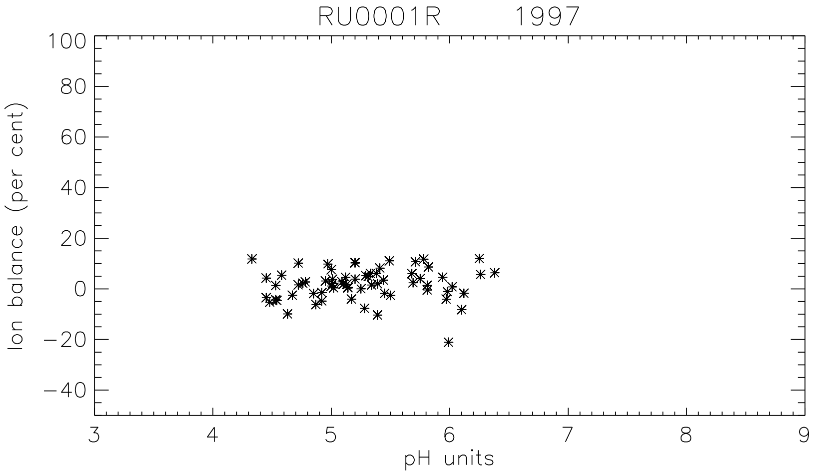
Ion sum (ueq/l)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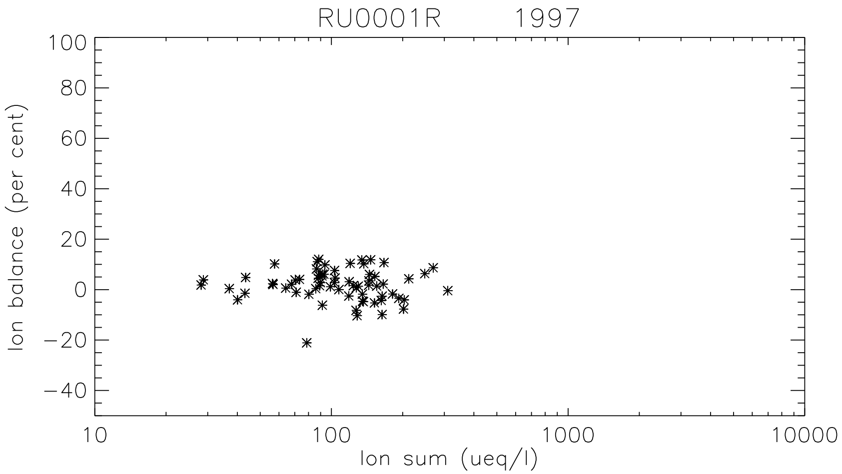
pH units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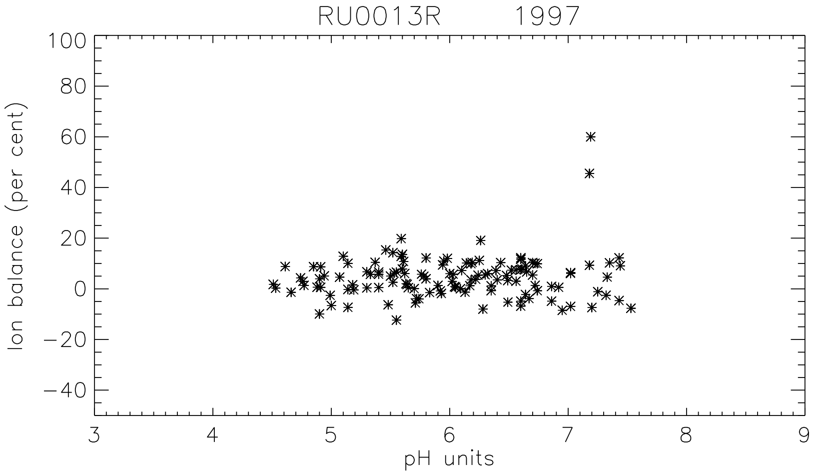
100
1000
10000
Ion sum (ueq/l)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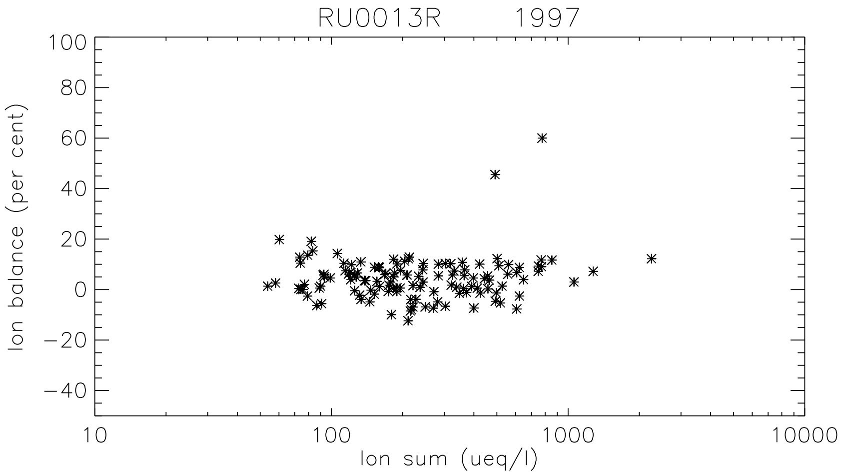
pH units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−20
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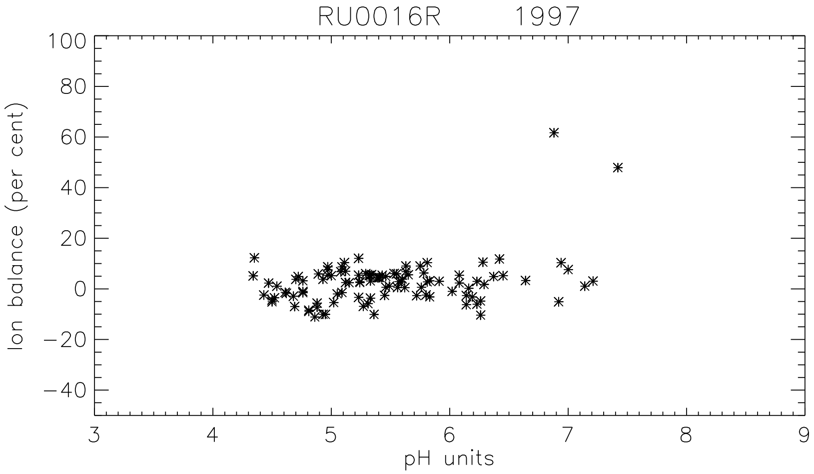
1000
10000
Ion sum (ueq/l)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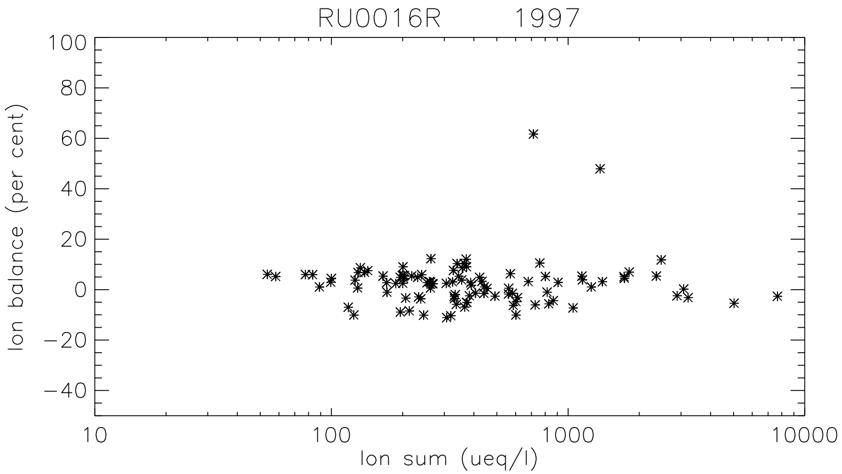
pH units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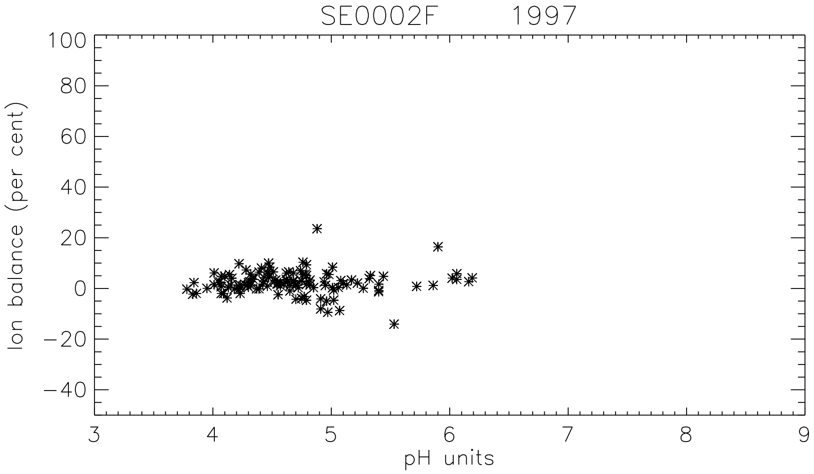
Ion sum (ueq/l)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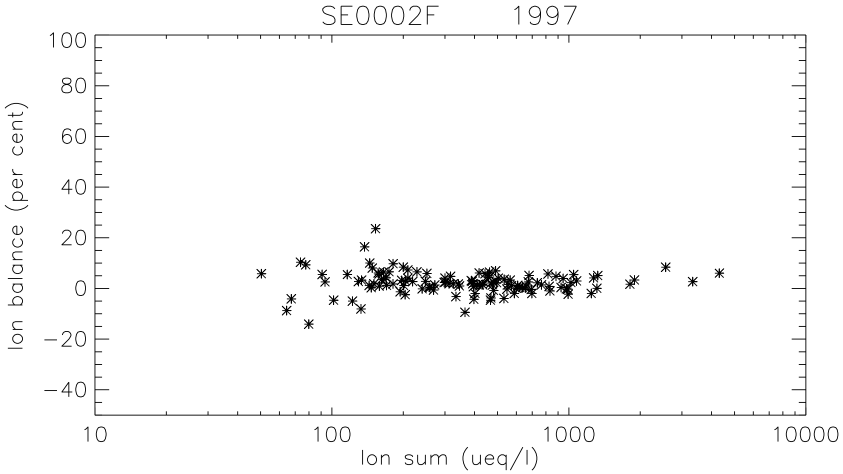
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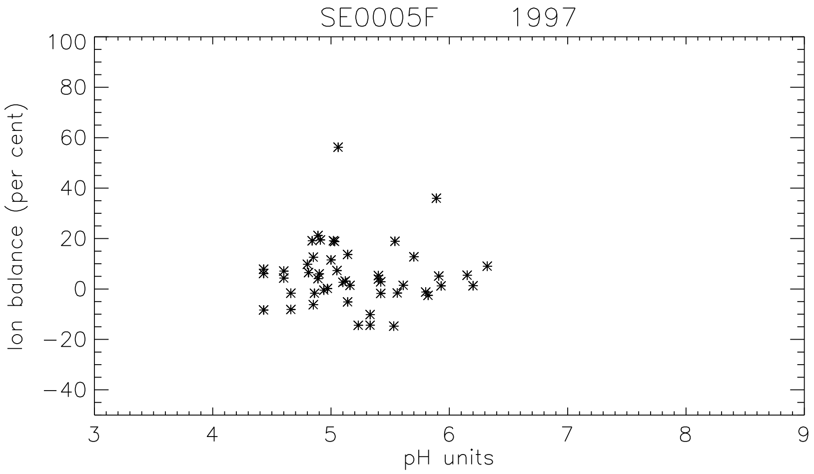
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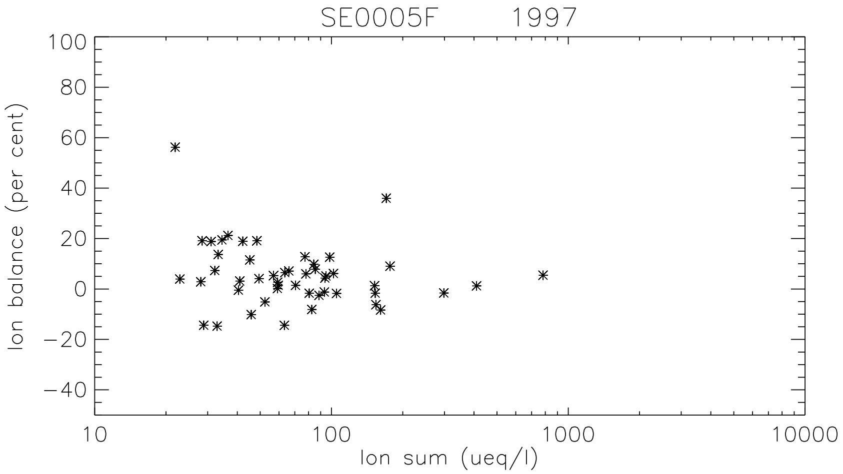
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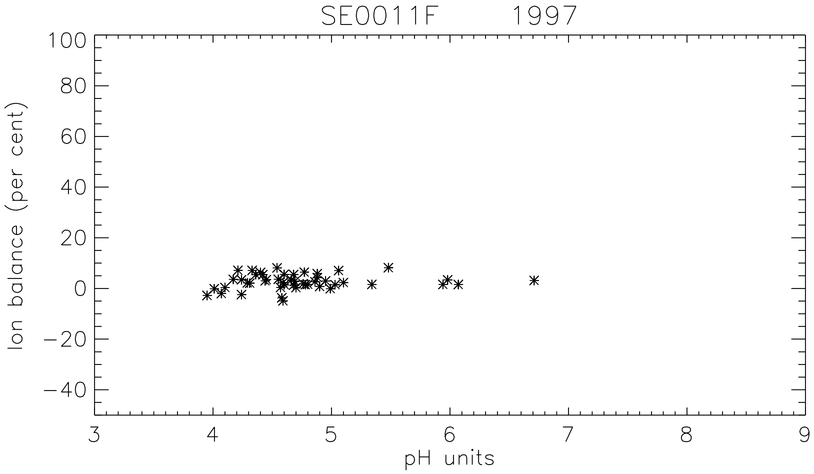
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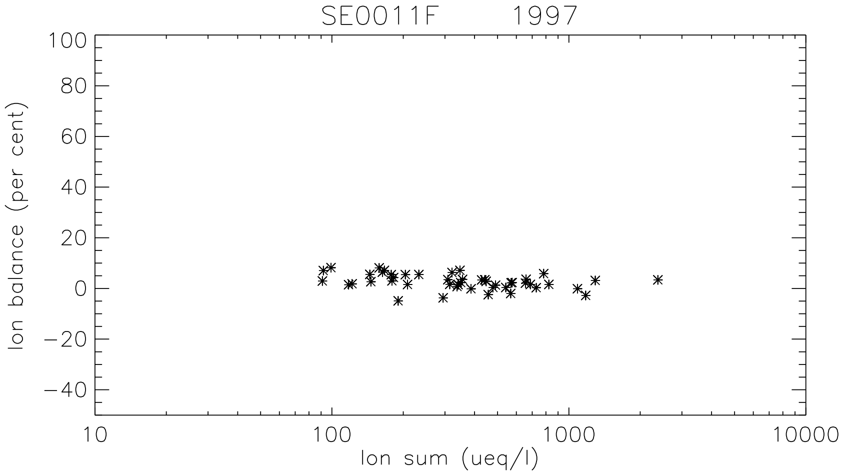
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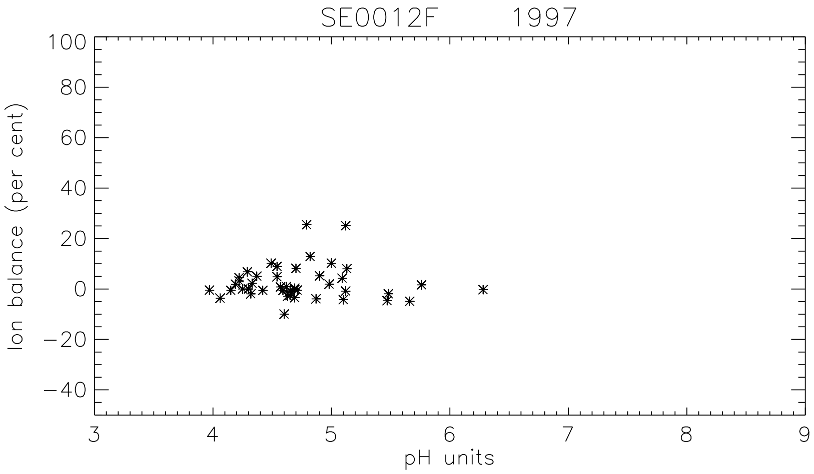
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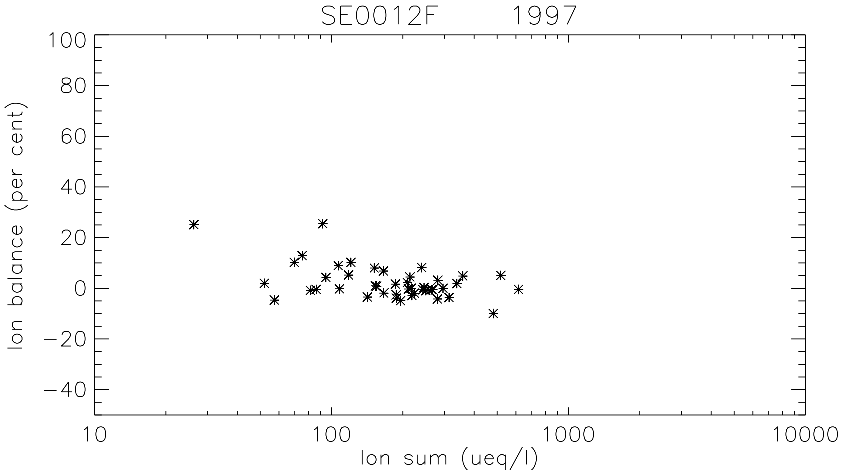
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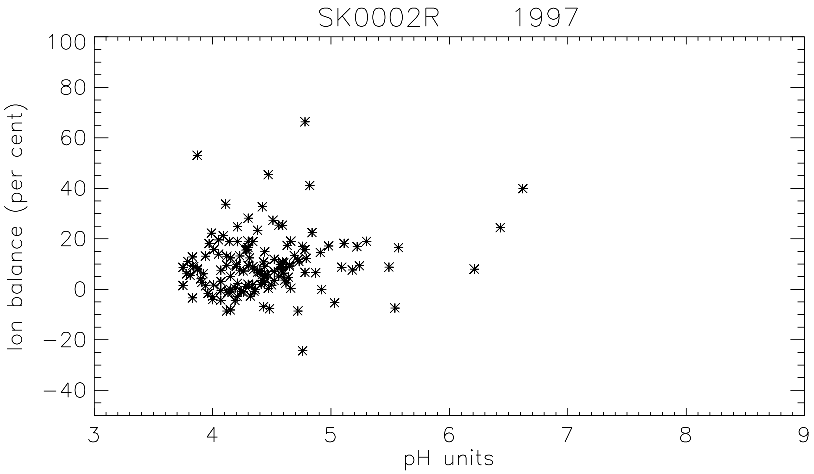
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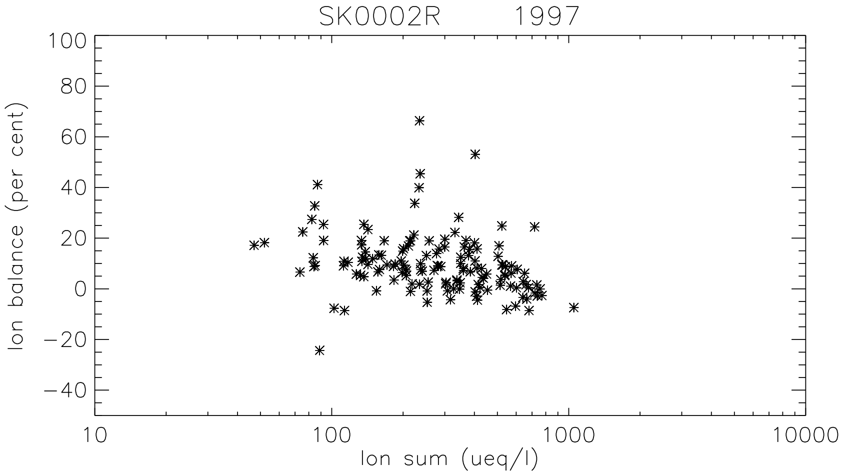
pH units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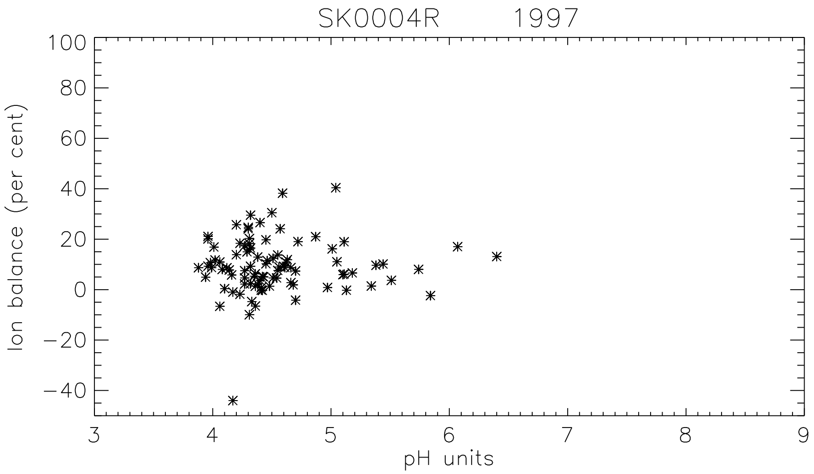
Ion sum (ueq/l)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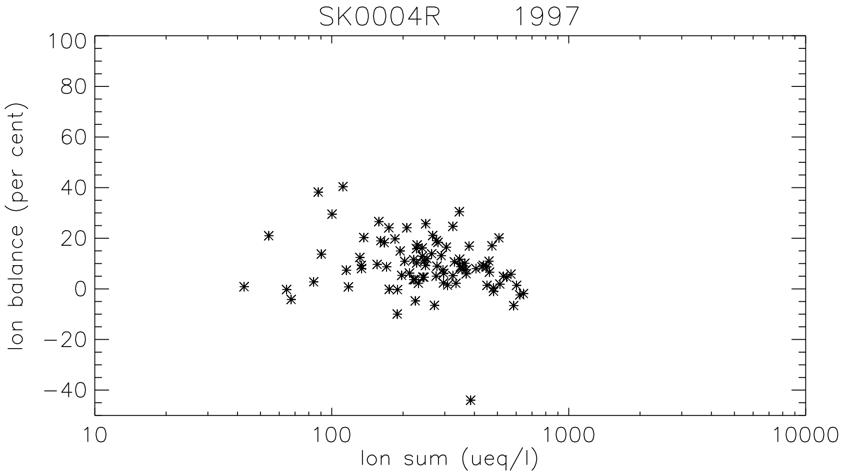
pH units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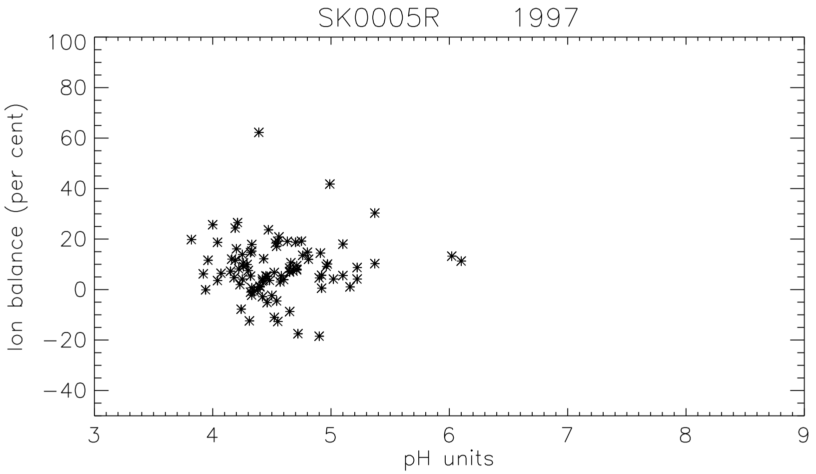
Ion sum (ueq/l)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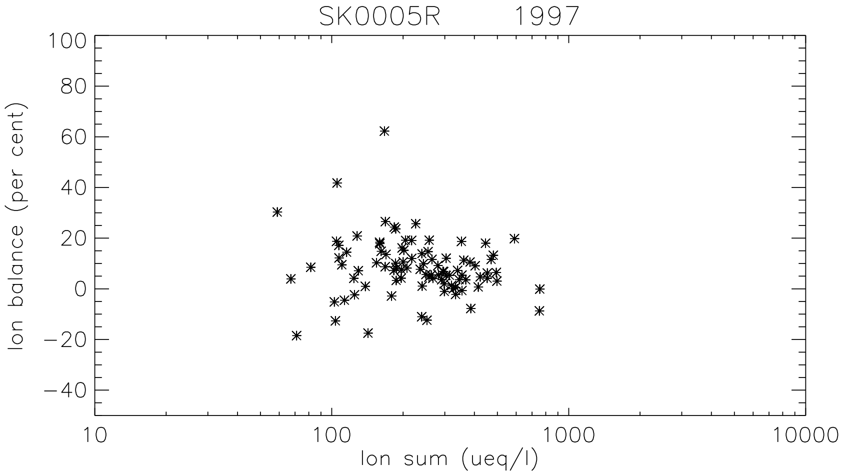
pH units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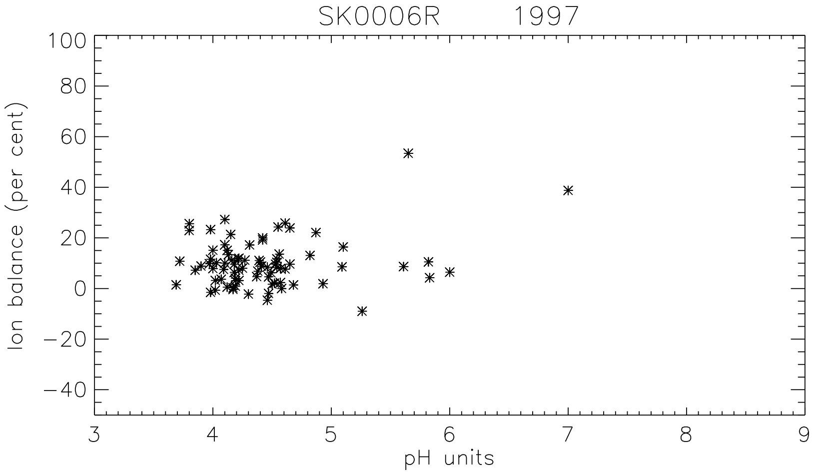
Ion sum (ueq/l)


SK0006R 1997
Ion balance (per cent)
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8
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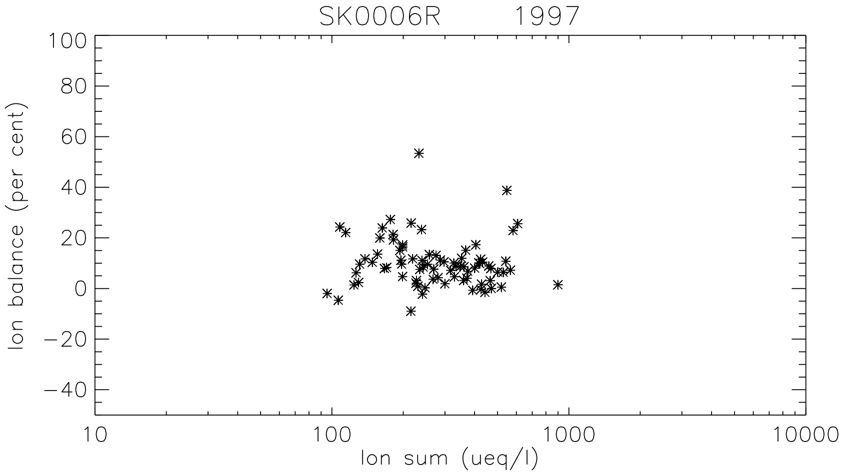
pH units


SK0006R 1997
Ion balance (per cent)
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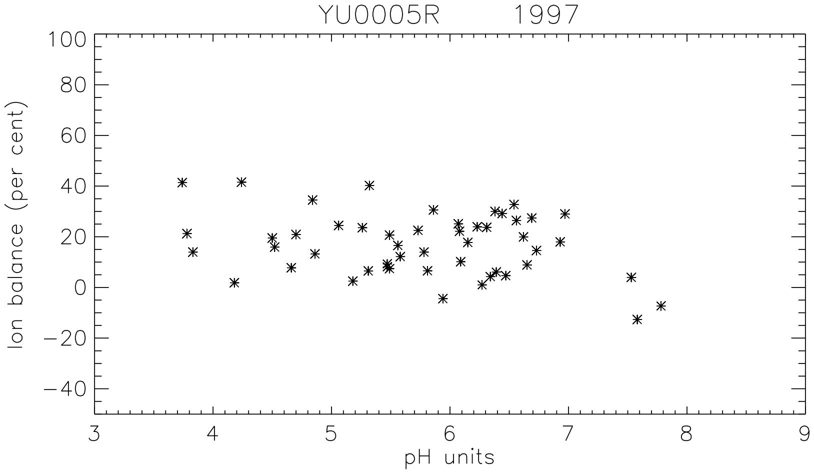
Ion sum (ueq/l)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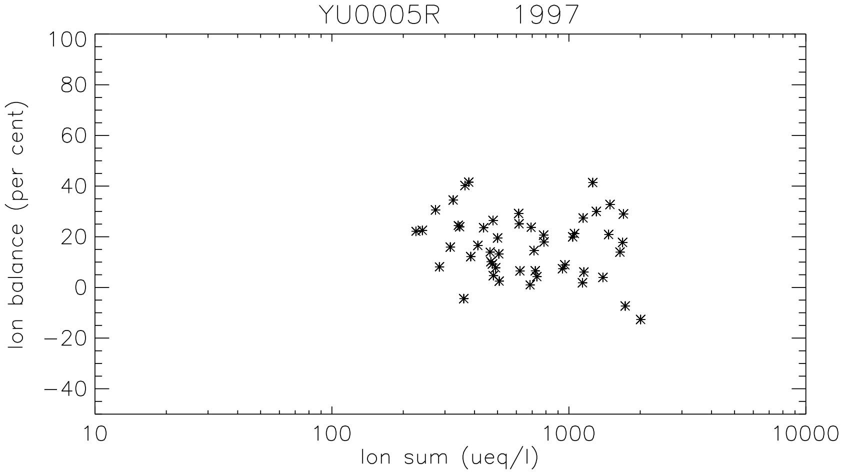
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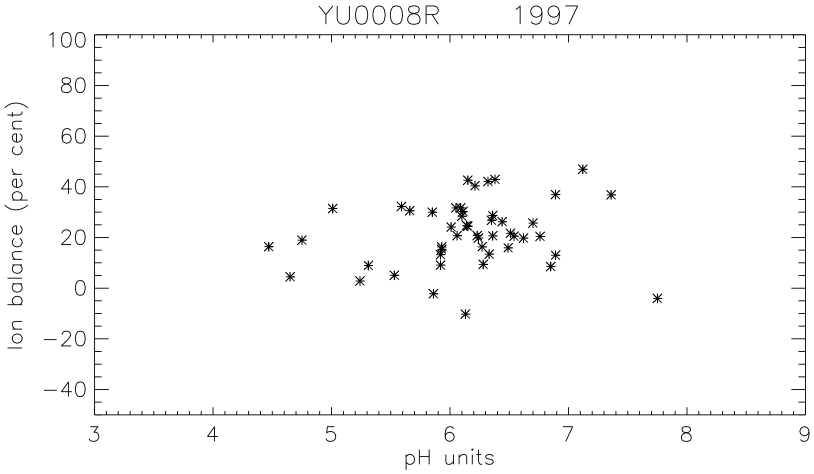
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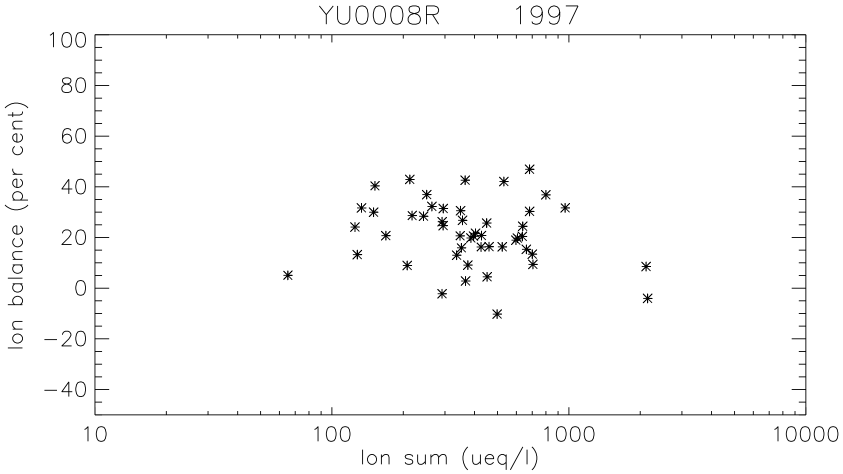
YU0008R 1997

Annex 3

Detection limits and precision

Table 3.1:

Ozone		
Country / site	Laboratory	Measurement precision
Commission of European Community	Joint Research Centre, Ispra Establishment	4 µg/m3 (from 1996)
Denmark	National Environmental Research Institute, Roskilde	2 ppb + 8% of the measured value
Estonia		2 µg/m3
Finland	Finnish Meteorological Institute, Helsingfors	2 µg/m3
France	l'Ecole des Mines de Douai, Laboratoire Wolff, Douai	2 µg/m3
Italy	C.N.R. Instituto Inquinamento Atmosferico Montelibretto, Rome	2 µg /m3
Norway	Norwegian Institute for Air Research, Kjeller	2 µg /m3 (1995)
Poland	Institute of Meteorology and Water Management, Warsaw	2 µg or 2% of reading whichever is greater, 03> 200 µg/m3; 2%
Switzerland	Swiss Fed. Lab. for Materials testing and Research	c<30 µg/m3: 6 µg/m3 30 µg/m3 < c < 90 µg/m3: 6-9 µg/m3 c > 90 µg/m3: 10%
Sweden	Swedish Environmental Research Institute (IVL), Gothenburg	4 µg/m3 and 2 µg/m3
United Kingdom	AEA Technology, Culham Abington	

Table 3.2:

Nitrogen dioxide			
Country / site	Laboratory	Laboratory precision	Method precision
Commission of European Communities	Joint Research Centre, Ispra Establishment		0.3 μg N/m3 (from 1996)
Czech Republic	Czech Hydrometeorological Institute, Prague	3.4 % RSD	12.2 % RSD
Denmark	National Environmental Research Institute, Roskilde	M.MAD: 0.02 mg N/l CoV: 1.5 %	
Estonia			2 μg/m3
Finland	Finnish Meteorological Institute, Helsingfors	-	0.3 μg N/m3
Greece	Ministry of Environment, Physical Planning and Public Works	M.MAD: 0.001 mg N/l CoV: 1.3%	
Hungary	Institute for Atmospheric Physics, Dep. for Air Chemistry, Budapest	ca. 5% RSD	
Italy	C.N.R. Instituto Inquinamento Atmosferico Montelibretto, Rome		0.6 μg n/m3
Lithuania	Institute of Physics, Vilnius	c=0.02-0.06 mg N/l; 6.3% RSD	c<0.5μg N/m3; 8.2 % RSD c> 0.5 μg N/m3; 5.4 % RSD
Norway	Norwegian Institute for Air Research, Kjeller	c= 0.0338 μg N/ml: 7% RSD c=0.1669 μg N/ml:4.6% RSD c=0.0834 μg N/ml:4.2% RSD	
Poland	Institute of Meteorology and Water Management, Warsaw	c= 0.304 mg N/l; 2%RSD c= 0.03 mg N/l; 8.1% RSD	
Switzerland	Swiss Fed. Lab. for Materials testing and Research		Daily mean c<30 μg N/m3: 1.2 μg N/m3; Annual mean c<40 μg N/m3: 0.9 N/m3
Turkey	Refik Saydam Centre of Hygiene, Ankara	M.MAD: 0.14 mg N/l CoV: 12.82%	

Table 3.3:

Sulphur dioxide			
Country / site	Laboratory	Laboratory precision	Method precision
Commission of European Communities	Joint Research Centre, Ispra Establishment		1.3 µg S/m3 (from 1996)
Czech Republic	Czech Hydrometeorological Institute, Prague	1.5 % RSD	M.MAD: 1.182 µg S/m3
Denmark	National Environmental Research Institute, Roskilde	M.MAD: 0.03 µg S/m3 CoV: 2.2%	
Estonia			1% of reading or 3 µg/m3
Finland	Finnish Meteorological Institute, Helsingfors		0.1 µg S/m3
France	l'Ecole des Mines de Douai, Laboratoire Wolff, Douai	c= 0.01-0.1 mg S/l: 8-12% RSD c= 0.1-0.5 mg S/l: 1.30% RSD	
Greece	Ministry of Environment, Physical Planning and Public Works	M.MAD: 0.038 mg S/l CoV: 9.5%	
Hungary	Institute for Atmospheric Physics, Dep. for Air Chemistry, Budapest	<10% RSD	
Italy	C.N.R. Instituto Inquinamento Atmosferico Montelibretto, Rome	-	c= 2 µg S/m3; 7% RSD
Lithuania	Institute of Physics, Vilnius	c<0.5 mg S/l; 17.9% RSD c>0.5 mg S/l; 3.2% RSD	c<1 µg S/m3; 15.7% RSD c>1 µg S/m3; 10% RSD
Norway	Norwegian Institute for Air Research, Kjeller		c= ~0 - 4.2 µg S/m3; M.MAD 0.012 µg S/m3(1995)
Slovenia	Hydrometeorological Institute of Slovenia, Ljubljana		0.043 mg S/l
Switzerland	Swiss Fed. Lab. for Materials testing and Research		CH1: c=0.5-25 µg S/m3; 0.85 µg S/m3 CH2–CH5: c<30 µg S/m3; 1.5 µg S/m3 (daily mean)
Turkey	Refik Saydam Centre of Hygiene, Ankara	M.MAD:0.06 mg S/l CoV: 9.6 %	
United Kingdom	AEA Technology, Culham Abington	2.5% RSD	

Table 3.4:

Sulphate in air			
Country / site	Laboratory	Laboratory precision	Method precision
Commission of European Communities	Joint Research Centre, Ispra Establishment	0.07 µg S/m3 (from 1996)	
Czech Republic	Czech Hydrometeorological Institute, Prague	<1.5 % RSD	M.MAD: 0.484 µg S/m3
Denmark	National Environmental Research Institute, Roskilde		
France	l'Ecole des Mines de Douai, Laboratoire Wolff, Douai	c<0.2 mg S/l; 5-10% 0.2<c<0.5 mg S/l; 3-5% 0.5<c<5 mg S/l; 1-3%	
Hungary	Institute for Atmospheric Physics, Dep. for Air Chemistry, Budapest	<10% RSD	-
Italy	C.N.R. Instituto Inquinamento Atmosferico Montelibretto, Rome		C= 1 µg S/m3; 1.9 % RSD
Lithuania	Institute of Physics, Vilnius	c<0.5 mg S/l; 17.9% RSD c>0.5 mg S/l; 3.2% RSD	c<0.6 µg S/m3; 17.9% RSD c>0.6µg S/m3; 3.2% RSD
Norway	Norwegian Institute for Air Research, Kjeller		c= < 2.4 µg S/m3; M.MAD 0.009 µg S/m3(1995)
Poland	Institute of Meteorology and Water Management, Warsaw		
Slovenia	Hydrometeorological Institute of Slovenia, Ljubljana		
Switzerland	Swiss Fed. Lab. for Materials testing and Research		0.25 µg S/m3
Turkey	Refik Saydam Centre of Hygiene, Ankara	M.MAD: 0.0234 mg S/l	
United Kingdom	AEA Technology, Culham Abington	2.5% RSD	

Table 3.5:

Nitrate + nitric acid in air			
Country / site	Laboratory	Laboratory precision	Method precision
Commission of European Communities	Joint Research Centre, Ispra Establishment	0.17 µg N/m3 (from 1996)	
Czech Republic	Czech Hydrometeorological Institute, Prague		
Denmark	National Environmental Research Institute, Roskilde	NO3: M.MAD: 0.01 µg N/m3 CoV: 2% HNO3: M.MAD: 0.005 µg N/m3 CoV: 3%	M.MAD: 0.12 µg N/m3 CoV: 4.4%
Hungary	Institute for Atmospheric Physics, Dep. for Air Chemistry, Budapest	<10% RSD	
Italy	C.N.R. Instituto Inquinamento Atmosferico Montelibretto, Rome		NO3: c= 1 µg N/m3; 1.7% RSD HNO3: c= 0.2 µg N/m3; 8.6% RSD
Lithuania	Institute of Physics, Vilnius	c< 1 mg N/l: 3.2% RSD	c<1.02 µg N/m3; 1.5-5.3 % RSD
Norway	Norwegian Institute for Air Research, Kjeller		M.MAD 0.012 µg N/m3 (at <1.6 µg N/m3) (1995)
Slovenia	Hydrometeorological Institute of Slovenia, Ljubljana		NO3: 0.014 mg N/l HNO3: 0.028 mg N/l
Switzerland	Swiss Fed. Lab. for Materials testing and Research		0.13 µg N/m3
Turkey	Refik Saydam Centre of Hygiene	HNO3: 0.007 mg N/l	

Table 3.6:

Ammonia + Ammonium in air			
Country / site	Laboratory	Laboratory precision	Method precision
Commission of European Communities	Joint Research Centre, Ispra Establishment	0.94 µg N/m3 (from 1996)	
Czech Republic	Czech Hydrometeorological Institute, Prague		
Denmark	National Environmental Research Institute, Roskilde	NH3: M.MAD: 0.03 µg N/m3 CoV: 2.7% NH4: M.MAD: 0.01 µg N/m3 CoV: 1.9%	
Hungary	Institute for Atmospheric Physics, Dep. for Air Chemistry, Budapest	<10% RSD	-
Italy	C.N.R. Instituto Inquinamento Atmosferico Montelibretto, Rome		NH4: c= 2 µg N/m3; 3.2% RSD NH3: c=1 µg N/m3; 6.1% RSD
Lithuania	Institute of Physics, Vilnius	c<1 mg N/l; 4.8% RSD	c<1.25 µg N/m3; 1.5-5.1% RSD
Norway	Norwegian Institute for Air Research, Kjeller		M.MAD 0.039 µg N/m3 (at <3.2 µg N/m3) (1995)
Slovenia	Hydrometeorological Institute of Slovenia, Ljubljana		NH4: 0.011 mg N/l NH3: 0.071 mg N/l
Switzerland	Swiss Fed. Lab. for Materials testing and Research		0.45 µg N/m3
Turkey	Refik Saydam Centre of Hygiene	NH3: M.MAD: 0.02 mg N/l NH4: M.MAD: 0.02 mg N/l CoV:10.04 %	

Table 3.7:

Nitrate in precipitation			
Country / site	Laboratory	Laboratory precision	Method precision
Austria	Umweltbundesamt, Klagenfurt	2.6 % RSD	5.2 % RSD
Commission of European Com.	Joint Research Centre, Ispra Establishment	0.02 mg N/l (from 1996)	
Czech Republic	Czech Hydrometeor. Institute, Prague	1 % RSD	M.MAD 0.128 mg/l
Denmark	National Env. Research Institute, Roskilde	M.MAD: 0.01 mg N/l CoV: 1.33 %	-
Estonia		2%	
France	l'Ecole des Mines de Douai, Laboratoire Wolff, Douai	c< 0.2 mg N/l; 5 - 10% c= 0.2 - 0.5 mg N/l; 3-5% c= 0.5 - 5 mg N/l; 1 - 3%	
Greece	Ministry of Env. Physical Planning & Public Works	M.MAD: 0.04 mg N/l CoV: 7.9%	
Hungary	Institute for Atmospheric Physics, Dep. for Air Chemistry, Budapest	5 - 10% RSD	-
Italy	C.N.R. Instituto Inquinamento Atmosferico Montelibretto, Rome	c=0.5 mg Cl/l; 0.6 % RSD c=0.05 mg Cl/l; 2.7% RSD	C= 1mg N/l; 1.7% RSD
Latvia	Latvian Hydrometer. Agency, Riga	17% RSD	
Lithuania	Institute of Physics, Vilnius	c<0.5 mg N/l; 4.5% RSD c>0.5 mg N/l; 1.2-3% RSD	
Netherlands	National Ins. for Public Health and Env.Protection (RIVM), Bilthoven	RSD=$(2.2 + 0.0031/c^2)^{1/2}$%; c=1.4 - 168 mg N/l: 1.5% RSD	
Norway	Norwegian Institute for Air Research, Kjeller	c=0.86 μg N/ml; 3.1% RSD c=0.39 μg N/ml; 4.8% RSD	
Poland	Institute of Meteorology and Water Management, Warsaw	c=4.52 mg N/l; 1.2% c=0.9 mg N/l; 1.4% c=0.45 mg N/l; 2.1%	
	Institute of Environmental Protection, Warsaw (PL5)	M.MAD: 0.01 mg N/l CoV: 2.7%	M.MAD: 0.016 mg N/l CoV.: 3.0%
Portugal	Ministèrio do ambiente e recursos naturais, Laboratorio de Santo Andre, Santo Andre	IC: c= 0.5 mg N/l; 1.68% RSD IC: c= 1 mg N/l; 0.4% RSD IC: c= 4 mg N/l; 0.34% RSD	
Slovenia	Hydrometeor. Institute of Slovenia, Ljubljana	c=0.3 mg N/l; 7.4% RSD	
Spain	Instituto de Salud Carlos III	1.2%	
Switzerland	Swiss Fed. Lab. for Mat. testing and Research		M.MAD: 0.05 mg N/m3
Turkey	Refik Saydam Centre of Hygiene	M.MAD: 0.02 mg N/l CoV: 9.57 %	
United Kingdom	AEA Technology, Culham Abington	4%	

Table 3.8:

Sulphate in precipitation			
Country / site	Laboratory	Laboratory precision	Measurement precision
Austria	Umweltbundesamt, Klagenfurt	1 % RSD	4.2 % RSD
Commission of European Communities	Joint Research Centre, Ispra Establishment	0.17 mg S/l (from 1996)	
Czech Republic	Czech Hydrometeorological Institute, Prague	1.2 % RSD	M.MAD 0.23 mg S/l
Denmark	National Env.l Research Institute, Roskilde	M.MAD: 0.02 mg S/l CoV: 1.66%	-
Estonia		1%	
France	l'Ecole des Mines de Douai, Laboratoire Wolff, Douai	c<0.2 mg S/l; 5 - 10% c= 0.2 - 0.5 mg S/l; 3 - 5% c= 0.5 - 5 mg S/l; 1 - 3%	
Greece	Ministry of Env., Physical Planning and Public Works	M.MAD: 0.10 mg S/l CoV: 7.8%	
Hungary	Institute for Atmospheric Physics, Dep. for Air Chemistry, Budapest	<10% RSD	-
Italy	C.N.R. Instituto Inquinamento Atmosferico Montelibretto, Rome	c=0.5 mg S/l; 0.5% RSD c=0.05 mg S/l; 2.1 % RSD	c= 1mg S/l; 0.8% RSD
Latvia	Latvian Hydrometerological Agency, Riga	15% RSD	
Lithuania	Institute of Physics, Vilnius	c<0.8 mg S/l; 8.9% RSD c=0.8-2.4 mg S/l; 1.1 % RSD	
Netherlands	National Ins. for Public Health and Env.l Protection (RIVM), Bilthoven	RSD=(2.3+0.0018/c2)1/2%; c: 1.6-16 mg S/l: 1.5% RSD	
Norway	Norwegian Institute for Air Research, Kjeller	c= 2.23 µg S/ml: 2.7% RSD c= 0.85 µg S/ml: 2.4% RSD	
Poland	Institute of Meteorology and Water Management, Warsaw	c=6.68 mg S/l; 1.2% c=1.340 mg S/l; 1.5% c=0.67 mg S/l; 1.8%	
	Institute of Environmental Protection, Warsaw (PL5)	M.MAD:0.03 mg S/l CoV: 5.5%	M.MAD: 0.031 mg S/l CoV: 4.4%
Portugal	Ministèrio do ambiente e recursos naturais, Laboratorio de Santo Andre, Santo Andre	IC: c=0.5 mg S/l; 2.5% RSD IC: c=1 mg S/l; 1% RSD IC: c=4 mg S/l; 0.4% RSD	
Slovenia	Hydrometeorological Inst. of Slovenia, Ljubljana	c= 0.5 mg S/l; 5.6% RSD	0.009 mg S/l
Spain	Inst. de Salud Carlos III	1.4%	
Switzerland	Swiss Fed. Lab. for Mat. testing and Research		M.MAD: 0.04 mg S/m3
Turkey	Refik Saydam Centre of Hygiene, Ankara	M.MAD: 0.09 mg N/l CoV: 13.23 %	
United Kingdom	AEA Technology, Culham	2%	

Table 3.9:

Potassium in precipitation			
Country / site	Laboratory	Laboratory precision	Method precision
Austria	Umweltbundesamt, Klagenfurt	2.8 % RSD	13 % RSD
Commission of European Communities	Joint Research Centre, Ispra Establishment	0.16 mg K/l (from 1996)	
Czech Republic	Czech Hydrometeorological Institute, Prague	c> 5 µg K/l; <5%	M.MAD: 0.01 mg K/l (CoV: 12.6%)
Estonia		3%	
France	l'Ecole des Mines de Douai, Laboratoire Wolff, Douai	c< 0.2 mg K/l; 5-10% c= 0.2-0.5 mg K/l; 3-5% c= 0.5-5 mg K/l; 1-5%	
Hungary	Institute for Atmospheric Physics, Dep. for Air Chemistry, Budapest	<5% RSD	
Italy	C.N.R. Instituto Inquinamento Atmosferico Montelibretto, Rome	c=0.5 mg K/l; 0.4% RSD c=0.05 mg K/l; 2.4% RSD	c=1 mg K/l; 1% RSD
Latvia	Latvian Hydrometerological Agency, Riga	12% RSD	
Netherlands	National Institute for Public Health and Environmental Protection (RIVM), Bilthoven	c= 0.27-0.39 mg K/l; 5% RSD c= 0.39-0.59 mg K/l; 4% RSD c= 0.59-0.78 mg K/l; 3% RSD c= 0.78-1.95 mg K/l; 2% RSD c= >1.95 mg K/l; 1.5% RSD	
Norway	Norwegian Institute for Air Research, Kjeller	c=0.61 µg K/ml: 3% RSD c=0.2 µg K/ml; 5.1% RSD	
Poland	Institute of Meteorology and Water Management, Warsaw	c=0.3 mg K/l; 1.7%RSD c= 0.1 mg K/l; 4.8%RSD c= 0.05 mg K/l; 8.3%RSD	
	Institute of Environmental Protection, Warsaw (PL5)	M.MAD: 0.005 mg K/l CoV: 7.5%	M.MAD: 0.055mg K/l CoV: 29.8%
Portugal	Ministèrio do ambiente e recursos naturais, Laboratorio de Santo Andre, Santo Andre	IC: c= 1 mg K/l; 8.87% RSD IC: c= 2 mg K/l; 2.2% RSD IC: c= 4 mg K/l; 0.3% RSD AAS: c= 2 mg K/l; 0.7% RSD	
Slovenia	Hydrometeorological Inst. of Slovenia, Ljubljana		
Spain	Instituto de Salud Carlos III	18%	
Switzerland	Swiss Fed. Lab. for Materials testing and Research		M.MAD: 0.01 mg K/m3
Turkey	Refik Saydam Centre of Hygiene, Ankara	M.MAD: 0.006 mg K/l CoV: 1.18 %	
United Kingdom	AEA Technology, Culham	6%	

Table 3.10:

Ammonium in precipitation			
Country / site	Laboratory	Laboratory precision	Method precision
Austria	Umweltbundesamt, Klagenfurt	4.5 % RSD	7% RSD
Czech Republic	Czech Hydrometeorological Institute, Prague	5.4 % RSD	M.MAD: 0.094 mg N/l
Denmark	National Environmental Research Institute, Roskilde	M.MAD: 0.01 mg N/l CoV: 1.8 %	-
Estonia		6%	
France	l'Ecole des Mines de Douai, Laboratoire Wolff, Douai	c< 0.2 mg N/l; 5-10% c= 0.2-0.5 mg N/l; 3-5% c= 0.5-5 mg N/l; 1-3%	
Hungary	Institute for Atmospheric Physics, Dep. for Air Chemistry, Budapest	5-10 % RSD	
Italy	C.N.R. Instituto Inquinamento Atmosferico Montelibretto, Rome	c=0.5 mg N/l; 0.5% RSD c=0.05 mg N/l; 2.2% RSD	c= 0.5 mg N/l; 0.8% RSD
Latvia	Latvian Hydrometerological Agency, Riga	9% RSD	
Lithuania	Institute of Physics, Vilnius	c<0.1 mg N/l; 9.1 % RSD c=0.2-1.0 mg N/l;4.5-1% RSD	
Netherlands	National Institute for Public Health and Environmental Protection (RIVM), Bilthoven	RSD=(0.76 + 1115.6/c2) 1/2%; c= 0.35-42 mg N/l; 1.5% RSD	
Norway	Norwegian Institute for Air Research, Kjeller	c=0.64 µg N/ml: 5.3% RSD c=0.32 µg N/ml: 7% RSD	
Poland	Institute of Meteorology and Water Management, Warsaw	c= 0.972 mg N/l; 7% c= 0.194 mg N/l; 8.3%	
	Institute of Environmental Protection, Warsaw (PL5)	M.MAD: 0.07 mg N/l CoV: 17.9%	M.MAD: 0.055 mg N/l CoV: 14%
Portugal	Ministèrio do ambiente e recursos naturais, Laboratorio de Santo Andre, Santo Andre	IC: c= 1 mg N/l; 2.1% RSD IC: c= 2 mg N/l; 4.7% RSD IC: c= 4 mg N/l; 1.42% RSD	
Slovenia	Hydrometeorological Institute of Slovenia, Ljubljana	c= 0.2 mg N/l: 3.5% RSD	
Spain	Instituto de Salud Carlos III	5%	
Switzerland	Swiss Fed. Lab. for Materials testing and Research		M.MAD: 0.02 mg N/m3
Turkey	Refik Saydam Centre of Hygiene, Ankara	Split samples: M.MAD 0.19 mgN/l CoV: 3.29%	
United Kingdom	AEA Technology, Culham Abington	10%	

Table 3.11:

Calcium in precipitation			
Country / site	Laboratory	Laboratory precision	Method precision
Austria	Umweltbundesamt, Klagenfurt	3% RSD	8.5 % RSD
Commission of European Com	Joint Research Centre, Ispra Establishment	0.54 mg Ca/l (from 1996)	
Czech Republic	Czech Hydrometeorological Institute, Prague	4.6 % RSD	M.MAD: 0.092 mg Ca/l
Estonia		1%	
France	l'Ecole des Mines de Douai, Laboratoire Wolff, Douai	c< 0.2 mg Ca/l; 10-20% c= 0.2-0.5 mg Ca/l; 5-10% c= 0.5-5 mg Ca/l; 1-5%	
Hungary	Inst. for Atmosph. Physics	< 5% RSD	-
Italy	C.N.R. Instituto Inquinamento Atmosferico Montelibretto, Rome	c=0.5 mg Ca/l; 0.8% RSD c=0.05 mg Ca/l; 3.1% RSD	c= 1 mg Ca/l; 1.8% RSD
Latvia	Latvian Hydrometerological Agency, Riga	9% RSD	
Netherlands	National Institute for Public Health and Environmental Protection (RIVM), Bilthoven		c= 0.08-0.12 mg Ca/l; 5% RSD c= 0.12-0.18 mg Ca/l; 4% RSD c= 0.18-0.24 mg Ca/l; 3% RSD c= 0.24-0.60 mg Ca/l; 2% RSD c= >0.60 mg Ca/l; 1.5% RSD
Norway	Norwegian Institute for Air Research, Kjeller	c=0.27 μg Ca/ml: 9.2% RSD c=0.15 μg Ca/ml: 6.3% RSD	
Poland	Institute of Meteorology and Water Management, Warsaw	c= 1.2 mg Ca/l; 1.6% RSD c= 0.4 mg Ca/l; 3.4% RSD c=0.2 mg Ca/l; 6.1% RSD	
	Institute of Environmental Protection, Warsaw (PL5)	M.MAD: 0.003 mg Ca/l CoV: 1.7%	M.MAD: 0.019mg Ca/l CoV: 12.2%
Portugal	Ministèrio do ambiente e recursos naturais, Laboratorio de Santo Andre, Santo Andre	IC: c= 1 mg Ca/l; 3.8% RSD IC: c= 2 mg Ca/l; 3.9% RSD IC: c= 4 mg Ca/l; 0.7% RSD AAS: c= 4 mg Ca/l; 1.8% RSD	
Russian Federation	Inst. of Global Climate and Ecology,		
Slovenia	Hydrometeorological Inst. of Slovenia, Ljubljana		
Spain	Inst de Salud Carlos III	7.4%	
Switzerland	Swiss Fed. Lab. for Mat. testing and Research		M.MAD: 0.02 mg Ca/m3
United Kingdom	AEA Technology, Culham	5%	

Table 3.12:

Magnesium in precipitation

Country / site	Laboratory	Laboratory precision	Method precision
Austria	Umweltbundesamt, Klagenfurt	2% RSD	8.5 % RSD
Commission of European Com	Joint Research Centre, Ispra Establishment	0.13 mg Mg/l (from 1996)	
Czech Republic	Czech Hydrometeorological Institute, Prague	7.6 % RSD	M.MAD: 0.006 mg Mg/l
Estonia		1%	
France	l'Ecole des Mines de Douai, Laboratoire Wolff, Douai	c< 0.2 mg Mg/l; 10-20% c= 0.2-0.5 mg Mg/l; 5-10% c= 0.5-5 mg Mg/l; 1-5%	
Hungary	Institute for Atmospheric Physics, Budapest	<5% RSD	
Italy	C.N.R. Instituto Inquinamento Atmosferico Montelibretto, Rome	c= 0.5 mg Mg/l; 0.7%RSD c= 0.05 mg Mg/l; 2.8%RSD	c= 0.5 mg Mg/l; 1.2% RSD
Latvia	Latvian Hydrometerological Agency, Riga	10% RSD	
Netherlands	National Institute for Public Health and Environmental Protection (RIVM), Bilthoven		c= 0.25-0.36 mg Mg/l; 5% RSD c= 0.36-0.54 mg Mg/l; 4% RSD c= 0.54-0.72 mg Mg/l; 3% RSD c= 0.72-1.8 mg Mg/l; 2% RSD c= >1.8 mg Mg/l; 1.5% RSD
Norway	Norwegian Institute for Air Research, Kjeller	c=0.31 μg Mg/ml: 5.4% RSD c=0.19 μg Mg/ml: 3.4% RSD	
Poland	Institute of Meteorology and Water Management, Warsaw	c= 0.15 mg Mg/l; 0.9% RSD c= 0.05 mg Mg/l; 1.9% RSD c= 0.025 mg Mg/l; 3.6% RSD	
	Institute of Environmental Protection, Warsaw (PL5)	M.MAD: 0.002 mg Mg/l CoV: 7.4%	M.MAD: 0.007 mg Mg/l CoV: 11.0%
Portugal	Ministèrio do ambiente e recursos naturais, Laboratorio de Santo Andre, Santo Andre	IC: c= 1 mg Mg/l; 1.5% RSD IC: c= 2 mg Mg/l; 2.6% RSD IC: c= 4 mg Mg/l; 0.4% RSD AAS: c= 1 mg Mg/l; 1% RSD	
Slovenia	Hydrometeorological Institute of Slovenia, Ljubljana	c=0.1 mg/l; 0.003 mg/l, 3.1% RSD	
Spain	Instituto de Salud Carlos III	7.2%	
Switzerland	Swiss Fed. Lab. for Materials testing and Research		M.MAD: 0.01 mg Mg/m3
United Kingdom	AEA Technology, Culham Abington	3.50%	

Table 3.13:

Sodium in precipitation			
Country / site	Laboratory	Laboratory precision	Method precision
Austria	Umweltbundesamt, Klagenfurt	3.5 %RSD	8.5 %RSD
Commission of European Com.	Joint Research Centre, Ispra Establishment	0.14 Na/l (from 1996)	
Czech Republic	Czech Hydrometeorological Institute, Prague	2 % RSD	M.MAD: 0.019 mg Na/l
Denmark	National Env. Research Institute, Roskilde	-	
Estonia		3%	
France	l'Ecole des Mines de Douai, Laboratoire Wolff, Douai	c< 0.2 mg Na/l; 10-20 % c= 0.2-0.5 mg Na/l; 5-10% c= 0.5-5 mg Na/l; 1-5%	-
Hungary	Institute for Atmospheric Physics, Dep. for Air Chemistry, Budapest	<5% RSD	
Italy	C.N.R. Instituto Inquinamento Atmosferico Montelibretto, Rome	c=0.5 mg Na/l; 0.6% RSD c=0.05 mg Na/l; 2.4% RSD	c=0.5 mg Na/l; 0.7% RSD
Latvia	Latvian Hydrometerological Agency, Riga	11% RSD	
Netherlands	National Institute for Public Health and Environmental Protection (RIVM), Bilthoven	c= 0.25-0.35 mg Na/l; 5% RSD c= 0.35-0.52 mg Na/l; 4% RSD c= 0.52-0.69 mg Na/l; 3% RSD c= 0.69-1.72 mg Na/l; 2% RSD c> 1.72 mg Na/l; 1.5% RSD	
Norway	Norwegian Institute for Air Research, Kjeller	c=0.75 μg Na/ml: 3.6% RSD c=0.3 μg Na/ml: 3.2% RSD	
Poland	Institute of Meteorology and Water Management, Warsaw	c= 0.6 mg Na/l; 0.9% RSD c= 0.2 mg Na/l; 2.4% RSD c= 0.1 mg Na/l; 4.2% RSD	
	Institute of Environmental Protection, Warsaw (PL5)	M.MAD: 0.006 mg Na/l CoV: 14.1%	M.MAD: 0.018 mg Na/l CoV: 10.5%
Portugal	Ministèrio do ambiente e recursos naturais, Laboratorio de Santo Andre, Santo Andre	IC: c= 1 mg Na/l; 4.28% RSD IC: c= 2 mg Na/l; 3.25% RSD IC: c= 4 mg Na/l; 0.54% RSD AAS: c= 1 mg Na/l; 1.9% RSD	
Slovenia	Hydrometeorological Institute of Slovenia, Ljubljana	c= 0.1 mg N/l; 0.007 mg N/l, 6.9% RSD	
Spain	Inst. de Salud Carlos III	14%	
Switzerland	Swiss Fed. Lab. for Materials testing and Research		M.MAD: 0.02 mg Na/m3
Turkey	Refik Saydam Centre of Hygiene, Ankara		
United Kingdom	AEA Technology, Culham Abington	3.50%	

Table 3.14:

Chloride in precipitation			
Country / site	Laboratory	Laboratory precision	Method precision
Austria	Umweltbundesamt, Klagenfurt	2.5% RSD	7.5 % RSD
Commission of European Com.	Joint Research Centre, Ispra Establishment	0.21 mg Cl/l (from 1996)	
Czech Republic	Czech Hydrometeorological Institute, Prague	1.4 % RSD	M.MAD: 0.065 mg Cl/l(
Denmark	National Environmental Research Institute, Roskilde	M.MAD: 0.12 mg Cl/l CoV: 1.54%	-
Estonia		1%	
France	l'Ecole des Mines de Douai, Laboratoire Wolff, Douai	c< 0.2 mg Cl/l; 10-20% c= 0.2-0.5 mg Cl/l; 5-10% c= 0.5-5 mg Cl/l; 1-5%	
Hungary	Institute for Atmospheric Physics, Dep. for Air Chemistry, Budapest	<10% RSD	-
Italy	C.N.R. Instituto Inquinamento Atmosferico Montelibretto, Rome	c= 0.5 mg Cl/l; 0.6% RSD c= 0.05 mg Cl/l; 2.7% RSD	c=0.5 mg Cl/l; 0.9% RSD
Latvia	Latvian Hydrometerological Agency, Riga	14% RSD	
Lithuania	Institute of Physics, Vilnius	c=0.25-2.5 mg Cl/l; 2.25-0.93% RSD	
Norway	Norwegian Institute for Air Research, Kjeller	c=1.16 μg Cl/ml; 3% RSD c=0.46 μg Cl/ml; 4.7% RSD	
Poland	Institute of Meteorology and Water Management, Warsaw	c= 10 mg Cl/l; 1.5% RSD c= 1 mg Cl/l; 1.7% RSD c= 0.5 mg Cl/l; 2.2%RSD	
	Institute of Environmental Protection, Warsaw (PL5)	M.MAD = 0.09 mg Cl/l CoV = 22.7%	M.MAD: 0.101 mg Cl/l CoV: 13.1%
Portugal	Ministèrio do ambiente e recursos naturais, Laboratorio de Santo Andre, Santo Andre	IC: c= 0.5 mg Cl/l; 1.16% RSD IC: c= 1 mg Cl/l; 1% RSD IC: c= 4 mg Cl/l; 0.5% RSD	
Slovenia	Hydrometeorological Institute of Slovenia, Ljubljana	c= 0.2 mg Cl/l; 0.012 mg Cl/l, 5.9% RSD	
Spain	Instituto de Salud Carlos III		
Switzerland	Swiss Fed. Lab. for Materials testing and Research		M.MAD: 0.02 mg Cl/m3
Turkey	Refik Saydam Centre of Hygiene, Ankara	Split samples: M.MAD: 0.02 mg Cl/l CoV: 2.02%	
United Kingdom	AEA Technology, Culham Abington	3%	

Table 3.15:

Ozone		
Country / site	Laboratory	Method lower limit
Commission of European Communities	Joint Research Centre, Ispra Establishment	4 µg/m3 (from 1996)
Denmark	National Environmental Research Institute, Roskilde	1 ppb
Czech Republic	Czech Hydrometeorological Institute, Prague	
Estonia		2 µg/m3
Finland	Finnish Meteorological Institute, Helsingfors	2 µg/m3
France	l'Ecole des Mines de Douai, Laboratoire Wolff, Douai	2 µg/m3
Germany	Umweltbundesamt, Messtelle Schauinsland	2 µg/m3
Italy	C.N.R. Instituto Inquinamento Atmosferico Montelibretto, Rome	1 µg /m3
Norway	Norwegian Institute for Air Research, Kjeller	
Poland	Institute of Meteorology and Water Management, Warsaw	2 µg/m3
	Institute of Environmental Protection, Warsaw (PL5)	
Sweden	Swedish Environmental Research Institute (IVL), Gothenburg	4 µg/m3 and 1 µg/m3
Switzerland	Swiss Federal Laboratory of Testing Materials and Research (EMPA), Dübendorf	2 µg/m3

Table 3.16:

Nitrogen dioxide			
Country / site	Laboratory	Laboratory lower limit	Method lower limit
Commission of European Communities	Joint Research Centre, Ispra Establishment		0.3 µg N/m3 (from 1996)
Czech Republic	Czech Hydrometeorological Institute, Prague	0.001 mg/l	0.07 μg N/m3
Denmark	National Environmental Research Institute, Roskilde	0.01 mg N/l	DK8: 0.08 µg N/m3
Estonia			0.01 μg/m3
Finland	Finnish Meteorological Institute, Helsingfors		Monitor: 0.2 µg N/m3
Germany	Umweltbundesamt, Messtelle Schauinsland	0.5 µg N/m3	
Greece	Ministry of Environment, Physical Planning and Public Works	0.018 mg N/l	
Hungary	Institute for Atmospheric Physics, Dep. for Air Chemistry, Budapest	ca.0.01 mg N/l	0.25 µg N/m3
Italy	C.N.R. Instituto Inquinamento Atmosferico Montelibretto, Rome		0.3 µg N/m3
Lithuania	Institute of Physics, Vilnius	0.02 mg N/l	0.08 µg N/m3
Norway	Norwegian Institute for Air Research, Kjeller	0.0045 mg N/l	
Poland	Institute of Meteorology and Water Management, Warsaw	0.008 mg N/l	0.2 µg N/m3
	Institute of Environmental Protection, Warsaw (PL5)	0.002 mg N/l	0.1 μg N/m3
Russian Federation	Institute of Global Climate and Ecology, Moscow		
Sweden	Swedish Environmental Research Institute (IVL), Gothenburg	0.27 mg N/m3	0.22 µg N/m3
Switzerland	Swiss Federal Laboratory of Testing Materials and Research (EMPA), Dübendorf		CH1: 0.03 µg N/m3 CH4, CH5, 1: 0.3 µg N/m3 CH2, CH3: 0.6 µg N/m3
Yugoslavia	Federal Hydrometeorological Institute, Belgrade	0.91 µg N/m3	

Table 3.17:

Sulphur dioxide			
Country / site	Laboratory	Laboratory lower limit	Method lower limit
Commission of European Communities	Joint Research Centre, Ispra Establishment		1.3 µg S/m3 (from 1996)
Czech Republic	Czech Hydrometeorological Institute, Prague	0.1 mg S/l	0.1 µg S/m3
Denmark	National Environmental Research Institute, Roskilde	0.02 mg S/l	DK3: 0.04 µg S/m3 DK5: 0.05 µg S/m3 DK8: 0.05 µg S/m3
Estonia			0.03 µg S/m3
Finland	Finnish Meteorological Institute, Helsingfors		0.05 µg S/m3
France	l'Ecole des Mines de Douai, Laboratoire Wolff, Douai	0.1 mg S/l in absorbing solution	
Germany	Umweltbundesamt, Messtelle Schauinsland	0.1 µg/m3	
Greece	Ministry of Environment, Physical Planning and Public Works	0.18 mg S/l	
Hungary	Institute for Atmospheric Physics, Dep. for Air Chemistry, Budapest	ca. 0.03 mg S/l	< 0,01 µg S/m3
Ireland	Meteorological Service H.Q., Dublin		0.07 µg S/m3 (1995), 0.1 µg S/m3 (1996)
Italy	C.N.R. Instituto Inquinamento Atmosferico Montelibretto, Rome		0.15 µg S/m3
Lithuania	Institute of Physics, Vilnius	0.06 mg S/l	0.09 µg S/m3
Poland	Institute of Meteorology and Water Management, Warsaw	0.04 mg S/l	0.2 µg S/m3
	Institute of Environmental Protection, Warsaw (PL5)	0.04 mg S/l	0.1 µg S/m3
Russian Federation	Institute of Global Climate and Ecology, Moscow		
Slovenia	Hydrometeorological Institute of Slovenia, Ljubljana		0.085 µg S/m3
Sweden	Swedish Environmental Research Institute (IVL), Gothenburg	0.02 mg S/m3	
Slovenia	Hydrometeorological Institute of Slovenia, Ljubljana		0.06 µg S/m3
Switzerland	Swiss Federal Laboratory of Testing Materials and Research (EMPA), Dübendorf		CH1: 0.03 µg S/m3 CH2, CH3: 0.7 µg S/m3 CH4, CH5: 0.13 µg S/m3
Turkey	Refik Saydam Centre of Hygiene, Ankara		1.45 – 8.8 µg S/sample
United Kingdom	AEA Technology, Culham Abington		
Yugoslavia	Federal Hydrometeorological Institute, Belgrade	2.5 µg S/m3	

Table 3.18:

Sulphate in air			
Country / site	Laboratory	Laboratory lower limit	Method lower limit
Czech Republic	Czech Hydrometeorological Institute, Prague	0.3 µg S/filter	0.03 µg S/m3
Denmark	National Environmental Research Institute, Roskilde		DK3: 0.01 µg S/m3 DK5: 0.02 µg S/m3 DK8: 0.01 µg S/m3
Finland	Finnish Meteorological Institute, Helsingfors		
France	l'Ecole des Mines de Douai, Laboratoire Wolff, Douai	0.2 µg S/filter	
Germany	Umweltbundesamt, Messtelle Schauinsland	0.1 µg S/m3	
Ireland	Meteorological Service H.Q., Dublin		0.28 (1995), 0.03 (1996) µg S/m3
Hungary	Institute for Atmospheric Physics, Dep. for Air Chemistry, Budapest	ca.0.03 mg S/l	0,02 µg S/m3
Italy	C.N.R. Instituto Inquinamento Atmosferico Montelibretto, Rome		0.05 µg S/m3
Lithuania	Institute of Physics, Vilnius	0.06 mg S/l	0.03 µg S/m3
Poland	Institute of Meteorology and Water Management, Warsaw	0.04 mg S/l	0.2 µg S/m3
	Institute of Environmental Protection, Warsaw (PL5)	0.04 mg S/l	0.1 µg S/m3
Russian Federation	Institute of Global Climate and Ecology, Moscow		
Slovenia	Hydrometeorological Institute of Slovenia, Ljubljana	0.081 mg S/l	
Sweden	Swedish Environmental Research Institute (IVL), Gothenburg	0.004 µg Sm3l	
Switzerland	Swiss Federal Laboratory of Testing Materials and Research (EMPA), Dübendorf	0.04 µg S/m3	
Turkey	Refik Saydam Centre of Hygiene, Ankara		0.02 – 0.05 µg S/m3
United Kingdom	AEA Technology, Culham Abington	Bubblers:0.01 mg S/l	

Table 3.19:

Nitrate + nitric acid in air			
Country / site	Laboratory	Laboratory lower limit	Method lower limit
Czech Republic	Czech Hydrometeorological Institute, Prague		
Denmark	National Environmental Research Institute, Roskilde	NO3: 0.03 mg N/l HNO3: 0.03 mg N/l	DK3: 0.04 µg N/m3 DK5: 0.02 µg N/m3 DK8: 0.03 µg N/m3
Finland	Finnish Meteorological Institute, Helsingfors		
Hungary	Institute for Atmospheric Physics, Dep. for Air Chemistry, Budapest	NO3: ca. 0.03 mg N/l HNO3: ca. 0.03 mg N/l	NO3: < 0.1 µg N/m3 HNO3: <0.1 µg N/m3
Italy	C.N.R. Instituto Inquinamento Atmosferico Montelibretto, Rome		NO3: 0.05 µg N/m3 HNO3: 0.02 µg N/m3
Lithuania	Institute of Physics, Vilnius	0.02 mg N/l	0.045 µg N/m3
Norway	Norwegian Institute for Air Research, Kjeller		
Poland	Institute of Meteorology and Water Management, Warsaw	0.02 µg N/ml	0.02 µg N/m3
	Institute of Environmental Protection, Warsaw (PL5)	0.05 mg N/l	0.02 µg N/m3
Russian Federation	Institute of Global Climate and Ecology, Moscow		
Slovenia	Hydrometeorological Institute of Slovenia, Ljubljana		NO3: 0.19 µg N/m3 HNO3: 0.039 µg N/m3
Sweden	Swedish Environmental Research Institute (IVL), Gothenburg	NO3: 0.002 mg N/l HNO3: 0.005 mg N/l	
Switzerland	Swiss Federal Laboratory of Testing Materials and Research (EMPA), Dübendorf		0.02 µg N/m3
Turkey	Refik Saydam Centre of Hygiene, Ankara		NO3: 0.02 – 0.05 µg N/m3

Table 3.20:

Ammonia + ammonium in air			
Country / site	Laboratory	Laboratory lower limit	Method lower limit
Czech Republic	Czech Hydrometeorological Institute, Prague		
Denmark	National Environmental Research Institute, Roskilde	0.03 mg N/l	DK3:0.10 µg N/m3 DK5:0.08 µg N/m3 DK8:0.09 µg N/m3
Finland	Finnish Meteorological Institute, Helsingfors	-	
Hungary	Institute for Atmospheric Physics, Dep. for Air Chemistry, Budapest	NH3: ca. 0.04 mg N/l NH4: ca. 0.04 mg N/l	NH3: ca.0,05 µg N/m3 NH4: <0.1 µg N/m3
Italy	C.N.R. Instituto Inquinamento Atmosferico Montelibretto, Rome		NH4: 0.1 µg N/m3 NH3; 0.05 µg N/m3
Lithuania	Institute of Physics, Vilnius	0.04 mg N/l	0.03 µg N/m3
Norway	Norwegian Institute for Air Research, Kjeller		
Poland	Institute of Meteorology and Water Management, Warsaw	0.02 mg N/l	0.06 µg N/m3
	Institute of Environmental Protection, Warsaw (PL5)	0.01 mg N/l	0.03 µg N/m3
Russian Federation	Institute of Global Climate and Ecology, Moscow		
Slovenia	Hydrometeorological Institute of Slovenia, Ljubljana		NH4:0.015 µg N/m3 NH3: 0.079 µg N/m3
Sweden	Swedish Environmental Research Institute (IVL), Gothenburg	NH4: 0.02 µg N/m3 NH3: 0.03 µg N/m3	
Switzerland	Swiss Federal Laboratory of Testing Materials and Research (EMPA), Dübendorf		0.2 µg N/m3
Turkey	Refik Saydam Centre of Hygiene, Ankara		

Table 3.21:

Nitrate in precipitation			
Country / site	Laboratory	Laboratory lower limit	Method lower limit
Austria	Umweltbundesamt, Klagenfurt	4μg N/l	10 μg N/l
Czech Republic	Czech Hydrometeorological Institute, Prague	30 μg N/l	30 μg N/l
Denmark	National Environmental Research Institute, Roskilde	0.04 mg N/l	
Estonia		0.02 mg N/l	
Finland	Finnish Meteorological Institute, Helsingfors		
France	l'Ecole des Mines de Douai, Laboratoire Wolff, Douai	0.02 mg N/l	
Germany	Umweltbundesamt, Messtelle Schauinsland	0.01 mg N/l	
Hungary	Institute for Atmospheric Physics, Dep. for Air Chemistry, Budapest	ca.0.03 mg N/l	ca 0.03 mg N/l
Italy	C.N.R. Instituto Inquinamento Atmosferico Montelibretto, Rome		0.01 μg N/l
Latvia	Latvian Hydrometerological Agency, Riga	0.1 mg N/l	
Lithuania	Institute of Physics, Vilnius	0.02 mg N/l	
Netherlands	National Institute for Public Health and Environmental Protection (RIVM), Bilthoven	0.028 mg N/l	
Norway	Norwegian Institute for Air Research, Kjeller	0.01 mg N/l	
Poland	Institute of Environmental Protection, Warsaw (PL5)	0.05 mg N/l	
Portugal	Ministèrio do ambiente e recursos naturais, Laboratorio de Santo Andre, Santo Andre	0.02 mg N/l	
Russian Federation	Institute of Global Climate and Ecology, Moscow	0.01 mg N/l	
Slovenia	Hydrometeorological Institute of Slovenia, Ljubljana	0.066 mg N/l	
Spain	Instituto de Salud Carlos III	0.12 mg N/l	
Sweden	Swedish Environmental Research Institute (IVL), Gothenburg	0.006 mg N/l	
Switzerland	Swiss Federal Laboratory of Testing Materials and Research (EMPA), Dübendorf	0.02 mg N/l	
Turkey	Refik Saydam Centre of Hygiene, Ankara		
United Kingdom	AEA Technology, Culham Abington	0.03 mg N/l	
Yugoslavia	Federal Hydrometeorological Institute, Belgrade	0.02 mg N/l	

Table 3.22:

Sulphate in precipitation			
Country / site	Laboratory	Laboratory lower limit	Method lower limit
Austria	Umweltbundesamt, Klagenfurt	0.040 mg S/l	0.01 mg S/l
Czech Republic	Czech Hydrometeorological Institute, Prague	0.2 mg S/l	0.2 mg S/l
Denmark	National Environmental Research Institute, Roskilde	0.02 mg S/l	
Estonia		0.1 mg S/l	
Finland	Finnish Meteorological Institute, Helsingfors		
France	l'Ecole des Mines de Douai, Laboratoire Wolff, Douai	0.02 mg S/l	
Germany	Umweltbundesamt, Messtelle Schauinsland	0.01 mg S/l	
Hungary	Institute for Atmospheric Physics, Dep. for Air Chemistry, Budapest	ca.0.03 mg S/l	ca. 0.03 mg S/l
Italy	C.N.R. Instituto Inquinamento Atmosferico Montelibretto, Rome		0.01 mg S/l
Latvia	Latvian Hydrometerological Agency, Riga	0.15 mg S/l	
Lithuania	Institute of Physics, Vilnius	0.06 mg S/l	
Netherlands	National Institute for Public Health and Environmental Protection (RIVM), Bilthoven	0.032 mg S/l	
Norway	Norwegian Institute for Air Research, Kjeller	0.01 mg S/l	
Poland	Institute of Meteorology and Water Management, Warsaw		
	Institute of Environmental Protection, Warsaw (PL5)	0.05 mg S/l	
Portugal	Ministèrio do ambiente e recursos naturais, Laboratorio de Santo Andre, Santo Andre	0.05 mg S/l	
Russian Federation	Institute of Global Climate and Ecology, Moscow	0.02 mg S/l	
Slovenia	Hydrometeorological Institute of Slovenia, Ljubljana	0.081 mg/l	
Spain	Instituto de Salud Carlos III	0.16 mg S/l	
Sweden	Swedish Environmental Research Institute (IVL), Gothenburg	0.005 mg S/l	
Switzerland	Swiss Federal Laboratory of Testing Materials and Research (EMPA), Dübendorf	0.03 mg S/l	
United Kingdom	AEA Technology, Culham Abington	0.04 mg S/l	
Yugoslavia	Federal Hydrometeorological Institute, Belgrade	0.05 mg S/l	

Table 3.23:

Potassium in precipitation			
Country / site	Laboratory	Laboratory lower limit	Method lower limit
Austria	Umweltbundesamt, Klagenfurt	0.080 mg K/l	0.1 mg K/l
Commission of European Com.	Joint Research Centre, Ispra Establishment		0.07 mg K/l (from 1996)
Czech Republic	Czech Hydrometeorological Institute, Prague	0.03 mg K/l	0.03 mg K/l
Estonia		0.1 mg K/l	
Finland	Finnish Meteorological Institute, Helsingfors		
France	l'Ecole des Mines de Douai, Laboratoire Wolff, Douai	0.02 mg K/l	
Germany	Umweltbundesamt, Messtelle Schauinsland	0.01 mg K/l	
Hungary	Institute for Atmospheric Physics, Dep. for Air Chemistry, Budapest	ca. 0.01 mg K/l	Ca. 0.01 mg K/l
Italy	C.N.R. Instituto Inquinamento Atmosferico Montelibretto, Rome		0.01 mg K/l
Latvia	Latvian Hydrometerological Agency, Riga	0.012 mg K/l	
Lithuania	Institute of Physics, Vilnius	0.02 mg K/l	
Netherlands	National Inst. for Public Health and Env. Protection, Bilthoven	0.039 mg K/l	
Norway	Norwegian Institute for Air Research, Kjeller	0.01 mg K/l	
Poland	Institute of Meteorology and Water Management, Warsaw	0.02 mg K/l	
	Institute of Environmental Protection, Warsaw (PL5)	0.003 mg K/l	
Portugal	Ministèrio do ambiente e recursos naturais, Laboratorio de Santo Andre, Santo Andre	IC: 0.077 mg K/l, AAS: 0.015 mg K/l	
Russian Federation	Institute of Global Climate and Ecology, Moscow	0.03 mg K/l	
Slovenia	Hydrometeorological Institute of Slovenia, Ljubljana	0.02 mg K/l	
Spain	Instituto de Salud Carlos III	0.05 mg K/l	
Sweden	Swedish Environmental Research Institute (IVL), Gothenburg	0.02 mg K/l	
Switzerland	Swiss Federal Lab. of Testing Mat. and Research Dübendorf	0.01 mg K/l	
Turkey	Refik Saydam Centre of Hygiene, Ankara		
United Kingdom	AEA Technology, Culham	0.05 mg K/l	
Yugoslavia	Federal Hydrometeorological Institute, Belgrade	0.006 mg K/l	

Table 3.24:

Ammonium in precipitation			
Country / site	Laboratory	Laboratory lower limit	Method lower limit
Austria	Umweltbundesamt, Klagenfurt	0.020 mg N/l	0.02 mg N/l
Commission of European Com.	Joint Research Centre, Ispra Establishment		0.13 mg N/l (from 1996)
Czech Republic	Czech Hydrometeorological Institute, Prague	0.02 mg N/l	0.26 mg N/l
Denmark	National Environmental Research Institute, Roskilde	0.04 mg N/l	
Estonia		0.01 mg N/l	
Finland	Finnish Meteorological Institute,		
France	l'Ecole des Mines de Douai, Laboratoire Wolff, Douai	0.03 mg N/l	
Germany	Umweltbundesamt, Messtelle Schauinsland	0.01 mg N/l	
Hungary	Institute for Atmospheric Physics, Dep. for Air Chemistry, Budapest	ca. 0.04 mg N/ml	ca 0.04 mg N/l
Italy	C.N.R. Instituto Inquinamento Atmosferico Montelibretto, Rome		0.005 mg N/l
Latvia	Latvian Hydrometerological Agency, Riga	0.03 mg N/l	
Lithuania	Institute of Physics, Vilnius	0.04 mg N/l	
Netherlands	National Inst. for Public Health and Env. Protection, Bilthoven	0.014 mg N/l	
Norway	Norwegian Institute for Air Research, Kjeller	0.01 mg N/l	
Poland	Institute of Meteorology and Water Management, Warsaw		
	Institute of Environmental Protection, Warsaw (PL5)	0.01 mg N/l	
Portugal	Ministèrio do ambiente e recursos naturais, Laboratorio de Santo Andre, Santo Andre	0.03 mg N/l	
Russian Federation	Institute of Global Climate and Ecology, Moscow	0.02 mg N/l	
Slovenia	Hydrometeorological Institute of Slovenia, Ljubljana	0.026 mg N/l	
Spain	Instituto de Salud Carlos III	0.08 mg N/l	
Sweden	Swedish Environmental Research Institute (IVL), Gothenburg	0.02 mg N/l	
Switzerland	Swiss Federal Laboratory of Testing Materials and Research (EMPA), Dübendorf	0.02 mg N/l	
Turkey	Refik Saydam Centre of Hygiene, Ankara		
United Kingdom	AEA Technology, Culham	0.03 mg N/l	
Yugoslavia	Federal Hydrometeorological Inst., Belgrade	0.03 mg N/l	

Table 3.25:

Calcium in precipitation			
Country / site	Laboratory	Laboratory lower limit	Method lower limit
Austria	Umweltbundesamt, Klagenfurt	0.10 mg Ca/l	0.1 mg Ca/l
Commission of European Com	Joint Research Centre, Ispra Establishment		0.4 mg Ca/l (from 1996)
Czech Republic	Czech Hydrometeorological Institute, Prague	0.11 mg Ca/l	0.11 mg Ca/l
Estonia		2 mg Ca/l	
Finland	Finnish Meteorological Institute		
France	l'Ecole des Mines de Douai, Laboratoire Wolff, Douai	0.02 mg Ca/l	
Germany	Umweltbundesamt, Messtelle Schauinsland	0.01 mg Ca/l	
Hungary	Institute for Atmospheric Physics, Dep. for Air Chemistry, Budapest	Ca. 0.01 mg Ca/l	ca. 0.01 mg Ca/l
Italy	C.N.R. Instituto Inquinamento Atmosferico Montelibretto, Rome	0.01 mg Ca/l	
Latvia	Latvian Hydrometerological Agency, Riga	0.015 mg Ca/l	
Lithuania	Institute of Physics, Vilnius	0.02 mg Ca/l	
Netherlands	National Inst. for Public Health and Env. Protection, Bilthoven	0.012 mg Ca/l	
Norway	Norwegian Institute for Air Research, Kjeller	0.01 mg Ca/l	
Poland	Institute of Meteorology and Water Management, Warsaw	0.03 mg Ca/l	
	Institute of Environmental Protection, Warsaw (PL5)	0.001 mg Ca/l	
Portugal	Ministèrio do ambiente e recursos naturais, Laboratorio de Santo Andre, Santo Andre	IC: 0.06 mg Ca/l; AAS: 0.018 mg Ca/l	
Russian Federation	Institute of Global Climate and Ecology, Moscow	0.05 mg Ca/l	
Slovenia	Hydrometeorological Institute of Slovenia, Ljubljana	0.01 mg Ca/l	
Spain	Instituto de Salud Carlos III	0.04 mg Ca/l	
Sweden	Swedish Environmental Research Institute (IVL), Gothenburg	0.02 mg Ca/l	
Switzerland	Swiss Federal Laboratory of Testing Materials and Research (EMPA), Dübendorf	0.03 mg Ca/l	
Turkey	Refik Saydam Centre of Hygiene,		
United Kingdom	AEA Technology, Culham Abington	0.05 mg Ca/l	
Yugoslavia	Federal Hydrometeorological Institute, Belgrade	0.005 mg Ca/l	

Table 3.26:

Magnesium in precipitation			
Country / site	Laboratory	Laboratory lower limit	Method lower limit
Austria	Umweltbundesamt, Klagenfurt	0.020 mg Mg/l	0.1 mg Mg/l
Commission of European Communities	Joint Research Centre, Ispra Establishment		0.06 mg Mg/l (from 1996)
Czech Republic	Czech Hydrometeorological Institute, Prague	0.01 mg Mg/l	0.01 mg Mg/l
Estonia		1 mg Mg/l	
Finland	Finnish Meteorological Institute, Helsingfors		
France	l'Ecole des Mines de Douai, Laboratoire Wolff, Douai	0.02 mg Mg/l	
Germany	Umweltbundesamt, Messtelle Schauinsland	0.01 mg Mg/l	
Hungary	Institute for Atmospheric Physics, Dep. for Air Chemistry, Budapest	Ca. 0.01 mg Mg/l	Ca 0.01 mg Mg/l
Italy	C.N.R. Instituto Inquinamento Atmosferico Montelibretto, Rome		0.005 mg Mg/l
Latvia	Latvian Hydrometerological Agency, Riga	0.005 mg Mg/l	
Netherlands	National Institute for Public Health and Environmental Protection (RIVM), Bilthoven	0.036 mg Mg/l	
Norway	Norwegian Institute for Air Research, Kjeller	0.01 mg Mg/l	
Poland	Institute of Meteorology and Water Management, Warsaw	0.007 mg Mg/l	
	Institute of Environmental Protection, Warsaw (PL5)	0.001 mg Mg/l	
Portugal	Ministèrio do ambiente e recursos naturais, Laboratorio de Santo Andre, Santo Andre	IC: 0.03 mg Mg/l, AAS: 0.002 mg Mg/l	
Russian Federation	Institute of Global Climate and Ecology, Moscow	0.001 mg Mg/l	
Slovenia	Hydrometeorological Institute of Slovenia, Ljubljana	0.01 mg Mg/l	
Spain	Instituto de Salud Carlos III	0.02 mg Mg/l	
Sweden	Swedish Environmental Research Institute (IVL), Gothenburg	0.02 mg Mg/l	
Switzerland	Swiss Federal Lab. of Testing Mat. and Research Dübendorf	0.01 mg Ca/l	
Turkey	Refik Saydam Centre of Hygiene,		
United Kingdom	AEA Technology, Culham Abington	0.05 mg Mg/l	
Yugoslavia	Federal Hydrometeorological Institute, Belgrade	0.003 mg Mg/l	

Table 3.27:

Sodium in precipitation			
Country / site	Laboratory	Laboratory lower limit	Method lower limit
Austria	Umweltbundesamt, Klagenfurt	0.10 mg Na/l	0.1 mg Na/l
Commission of European Com.	Joint Research Centre, Ispra Establishment		0.04 mg Na/l (from 1996)
Czech Republic	Czech Hydrometeorological Institute, Prague	0.02 mg Na/l	0.02 mg Na/l
Estonia		0.1 mg Na/l	
Finland	Finnish Meteorological Institute		
France	l'Ecole des Mines de Douai, Laboratoire Wolff, Douai	0.02 mg Na/l	
Germany	Umweltbundesamt, Messtelle Schauinsland	0.01 mg Na/l	
Hungary	Institute for Atmospheric Physics, Dep. for Air Chemistry, Budapest	ca. 0.01 mg Na/l	ca 0.01 mg Na/l
Italy	C.N.R. Instituto Inquinamento Atmosferico Montelibretto, Rome		0.005 mg Na/l
Lithuania	Institute of Physics, Vilnius	0.02 mg Na/l	
Latvia	Latvian Hydrometerological Agency, Riga	0.013 mg Na/l	
Netherlands	National Institute for Public Health and Environmental Protection (RIVM), Bilthoven	0.034 mg Na/l	
Norway	Norwegian Institute for Air Research, Kjeller	0.01 mg Na/l	
Poland	Institute of Meteorology and Water Management, Warsaw	0.05 mg Na/l	
	Institute of Environmental Protection, Warsaw (PL5)	0.003 mg Na/l	
Portugal	Ministèrio do ambiente e recursos naturais, Laboratorio de Santo Andre, Santo Andre	IC: 0.024 mg Na/l, AAS: 0.006 mg Na/l	
Russian Federation	Institute of Global Climate and Ecology, Moscow	0.01 mg Na/l	
Slovenia	Hydrometeorological Institute of Slovenia, Ljubljana	0.02 mg Na/l	
Spain	Instituto de Salud Carlos III	0.12 mg Na/l	
Sweden	Swedish Environmental Research Institute (IVL), Gothenburg	0.02 mg Na/l	
Switzerland	Swiss Federal Lab. of Testing Mat. and Research Dübendorf	0.02 mg Na/l	
Turkey	Refik Saydam Centre of Hygiene,		
United Kingdom	AEA Technology, Culham Abington	0.03 mg Na/l	
Yugoslavia	Federal Hydrometeorological Institute, Belgrade	0.002 mg Na/l	

Table 3.28:

Chloride in precipitation			
Country / site	Laboratory	Laboratory lower limit	Method lower limit
Austria	Umweltbundesamt, Klagenfurt	0.1 mg Cl/l	0.2 mg Cl/l
Commission of European Com	Joint Research Centre, Ispra Establishment		0.09 mg Cl/l
Czech Republic	Czech Hydrometeorological Institute, Prague	0.2 mg Cl/l	0.2 mg Cl/l
Denmark	National Environmental Research Institute, Roskilde	0.27 mg Cl/l	
Estonia		0.1 mg Cl/l	
Finland	Finnish Meteorological Institute,		
France	l'Ecole des Mines de Douai, Laboratoire Wolff, Douai	0.05 mg Cl/l	
Germany	Umweltbundesamt, Messtelle Schauinsland	0.01 mg Cl/l	
Hungary	Institute for Atmospheric Physics, Dep. for Air Chemistry, Budapest	ca.0.1 mg Cl/l	ca 0.01 mg Cl/l
Italy	C.N.R. Instituto Inquinamento Atmosferico Montelibretto, Rome		0.005 mg Cl/l
Latvia	Latvian Hydrometerological Agency, Riga	0.1 mg Cl/l	
Lithuania	Institute of Physics, Vilnius	0.06 mg Cl/l	
Netherlands	National Inst. for Public Health and Env. Protection, Bilthoven	0.11 mg Cl/l	
Norway	Norwegian Institute for Air Research, Kjeller	0.01 mg Cl/l	
Poland	Institute of Meteorology and Water Management, Warsaw	0.05 mg Cl/l	
	Institute of Environmental Protection, Warsaw (PL5)	0.10 mg Cl/l	
Portugal	Ministèrio do ambiente e recursos naturais, Lab. de Santo Andre,	0.03 mg Cl/l	
Russian Federation	Institute of Global Climate and Ecology, Moscow	0.03 mg Cl/l	
Slovenia	Hydrometeorological Institute of Slovenia, Ljubljana	0.04 mg Cl/l	
Spain	Instituto de Salud Carlos III	0.31 mg Cl/l	
Sweden	Swedish Environmental Research Institute (IVL), Gothenburg	0.05 mg Cl/l	
Switzerland	Swiss Federal Lab. of Testing Mat. and Research, Dübendorf	0.05 mg Cl/l	
United Kingdom	AEA Technology, Culham	0.05 mg Cl/l	
Turkey	Refik Saydam Centre of Hygiene		
Yugoslavia	Federal Hydrometeorological Institute, Belgrade	0.05 mg Cl/l	

Annex 4

Data quality at the different stations

Austria

Site code and name	Component	Sampling frequency	Sampling period	Methods in field	Methods in laboratory	Data quality	Comments
	Precipitation:						
Illmitz AT2	amount	daily	24 hours	wet-only			
St. Koloman AT4	SO4	daily	24 hours	wet-only	IC	A	
Vorhegg AT5	H						not measured
	pH	daily	24 hours	wet only	pH meter	A	
	NH4	daily	24 hours	wet-only	IC	A	
	NO3	daily	24 hours	wet-only	IC	A	
	Na	daily	24 hours	wet-only	IC	A	
	Mg	daily	24 hours	wet-only	IC	B	
	Cl	daily	24 hours	wet-only	IC	A	
	Ca	daily	24 hours	wet-only	IC	A	
	K	daily	24 hours	wet-only	IC	A	
	κ	daily	24 hours	Cond. meter		A	
	Air:						
	SO2(g)		continuous	DOAS		D	daily averages reported
	NO2(g)		continuous	DOAS		D	daily averages reported
	HNO3(g)						not measured
	NH3(g)						not measured
	SO4(p)	daily	24 hours	filter	IC	A	Whatman 41 filter, 3-4 m3/day
	NO3(p)						not measured
	NH4(p)						not measured
	HNO3(g)+NO3(p)						not measured
	NH3(g)+NH4(p)						not measured

Comments: Good precipitation measurements**.** SO4 in particles measured at AT2 only.
Completeness SO2 79, 40 and 20 per cent respectively at AT 2-5, NO2 68, 47 and 26 per cent, and SO4(p) at AT2 has 70 per cent completeness.
Recommendations: SO2 and NO2 are useless for EMEP, it is strongly recommended to change methods for air measurements. There is also a need to measure all nitrogen components in air.

Croatia

Site code and name	Component	Sampling frequency	Sampling period	Methods in field	Methods in laboratory	Data quality	Comments
Puntijarka HR2 Zavizan HR4	**Precipitation:** amount SO4 H pH NH4 NO3 Na Mg Cl Ca K κ **Air:** SO2(g) NO2(g) HNO3(g) NH3(g) SO4(p) NO3(p) NH4(p) HNO3(g)+NO3(p) NH3(g)+NH4(p)						

Comments: No data reported for 1997

Recommendations: Earlier results show a need for continued efforts on the QA/QC, and a need for replacement of outdated methods

Czech Republic

Site code and name	Component	Sampling frequency	Sampling period	Methods in field	Methods in laboratory	Data quality	Comments
	Precipitation:						
Svratouch CS 1	amount	weekly	1 week	bulk			
	SO4	weekly	1 week	bulk	IC	A	
	H						not measured
	pH	weekly	1 week	bulk	pH meter	B	
	NH4	weekly	1 week	bulk	?	B	
	NO3	weekly	1 week	bulk	IC	B	
	Na	weekly	1 week	bulk	AES	B	
	Mg	weekly	1 week	bulk	AAS	B	
	Cl	weekly	1 week	bulk	IC	B	
	Ca	weekly	1 week	bulk	AAS	B	
	K	weekly	1 week	bulk	AES	B	
	κ	weekly	1 week	bulk	Cond. meter	A	
	Air:						
	SO2(g)	daily	24 hours	filter	Thorin	B	KOH imp. W41, 6-8 m3/day
	NO2(g)	daily	24 hours	filter	Griess	C	NaOH imp. W40 filter 0.72 m3/day
	HNO3(g)						not measured
	NH3(g)						not measured
	SO4(p)	daily	24 hours	filter	XRF	B	W40 filter, 6-8 m3/day
	NO3(p)						not measured
	NH4(p)						not measured
	HNO3(g)+NO3(p)	daily	24 hours	filter-2-pack	Griess	D	see below, HNO3 with NaCl imp.
	NH3(g)+NH4(p)	daily	24 hours	filter-2-pack	Indophenol	B	see below, NH3 with H2OX imp.

Comments: NO3(p) and NH4(p) sampled on S&S TE36 with 5 m3/day, NH3(g) on W 41 with 5 m3/day, HNO3 on W41 with 0.72 m3/day
Completeness NO2 was only 50 per cent. Completeness precipitation components lower than 80 per cent.
Recommendations: Sampling of the nitrogen compounds on filters do not give reliable individual concentrations, the sum has therefore been given in the table. To get individual concentrations denuders are recommended. Poor data qualities on air components are given due to big discrepancies in the field comparison at CS3. It is recommended to follow the EMEP programme with respect to sampling period for precipitation. Wet only sampler is recommended.

Czech Republic

Site code and name	Component	Sampling frequency	Sampling period	Methods in field	Methods in laboratory	Data quality	Comments
	Precipitation:						
Kosetice CS 3	amount	daily	24 hours	wet-only			
	SO4	daily	24 hours	wet-only	IC	A	
	H						not measured
	pH	daily	24 hours	wet-only	pH meter	A	
	NH4	daily	24 hours	wet-only	?	A	
	NO3	daily	24 hours	wet-only	IC	A	
	Na	daily	24 hours	wet-only	AES	A	
	Mg	daily	24 hours	wet-only	AAS	A	
	Cl	daily	24 hours	wet-only	IC	A	
	Ca	daily	24 hours	wet-only	AAS	A	
	K	daily	24 hours	wet-only	AES	A	
	κ	daily	24 hours	wet-only	Cond. meter	A	
	Air:						
	SO2(g)	daily	24 hours	filter	Thorin	B	KOH imp. W41, 6-8 m3/day
	NO2(g)	daily	24 hours	filter	Griess	C	NaOH imp. W40 filter 0.72 m3/day
	HNO3(g)						not measured
	NH3(g)						not measured
	SO4(p)	daily	24 hours	filter	XRF	B	W40 filter, 6-8 m3/day
	NO3(p)						not measured
	NH4(p)						not measured
	HNO3(g)+NO3(p)	daily	24 hours	2- filter pack	Griess	D	see below, HNO3 with NaCl imp.
	NH3(g)+NH4(p)	daily	24 hours	2- filter pack	Indophenol	B	see below, NH3 with H2OX imp.

Comments: NO3(p) and NH4(p) sampled on S&S TE36 with 5 m3/day, NH3(g) on W 41 with 5 m3/day, HNO3 on W41 with 0.72 m3/day
Recommendations: Sampling of the nitrogen compounds on filters do not give reliable individual concentrations, the sum has therefore been given in the table, To get individual concentrations denuders are recommended. Poor data qualities on air components are given due to big discrepancies in the field comparison test.

Denmark

Site code and name	Component	Sampling frequency	Sampling period	Methods in field	Methods in laboratory	Data quality	Comments
	Precipitation:						
Tange DK3	amount	daily	24 hours	wet-only			
Keldsnor DK5	SO4	daily	24 hours	wet-only	IC	A	
	H						not measured
	pH	daily	24 hours	wet-only	pH meter	A	
	NH4	daily	24 hours	wet-only	Berthelot	A	
	NO3	daily	24 hours	wet-only	IC	A	
	Na	daily	24 hours	wet-only	AAS	A	
	Mg	daily	24 hours	wet-only	AAS	A	
	Cl	daily	24 hours	wet-only	IC	A	
	Ca	daily	24 hours	wet-only	AAS	A	
	K	daily	24 hours	wet-only	AAS	A	
	κ	daily	24 hours	wet-only	Cond. meter	B	
	Air:						
	SO2(g)	daily	24 hours	filter-3 pack	IC	A	NaF and KOH impr W41
	NO2(g)	daily	24 hours	KI method	Griess	A	Glass sinter 0.7 m3/day
	HNO3(g)						not measured
	NH3(g)						not measured
	SO4(p)	daily	24 hours	filter-3-pack	PIXE	B	MP RAWP
	NO3(p)						not measured
	NH4(p)						not measured
	HNO3(g)+NO3(p)	daily	24 hours	filter-3-pack	Griess	A	W41 NaF impregnated
	NH3(g)+NH4(p)	daily	24 hours	filter-3-pack	Berthelot	A	W41 H2OX impregnated

Comments: PIXE is not a recommended method. Filter-3-pack samples 58 m3/day. Precipitation amounts completeness only 76 per cent at DK5, summer months missing.

Recommendations: Compare PIXE with recommended method and quantify differences.

Denmark

Site code and name	Component	Sampling frequency	Sampling period	Methods in field	Methods in laboratory	Data quality	Comments
	Precipitation:						
Anholt DK8	amount	weekly	one week	wet-only			
	SO4	weekly	one week	wet-only	IC	A	
	H						not measured
	pH	weekly	one week	wet-only	pH meter	A	
	NH4	weekly	one week	wet-only	Berthelot	A	
	NO3	weekly	one week	wet-only	IC	A	
	Na	weekly	one week	wet-only	AAS	A	
	Mg	weekly	one week	wet-only	AAS	A	
	Cl	weekly	one week	wet-only	IC	A	
	Ca	weekly	one week	wet-only	AAS	A	
	K	weekly	one week	wet-only	AAS	A	
	κ	weekly	one week	wet-only	Cond. meter	B	
	Air:						
	SO2(g)	daily	24 hours	filter-3 pack	IC	A	NaF and KOH impr W41
	NO2(g)	daily	24 hours	KI method	Griess	A	Glass sinter 0.7 m^3/day
	HNO3(g)						not measured
	NH3(g)						not measured
	SO4(p)	daily	24 hours	filter-3-pack	PIXE	B	MP RAWP
	NO3(p)						not measured
	NH4(p)						not measured
	HNO3(g)+NO3(p)	daily	24 hours	filter-3-pack	Griess	A	W41 NaF impregnated
	NH3(g)+NH4(p)	daily	24 hours	filter-3-pack	Berthelot	A	W41 H2OX impregnated

Comments: PIXE is not recommended method. Filter-3-pack samples 58 m^3/day.

Recommendations: Compare PIXE with recommended method and quantify differences.

Estonia

Site code and name	Component	Sampling frequency	Sampling period	Methods in field	Methods in laboratory	Data quality	Comments
Vilsandy, EE11	**Precipitation:**						
	amount	daily	24 hours	Bulk			
	SO4	daily	24 hours	Bulk	IC	C	
	H						not measured
	pH	daily	24 hours	Bulk	pH meter	C	
	NH4	daily	24 hours	Bulk	Berthelot	C	
	NO3	daily	24 hours	Bulk	IC	C	
	Na	daily	24 hours	Bulk	AES	C	
	Mg	daily	24 hours	Bulk	AAS	C	
	Cl	daily	24 hours	Bulk	IC	C	
	Ca	daily	24 hours	Bulk	AAS	C	
	K	daily	24 hours	Bulk	AES	C	
	κ	daily	24 hours	Bulk	Cond. meter	D	
	Air:						
	SO2(g)		continuous	monitor		D	UV fluorescence, daily averages rep.
	NO2(g)	daily	24 hours	KI method		B	Adsorbing tubes
	HNO3(g)						not measured
	NH3(g)						not measured
	SO4(p)						not measured
	NO3(p)						not measured
	NH4(p)						not measured
	HNO3(g)+NO3(p)						not measured
	NH3(g)+NH4(p)						not measured

Comments: Completeness of SO2 and NO2 measurements are 70 and 76 per cent respectively. Routine measurements give generally poor ion balance

Recommendations: Improvements of QA/QC procedures in the laboratory. Change to recommended methods for air components.

Estonia

Site code and name	Component	Sampling frequency	Sampling period	Methods in field	Methods in laboratory	Data quality	Comments
Lahemaa, EE9	**Precipitation:**						
	amount	daily	24 hours	Bulk			
	SO4	daily	24 hours	Bulk	IC	C	
	H						not measured
	pH	daily	24 hours	Bulk	pH meter	C	
	NH4	daily	24 hours	Bulk	Berthelot	C	
	NO3	daily	24 hours	Bulk	IC	C	
	Na	daily	24 hours	Bulk	AES	C	
	Mg	daily	24 hours	Bulk	AAS	C	
	Cl	daily	24 hours	Bulk	IC	C	
	Ca	daily	24 hours	Bulk	AAS	C	
	K	daily	24 hours	Bulk	AES	C	
	κ	daily	24 hours	Bulk	Cond. meter	D	
	Air:						
	SO2(g)						
	NO2(g)		continuous	monitor		D	Chemiluminescence, daily averages
	HNO3(g)						not measured
	NH3(g)						not measured
	SO4(p)						not measured
	NO3(p)						not measured
	NH4(p)						not measured
	HNO3(g)+NO3(p)						not measured
	NH3(g)+NH4(p)						not measured

Comments: Routine measurements give generally poor ion balance

Recommendations: Improve QA/QC procedures in the laboratory. Change to recommended methods for air components.

Finland

Site code and name	Component	Sampling frequency	Sampling period	Methods in field	Methods in laboratory	Data quality	Comments
	Precipitation:						
Utoe F19	amount	daily	24 hours	bulk			
Virolahti FI17	SO4	daily	24 hours	bulk	IC	A	
Oulanka FI22	H						
	pH	daily	24 hours	bulk	IC	A	
	NH4	daily	24 hours	bulk	IC	A	
	NO3	daily	24 hours	bulk	IC	A	
	Na	daily	24 hours	bulk	IC	A	
	Mg	daily	24 hours	bulk	IC	A	
	Cl	daily	24 hours	bulk	IC	A	
	Ca	daily	24 hours	bulk	IC	A	
	K	daily	24 hours	bulk	IC	A	
	κ	daily	24 hours	bulk	IC	A	
	Air:						
	SO2(g)	daily	24 hours	filter-2-pack	IC	B	W40, NaOH impr. 24 m3/day
	NO2(g)		continuous	monitor	-	D	Chemiluminescence
	HNO3(g)						not measured
	NH3(g)						not measured
	SO4(p)	daily	24 hours	filter-2-pack	IC	A	W40, 24 m3/day
	NO3(p)						not measured
	NH4(p)						not measured
	HNO3(g)+NO3(p)	daily	24 hours	filter-2-pack	IC	A	W40 + W40 NaOH imp., 24 m3/day
	NH3(g)+NH4(p)	daily	24 hours	filter-1-pack	IC	A	W40, H2OX imp., 24 m3/day

Comments:

Recommendations: The NO2 method is recommended replaced with the KI method from the Manual.

Finland

Site code and name	Component	Sampling frequency	Sampling period	Methods in field	Methods in laboratory	Data quality	Comments
	Precipitation:						
Ahtari FI4	amount	daily	24 hours	Bulk			
Ahtari(II) FI 37	SO4	daily	24 hours	Bulk	IC	A	
	H						not measured
	pH	daily	24 hours	Bulk	IC	A	
	NH4	daily	24 hours	Bulk	IC	A	
	NO3	daily	24 hours	Bulk	IC	A	
	Na	daily	24 hours	Bulk	IC	A	
	Mg	daily	24 hours	Bulk	IC	A	
	Cl	daily	24 hours	Bulk	IC	A	
	Ca	daily	24 hours	Bulk	IC	A	
	K	daily	24 hours	Bulk	IC	A	
	κ	daily	24 hours	Bulk	IC	A	
	Air:						
	SO2(g)	daily	24 hours	filter-2-pack	IC	B	W40, NaOH impr. 24 m3/day
	NO2(g)	daily	semi-cont.	monitor	-	D	Salzmann
	HNO3(g)						not measured
	NH3(g)						not measured
	SO4(p)	daily	24 hours	filter-2-pack	IC	A	W40, 24 m3/day
	NO3(p)						not measured
	NH4(p)						not measured
	HNO3(g)+NO3(p)	daily	24 hours	filter-2-pack	IC	A	W40 + W40 NaOH imp., 24 m3/day
	NH3(g)+NH4(p)	daily	24 hours	filter-1-pack	IC	A	W40, H2OX imp., 24 m3/day

Comments: FI4**:** Comparisons of NO2 measurements in Germany indicate that Saltzmann method overestimates NO2 concentrations below 1 ug N/m3. Only 30 % completeness of NO2 data, and 40% completeness for the other air components. Air sampling moved to FI37 in the middle of the year, precipitation measurements continued at FI4.

Recommendations: The NO2 method is recommended replaced with the KI method from the Manual.

France

Site code and name	Component	Sampling frequency	Sampling period	Methods in field	Methods in laboratory	Data quality	Comments
	Precipitation:						
FR3 La Crouzille	amount	daily	24 hours	wet-only			
FR5 La Hague	SO4	daily	24 hours	wet-only	IC	A	
FR8 Donon	H						not measured
FR9 Revin	pH	daily	24 hours	wet-only	pH meter	A	
FR10 Morvan	NH4	daily	24 hours	wet-only	Spectrophot.	A	Flow injection analysis
FR11 Bonnevaux	NO3	daily	24 hours	wet-only	IC	A	
FR12 Iraty	Na	daily	24 hours	wet-only	IC	A	
	Mg	daily	24 hours	wet-only	IC	C	
	Cl	daily	24 hours	wet-only	IC	A	
	Ca	daily	24 hours	wet-only	IC	B	
	K	daily	24 hours	wet-only	IC	C	
	κ	daily	24 hours	wet-only	Cond. meter	A	
	Air:						
	SO2(g)	daily	24 hours	Absorb. Sol.	IC	B	H2O2 2.5 m3/day
	NO2(g)						not measured
	HNO3(g)						not measured
	NH3(g)						not measured
	SO4(p)	daily	24 hours	Filter	IC	B	W40, 2.5 m3/day
	NO3(p)						not measured
	NH4(p)						not measured
	HNO3(g)+NO3(p)						not measured
	NH3(g)+NH4(p)						not measured

Comments: Air data quality based on field comparisons at FR8.

Recommendations: Start sampling the nitrogen air components, preferably using denuders. SO2 sampling should be changed to recommended EMEP method

Germany

Site code and name	Component	Sampling frequency	Sampling period	Methods in field	Methods in laboratory	Data quality	Comments
	Precipitation:						
Westerland DE1	amount	daily	24 hours	Bulk			
Langenbruegge DE2	SO4	daily	24 hours	Bulk	IC	A	
Schauinsland DE3	H						not measured
Deuselbach DE4	pH	daily	24 hours	Bulk	pH meter	A	
Brotjackriegel DE5	NH4	daily	24 hours	Bulk	Spectrophoto.	A	Flow injection analysis
Neuglobsow DE7	NO3	daily	24 hours	Bulk	IC	A	
Schmuecke DE8	Na	daily	24 hours	Bulk	AAS	A	
Zingst DE9	Mg	daily	24 hours	Bulk	IC	A	
	Cl	daily	24 hours	Bulk	IC	A	
	Ca	daily	24 hours	Bulk	IC	A	
	K	daily	24 hours	Bulk	AAS	A	
	κ	daily	24 hours	Bulk	Cond. meter	A	
	Air:						
	SO2(g)	daily	24 hours	Absorbing sol.	pararosanilin	C	TCM 1 m3/day
	NO2(g)	daily	24 hours	Absorbing sol.	Salzmann	D	1 m3/day
	HNO3(g)						not measured
	NH3(g)						not measured
	SO4(p)	daily	24 hours	Filter	XRF	B	SS 589/2L 1 m3/day
	NO3(p)						not measured
	NH4(p)						not measured
	HNO3(g)+NO3(p)						not measured
	NH3(g)+NH4(p)						not measured

Comments: Good precipitation measurements. Saltzmann method for NO2 overestimates when concentrations are below 1 ug N/m3**.**

Recommendations: Precipitation measurements: wet-only sampler is recommended. It is recommended to change to recommended methods for air sampling methods, and to take up measurements of N-components in air in accordance with the measurement programme.

Greece

Site code and name	Component	Sampling frequency	Sampling period	Methods in field	Methods in laboratory	Data quality	Comments
	Precipitation:						
GR1 Aliartos	amount						not measured
	SO4						not measured
	H						not measured
	pH						not measured
	NH4						not measured
	NO3						not measured
	Na						not measured
	Mg						not measured
	Cl						not measured
	Ca						not measured
	K						not measured
	κ						not measured
	Air:						
	SO2(g)	daily	24 hours	Absorbing sol.	Thorin	D	1.1 m3/day
	NO2(g)	daily	24 hours	Absorbing sol.	TGS	C	1.1 m3/day
	HNO3(g)						not measured
	NH3(g)						not measured
	SO4(p)	daily	24 hours	filter	Thorin	D	W41 1.1 m3/day
	NO3(p)						not measured
	NH4(p)						not measured
	HNO3(g)+NO3(p)						not measured
	NH3(g)+NH4(p)						not measured

Comments: Completeness of all measured components are less than 70 percent. Data are useless for EMEP

Recommendations: Change Thorin to recommended EMEP method. A full precipitation and air program is needed.

Hungary

Site code and name	Component	Sampling frequency	Sampling period	Methods in field	Methods in laboratory	Data quality	Comments
	Precipitation:						
K-puszta HU2	amount	daily	24 hours	wet-only			
	SO4	daily	24 hours	wet-only	IC	B	
	H	daily	24 hours	wet-only	Alkali tit.	A	
	pH	daily	24 hours	wet-only	pH meter	A	
	NH4	daily	24 hours	wet-only	Berthelot	B	
	NO3	daily	24 hours	wet-only	IC	A	
	Na	daily	24 hours	wet-only	AES	B	
	Mg	daily	24 hours	wet-only	AAS	A	
	Cl	daily	24 hours	wet-only	IC	B	
	Ca	daily	24 hours	wet-only	AAS	B	
	K	daily	24 hours	wet-only	AES	B	
	κ	daily	24 hours	wet-only	Cond meter	A	
	Air:						
	SO2(g)	daily	24 hours	filter-3-pack	IC	A	Imp filter
	NO2(g)	daily	24 hours	Absorbing sol.	Griess	A	0.5 m3/day
	HNO3(g)						not measured
	NH3(g)	daily	24 hours	tub. denuder	Berthelot	B	Coating: H2OX, 4 m3/day
	SO4(p)	daily	24 hours	filter-3-pack	IC	A	KP 25 m3/day
	NO3(p)						not measured
	NH4(p)	daily	24 hours	filter-3-pack	Berthelot	B	KP 25 m3/day
	HNO3(g)+NO3(p)	daily	24 hours	filter-3-pack	IC	A	KP 25 m3/day
	NH3(g)+NH4(p)						not measured

Comments: Improvements made over the past years.
NH4 in particles is biased due to chemical reactions on the aerosol filter. Acidity both in precipitation and aerosols are measured.
Recommendations: To separate gas and particles denuderes should be used.

Iceland

Site code and name	Component	Sampling frequency	Sampling period	Methods in field	Methods in laboratory	Data quality	Comments
	Precipitation:						
Irafoss IS2	amount	daily	24 hours	Bulk			
	SO4	daily	24 hours	Bulk	IC	A	
	H						not measured
	pH	daily	24 hours	Bulk	pH meter	A	
	NH4						not measured
	NO3						not measured
	Na	daily	24 hours	Bulk	AAS	A	
	Mg						not measured
	Cl						not measured
	Ca						not measured
	K						not measured
	κ						not measured
	Air:						
	SO2(g)	daily	24 hours	filter-2-pack	IC	B	KOH imp. filter, 20-25 m3/day
	NO2(g)						not measured
	HNO3(g)						not measured
	NH3(g)						not measured
	SO4(p)	daily	24 hours	filter-2-pack	IC	B	W40 20-25 m3/day
	NO3(p)						not measured
	NH4(p)						not measured
	HNO3(g)+NO3(p)						not measured
	NH3(g)+NH4(p)						not measured

Comments:

Recommendations: Start measurements of all precipitation components since incomplete data sets will not be accepted in the future. Consider titration of weak acids in precipitation. A full air measurement programme is needed and recommended.

Ireland

Site code and name	Component	Sampling frequency	Sampling period	Methods in field	Methods in laboratory	Data quality	Comments
	Precipitation:						
Valentia Observatory IE 1	amount	daily	24 hours	bulk			
	SO4	daily	24 hours	bulk	IC	A	
	H						not measured
	pH	daily	24 hours	bulk	pH meter	B	
	NH4	daily	24 hours	bulk	IC	A	
	NO3	daily	24 hours	bulk	IC	A	
	Na	daily	24 hours	bulk	IC	A	
	Mg	daily	24 hours	bulk	IC	B	
	Cl	daily	24 hours	bulk	IC	B	
	Ca	daily	24 hours	bulk	IC	B	
	K	daily	24 hours	bulk	IC	B	
	κ	daily	24 hours	bulk	Cond. meter	A	
	Air:						
	SO2(g)	daily	24 hours	filter-2-pack	IC	A	KOH impr. W40 filter, 20-25 m3/day
	NO2(g)	daily	24 hours	Absorbing sol.	Griess	C	TGS, 1.5 m3/day
	HNO3(g)						not measured
	NH3(g)						not measured
	SO4(p)	daily	24 hours	filter-2-pack	IC	B	W40 filter, 20-25 m3/day
	NO3(p)						not measured
	NH4(p)						not measured
	HNO3(g)+NO3(p)						not measured
	NH3(g)+NH4(p)						not measured

Comments:

Recommendations: Check the QA/QC procedures in the laboratory. Change to a 3- filter pack in order to measure more nitrogen components in air, or preferably start denuder measurements. Replace the TGS method for NO2 with the KI method. Consider titration of weak acids in precipitation again.

Ireland

Site code and name	Component	Sampling frequency	Sampling period	Methods in field	Methods in laboratory	Data quality	Comments
	Precipitation:						
Turlough Hill IE2	amount	daily	24 hours	wet only			
The Burren IE3	SO4	daily	24 hours	wet only	IC	B	
Ridge of Capard IE4	H						not measured
	pH	daily	24 hours	wet only	pH meter	B	
	NH4	daily	24 hours	wet only	IC	B	
	NO3	daily	24 hours	wet only	IC	B	
	Na	daily	24 hours	wet only	IC	B	
	Mg	daily	24 hours	wet only	IC	B	
	Cl	daily	24 hours	wet only	IC	B	
	Ca	daily	24 hours	wet only	IC	B	
	K	daily	24 hours	wet only	IC	B	
	κ	daily	24 hours	wet only	Cond. meter	B	
	Air:						
	SO2(g)	daily	24 hours	filter 2 pack	IC	undetermined	KOH- W40 20-25 m^3/day
	NO2(g)						not measured
	HNO3(g)						not measured
	NH3(g)						not measured
	SO4(p)	daily	24 hours	filter 2 pack	IC	undetermined	Gelman GN-6 Metricel filter , 20m^3/day
	NO3(p)						not measured
	NH4(p)						not measured
	HNO3(g)+NO3(p)						not measured
	NH3(g)+NH4(p)						not measured

Comments: IE2: Electricity Supply Board took over the analysis 1 October.

Recommendations: Change to a 3- filter pack in order to measure more nitrogen components in air, or preferably start denuder measurements. Sampling of NO2 should be included as well

Italy

Site code and name	Component	Sampling frequency	Sampling period	Methods in field	Methods in laboratory	Data quality	Comments
	Precipitation:						
Montelibretti IT1	amount	daily	24 hours	wet only			
	SO4	daily	24 hours	wet only	IC	A	
	H						not measured
	pH	daily	24 hours	wet only	pH meter	D	
	NH4	daily	24 hours	wet only	IC	B	
	NO3	daily	24 hours	wet only	IC	A	
	Na	daily	24 hours	wet only	IC	A	
	Mg	daily	24 hours	wet only	IC	A	
	Cl	daily	24 hours	wet only	IC	B	
	Ca	daily	24 hours	wet only	IC	D	
	K	daily	24 hours	wet only	IC	B	
	κ	daily	24 hours	wet only	Cond meter	A	
	Air:						
	SO2(g)	daily	24 hours	denuder	IC	A	NaCl ,Na2CO3+glycerine, 17 m3/day
	NO2(g)		continuous	monitor		D	Chemiluminescence
	HNO3(g)	daily	24 hours	denuder	IC	A	diff tube, NaCl coated, 17 m3/day
	NH3(g)	daily	24 hours	denuder	IC	B	diff. tube, H3PO4 coated, 17 m3/day
	SO4(p)	daily	24 hours	denuder	IC	A	Teflon GZ 1 µm, 17 m3/day
	NO3(p)	daily	24 hours	denuder	IC	A	GZ+Nylasorb filt, 17 m3/day
	NH4(p)	daily	24 hours	denuder	IC	B	GZ+H3PO4imp filt, 17 m3/day
	HNO3(g)+NO3(p)						not measured
	NH3(g)+NH4(p)						not measured

Comments: Completeness < 80% for NO2

Recommendations:

It is recommended to replace the monitor for NO2 with the recommended KI method. There is a need to check the QA/QC procedures.

Italy - European Commission

Site code and name	Component	Sampling frequency	Sampling period	Methods in field	Methods in laboratory	Data quality	Comments
	Precipitation:						
Ispra IT4	amount	daily	24 hours	Wet only			
	SO4	daily	24 hours	Wet only	IC	A	
	H						
	pH	daily	24 hours	Wet only	pH meter	A	
	NH4	daily	24 hours	Wet only	IC	A	
	NO3	daily	24 hours	Wet only	IC	A	
	Na	daily	24 hours	Wet only	IC	A	
	Mg	daily	24 hours	Wet only	IC	A	
	Cl	daily	24 hours	Wet only	IC	A	
	Ca	daily	24 hours	Wet only	IC	A	
	K	daily	24 hours	Wet only	IC	A	
	κ	daily	24 hours	Wet only	Cond meter	A	
	Air:						
	SO2(g)		continuously	monitor	-	D	UV-fluorescence
	NO2(g)		continuously	monitor	-	D	Chemiluminescence
	HNO3(g)						Not measured
	NH3(g)						Not measured
	SO4(p)	daily	24 hours	Filter	IC	A	Cellulose acetate, 0.8 µm 12 m3/day
	NO3(p)	daily	24 hours	Filter	IC	unknown	Cellulose acetate, 0.8 µm 12 m3/day
	NH4(p)	daily	24 hours	Filer	IC	unkmown	Cellulose acetate, 0.8 µm 12 m3/day
	HNO3(g)+NO3(p)						Not measured
	NH3(g)+NH4(p)						Not measured

Comments: Good precision in precipitation data. Filter measurements of NH4(p) and NO3(p) are biased and not accepted. Completeness: NO2 is only 78%

Recommendations: It is strongly recommended to replace the monitors with recommended methods and to start denuder measurements of the N components in air. There is a need to check the QA/QC procedures.

Latvia

Site code and name	Component	Sampling frequency	Sampling period	Methods in field	Methods in laboratory	Data quality	Comments
	Precipitation:						
LV10 Rucava	amount	daily	24 hours	wet only			One additional monthly precip coll.
	SO4	daily	24 hours	wet only	IC/Thorin	A	
	H						not measured
	pH	daily	24 hours	wet only	pH meter	B	
	NH4	daily	24 hours	wet only	Berthelot	B	
	NO3	daily	24 hours	wet only	IC/Griess	B	
	Na	daily	24 hours	wet only	AES	B	
	Mg	daily	24 hours	wet only	AAS	B	
	Cl	monthly	1 month	unknown	unknown	unknown	
	Ca	daily	24 hours	wet only	AES	A	
	K	daily	24 hours	wet only	AES	A	
	κ	daily	24 hours	wet only	Cond. meter	B	
	Air:						
	SO2(g)	daily	24 hours	Filter pack	Thorin	B	KOH W40 14-20 m3/day
	NO2(g)	daily	24 hours	KI method	NEDA	B	Glass granules, 0.2-0.4 m3/day
	HNO3(g)						not measured
	NH3(g)						not measured
	SO4(p)	daily	24 hours	Filter pack	Thorin	B	W40 14-28 m3/day
	NO3(p)	daily	24 hours	Filter pack	Griess	unknown	W40 14-28 m3/day
	NH4(p)	daily	24 hours	Filter pack	Berthelot	unknown	W40 14-28 m3/day
	HNO3(g)+NO3(p)	daily	24 hours	Filter pack	IC	B	W40, NaOH 24 m3/day
	NH3(g)+NH4(p)	daily	24 hours	Filter pack	Berthelot	B	W40, ox. acid 24 m3/day

Comments: NO3(p) and NH4(p) data from filters are biased.
Recommendations: To change from the Thorin method to IC. By using filter pack, only the sum of nitrate and sum of ammonia can be given; preferably change to denuder measurements. Change to daily sampling for Cl in precipitation.

Latvia

Site code and name	Component	Sampling frequency	Sampling period	Methods in field	Methods in laboratory	Data quality	Comments
	Precipitation:						
LV16 Zoseni	amount	daily	24 hours	wet only			
	SO4	daily	24 hours	wet only	IC/Thorin	A	
	H						not measured
	pH	daily	24 hours	wet only	pH meter	B	
	NH4	daily	24 hours	wet only	berthelot	B	
	NO3	daily	24 hours	wet only	IC/Griess	B	
	Na	daily	24 hours	wet only	AES	B	
	Mg	daily	24 hours	wet only	AAS	B	
	Cl	daily	24 hours	wet only	IC	B	
	Ca	daily	24 hours	wet only	AES	A	
	K	daily	24 hours	wet only	AES	A	
	κ	daily	24 hours	wet only	Cond. meter	B	
	Air:						
	SO2(g)	daily	24 hours	filter pack	Thorin	B	KOH W40 14-20 m^3/day
	NO2(g)	daily	24 hours	KI method	NEDA	B	Glass granules, 0.2-0.4 m^3/day
	HNO3(g)						not measaured
	NH3(g)						not measured
	SO4(p)	daily	24 hours	filter pack	Thorin	B	W40 14-28 m^3/day
	NO3(p)	daily	24 hours	filter pack	Griess	unknown	W40 14-28 m^3/day
	NH4(p)	daily	24 hours	filter pack	berthelot	unknown	W40 14-28 m^3/day
	HNO3(g)+NO3(p)	daily	24 hours	filter pack	IC	B	W40, NaOH 24 m^3/day
	NH3(g)+NH4(p)	daily	24 hours	filter pack	berthelot	B	W40, ox. acid 24 m^3/day

Comments: NO3 (p) and NH4(p) are biased

Recommendations: Change the Thorin method to IC. By using filter pack, only the sum of nitrate and sum of ammonia can be given –preferably change to denuders. Review and strengthen the QA/QC procedures.

Lithuania

Site code and name	Component	Sampling frequency	Sampling period	Methods in field	Methods in laboratory	Data quality	Comments
	Precipitation:						
Preila LT15	amount	weekly	one week	wet only			
	SO4	weekly	one week	wet only	Thorin	B	
	H						not measured
	pH	weekly	one week	wet only	pH meter	A	
	NH4	weekly	one week	wet only	Berthelot	A	
	NO3	weekly	one week	wet only	Griess	A	
	Na	weekly	one week	wet only	AES	A	
	Mg						not measured
	Cl	weekly	one week	wet only	Hg SCN Fe	B	
	Ca	weekly	one week	wet only	AES	A	
	K	weekly	one week	wet only	AES	A	
	κ	weekly	one week	wet only	Cond. meter	B	
	Air:						
	SO2(g)	daily	24 hours	filter 3 pack	Thorin	B	KOH W40 24 m^3/day
	NO2(g)	daily	24 hours	KI method	NEDA	B	Sulphanilamid, 0.72 m^3/day
	HNO3(g)						not measured
	NH3(g)						not measured
	SO4(p)						not measured
	NO3(p)						not measured
	NH4(p)						not measured
	HNO3(g)+NO3(p)	daily	24 hours	filter 3 pack	Griess	B	W40, KOH 16-17 m^3/day
	NH3(g)+NH4(p)	daily	24 hours	filter 3 pack	Berthelot	B	W40, H2Ox, 16-17 m^3/day

Comments: Information about flow through filters seems to be inconsistent. EMEP’s measurement programme does not contain weekly precipitation sampling.

Recommendations: Precipitation sampling has to be daily. The Thorin method is not recommended any longer and should be replace by ion chromatography. The measurement program needs to be completed by including Mg and SO4(p). SO4(p) is already sampled on the aerosol filter. It is recommended to review and strengthen the QA/QC procedures.

Netherlands

Site code and name	Component	Sampling frequency	Sampling period	Methods in field	Methods in laboratory	Data quality	Comments
	Precipitation:						
NL9 Kollumerwaard	amount	daily	24 hours	wet only			
	SO4	daily	24 hours	wet only	IC	A	
	H	daily	24 hours	wet only	Titration	A	Acidimetric titration
	pH	daily	24 hours	wet only	pH meter	A	
	NH4	daily	24 hours	wet only	Berthelot	A	Berthelot reaction, salicylicate
	NO3	daily	24 hours	wet only	IC	A	
	Na	daily	24 hours	wet only	ICP-AES	A	
	Mg	daily	24 hours	wet only	ICP-AES	A	
	Cl	daily	24 hours	wet only	IC	A	
	Ca	daily	24 hours	wet only	ICP-AES	A	
	K	daily	24 hours	wet only	ICP-AES	A	
	κ	daily	24 hours	wet only	Cond meter	A	
	Air:						
	SO2(g)		continuous	monitor		D	UV-fluorescence
	NO2(g)		continuous	monitor		C	Chemiluminescence
	HNO3(g)						not measured
	NH3(g)						not measured
	SO4(p)	daily	24 hours	denuder	IC	A	W42 2.5 m^3/day
	NO3(p)	daily	24 hours	denuder	IC	A	W42 2.5 m^3/day
	NH4(p)	daily	24 hours	denuder	Berthelot	A	W42 2.5 m^3/day
	HNO3(g)+NO3(p)						not measured
	NH3(g)+NH4(p)						not measured

Comments: Data completeness for SO2(g) and NO2(g) are only 70 %.

Recommendations: Change to recommended manual methods for SO2 and NO2 and include measurements of NH3 and HNO3

Netherlands

Site code and name	Component	Sampling frequency	Sampling period	Methods in field	Methods in laboratory	Data quality	Comments
	Precipitation:						
NL10 Vreedepeel	amount						not measured
	SO4						not measured
	H						not measured
	pH						not measured
	NH4						not measured
	NO3						not measured
	Na						not measured
	Mg						not measured
	Cl						not measured
	Ca						not measured
	K						not measured
	κ						not measured
	Air:						
	SO2(g)		continuous	monitor		D	UV-fluorescence
	NO2(g)		continuous	monitor		C	Chemiluminescence
	HNO3(g)						not measured
	NH3(g)	daily	24 hours	abs	Berthelot	unknown	NaHSO4, membr. sep., cond. meas.
	SO4(p)	daily	24 hours	Denuder	IC	A	W42 2.5 m^3/day
	NO3(p)	daily	24 hours	Denuder	IC	A	W42 2.5 m^3/day
	NH4(p)	daily	24 hours	Denuder	Berthelot	A	W42 2.5 m^3/day
	HNO3(g)+NO3(p)						not measured
	NH3(g)+NH4(p)						not measured

Comments: Data completeness for NH3(g) is only 70 %. HNO3 concentrations can not be expected to be high, still it would be interesting to have HNO3 measurements in accordance with the programme.

Recommendations: The NH3 method needs to be compared with the recommended (denuder) method in order to quantify any difference; further, change to recommended manual methods for SO2 and NO2 and include HNO3 (or HNO3(g) + NO3(p) measurements)

Norway

Site code and name	Component	Sampling frequency	Sampling period	Methods in field	Methods in laboratory	Data quality	Comments
	Precipitation:						
NO15 Tustervatn	amount	daily	24 hours	bulk			
NO39 Kaarvatn	SO4	daily	24 hours	bulk	IC	A	
NO41 Osen	H						not measured
NO55 Karasjok	pH	daily	24 hours	bulk	pH meter	A	
	NH4	daily	24 hours	bulk	IC	A	
	NO3	daily	24 hours	bulk	IC	A	
	Na	daily	24 hours	bulk	IC	A	
	Mg	daily	24 hours	bulk	IC	A	
	Cl	daily	24 hours	bulk	IC	A	
	Ca	daily	24 hours	bulk	IC	A	
	K	daily	24 hours	bulk	IC	A	
	κ	daily	24 hours	bulk	Cond-meter	A	
	Air:						
	SO2(g)	daily	24 hours	Filter –3 pack	IC	A	KOH, W40, 25 m3/day
	NO2(g)	daily	24 hours	KI method	NEDA, IC	B	Glass sinter, 0.7 m3/day
	HNO3(g)						not measured
	NH3(g)						not measured
	SO4(p)	daily	24 hours	Filter –3 pack	IC	A	Teflon Gelman Zefluor, 25 m3/day
	NO3(p)						not measured
	NH4(p)						not measured
	HNO3(g)+NO3(p)	daily	24 hours	Filter –3 pack	IC	A	Teflon + KOH impr, 25 m3/day
	NH3(g)+NH4(p)	daily	24 hours	Filter –3 pack	IC	A	Teflon + oxalic acid impr, 25 m3/day

Comments: Completeness of precipitation data on NO55 and NO15 are 80 and 70%, respectively.

Recommendations: Wet only samplers are recommended. Titration of acids are strongly recommended.

Norway

Site code and name	Component	Sampling frequency	Sampling period	Methods in field	Methods in laboratory	Data quality	Comments
	Precipitation:						
NO1 Birkenes	amount	daily	24 hours	bulk			
NO8 Skreaadalen	SO4	daily	24 hours	bulk	IC	A	
	H						not measured
	pH	daily	24 hours	bulk	pH meter	A	
	NH4	daily	24 hours	bulk	IC	A	
	NO3	daily	24 hours	bulk	IC	A	
	Na	daily	24 hours	bulk	IC	A	
	Mg	daily	24 hours	bulk	IC	A	
	Cl	daily	24 hours	bulk	IC	A	
	Ca	daily	24 hours	bulk	IC	A	
	K	daily	24 hours	bulk	IC	A	
	κ	daily	24 hours	bulk	Cond-meter	A	
	Air:						
	SO2(g)	daily	24 hours	Filter –3 pack	IC	A	KOH, W40, 25 m3/day
	NO2(g)	daily	24 hours	KI method	NEDA, IC	B	Glass sinter, 0.7 m3/day
	HNO3(g)						not measured
	NH3(g)						not measured
	SO4(p)	daily	24 hours	Filter –3 pack	IC	A	Teflon Gelman Zefluor, 25 m3/day
	NO3(p)						not measured
	NH4(p)						not measured
	HNO3(g)+NO3(p)	daily	24 hours	Filter –3 pack	IC	A	Teflon + KOH impr, 25 m3/day
	NH3(g)+NH4(p)	daily	24 hours	Filter –3 pack	IC	A	Teflon + oxalic acid impr, 25 m3/day

Comments:

Recommendations:

Norway

Site code and name	Component	Sampling frequency	Sampling period	Methods in field	Methods in laboratory	Data quality	Comments
	Precipitation:						
NO42 Spitzbergen, Z	amount						not measured
	SO4						not measured
	H						not measured
	pH						not measured
	NH4						not measured
.	NO3						not measured
	Na						not measured
	Mg						not measured
	Cl						not measured
	Ca						not measured
	K						not measured
	κ						not measured
	Air:						
	SO2(g)	daily	24 hours	Filter –3 pack	IC	A	KOH, W40, 25 m3/day
	NO2(g)						not measured
	HNO3(g)						not measured
	NH3(g)						not measured
	SO4(p)	daily	24 hours	Filter –3 pack	IC	A	Teflon Gelman Zefluor, 25 m3/day
	NO3(p)						not measured
	NH4(p)						not measured
	HNO3(g)+NO3(p)	daily	24 hours	Filter –3 pack	IC	A	Teflon + KOH impr, 25 m3/day
	NH3(g)+NH4(p)	daily	24 hours	Filter –3 pack	IC	A	Teflon + oxalic acid impr, 25 m3/day

Comments:

Recommendations:

Poland

Site code and name	Component	Sampling frequency	Sampling period	Methods in field	Methods in laboratory	Data quality	Comments
	Precipitation:						
Jarczew PL2	amount	daily	24 hours	Bulk			
Sniezka PL3	SO4	daily	24 hours	Bulk	IC	A	
Leba PL4	H						not measured
	pH	daily	24 hours	Bulk	pH meter	A	
	NH4	daily	24 hours	Bulk	Chloramin T	A	
	NO3	daily	24 hours	Bulk	IC	A	
	Na	daily	24 hours	Bulk	AAS	B	
	Mg	daily	24 hours	Bulk	AAS	A	
	Cl	daily	24 hours	Bulk	IC	A	
	Ca	daily	24 hours	Bulk	AAS	B	
	K	daily	24 hours	Bulk	AAS	A	
	κ	daily	24 hours	Bulk	Cond. meter	A	
	Air:						
	SO2(g)	daily	24 hours	filter	Thorin	B	W40 KOH imp., 3.5–4 m3/day
	NO2(g)	daily	24 hours	abs solution	Griess	B	TGS, 0.7 m3/day
	HNO3(g)						not measured
	NH3(g)						not measured
	SO4(p)	daily	24 hours	filter	Thorin	A	W40, 3.5–4 m3/day
	NO3(p)	daily	24 hours	filter	Griess.	unknown	W40, 3.5–4 m3/day
	NH4(p)	daily	24 hours	filter	Chloramin T	unknown	W40, 3.5–4 m3/day
	HNO3(g)+NO3(p)	daily	24 hours	filter	Griess.	A	NaF impr W40, 4 m3/day
	NH3(g)+NH4(p)	daily	24 hours	filter	Chloramin T	A	Ox. Acid impr W40. 4m37day

Comments: Filter pack method for the individual concentrations of NO3(p) and NH4(p) is biased and only the sum of gas and particles should be given.

Recommendations: It is recommended to replace the Thorin method for SO2 and SO4(p) with IC. Preferably change to denuders to obtain individual concentrations of gas and particles

Poland

Site code and name	Component	Sampling frequency	Sampling period	Methods in field	Methods in laboratory	Data quality	Comments
	Precipitation:						
Diabla Gora PL5	amount	daily	24 hours	Bulk			
	SO4	daily	24 hours	Bulk	IC	B	
	H						not measured
	pH	daily	24 hours	Bulk	pH meter	B	
	NH4	daily	24 hours	Bulk	Berthelot	B	
	NO3	daily	24 hours	Bulk	IC	B	
	Na	daily	24 hours	Bulk	AES	B	
	Mg	daily	24 hours	Bulk	AAS	B	
	Cl	daily	24 hours	Bulk	IC	B	
	Ca	daily	24 hours	Bulk	AES	B	
	K	daily	24 hours	Bulk	AES	B	
	κ	daily	24 hours	Bulk	Cond. meter	B	
	Air:						
	SO2(g)	daily	24 hours	abs. solution	IC	A	KOH, W40, 3.5–5 m3/day
	NO2(g)	daily	24 hours	abs. solution	Griess	A	TGS, 0.3-0.7 m3/day
	HNO3(g)						not measured
	NH3(g)						not measured
	SO4(p)	daily	24 hours	filter	IC	B	W40, 3.5–5 m3/day
	NO3(p)						not measured
	NH4(p)						not measured
	HNO3(g)+NO3(p)	daily	24 hours	filter	Griess.	B	NaF impr W40, 4m3/day
	NH3(g)+NH4(p)	daily	24 hours	filter	Chloramin T	unknown	H2Ox impr W40. 4m37day

Comments:

Recommendations: Improve and strengthen the QA/QC procedures

Portugal

Site code and name	Component	Sampling frequency	Sampling period	Methods in field	Methods in laboratory	Data quality	Comments
	Precipitation:						
Braganca PT1	amount	daily	24 hours	Bulk			
V.d. Castelo PT3	SO4	daily	24 hours	Bulk	IC	A	
Monte Velho PT4	H						not measured
	pH	daily	24 hours	Bulk	pH meter	A	
	NH4	daily	24 hours	Bulk	Berthelot	A	
	NO3	daily	24 hours	Bulk	IC	A	
	Na	daily	24 hours	Bulk	AAS	A	
	Mg	daily	24 hours	Bulk	AAS	A	
	Cl	daily	24 hours	Bulk	IC	A	
	Ca	daily	24 hours	Bulk	AAS	A	
	K	daily	24 hours	Bulk	AAS	A	
	κ	daily	24 hours	Bulk	Cond. meter	A	
	Air:						
	SO2(g)						not measured
	NO2(g)						not measured
	HNO3(g)						not measured
	NH3(g)						not measured
	SO4(p)						not measured
	NO3(p)						not measured
	NH4(p)						not measured
	HNO3(g)+NO3(p)						not measured
	NH3(g)+NH4(p)						not measured

Comments: Measurement quality seems to be improved.

Recommendations: Reliable measurements of air components in the EMEP programme are needed.

Russian Federation

Site code and name	Component	Sampling frequency	Sampling period	Methods in field	Methods in laboratory	Data quality	Comments
	Precipitation:						
	amount	daily	24 hours	Bulk			
Pinega RU13	SO4	daily	24 hours	Bulk	IC	A	
Shepeljovo RU16	H						not measured
	pH	daily	24 hours	Bulk	pH meter	B	
	NH4	daily	24 hours	Bulk	IC	A	
	NO3	daily	24 hours	Bulk	IC	B	
	Na	daily	24 hours	Bulk	IC	A	
	Mg	daily	24 hours	Bulk	AAS	A	
	Cl	daily	24 hours	Bulk	IC	B	
	Ca	daily	24 hours	Bulk	AAS	B	
	K	daily	24 hours	Bulk	IC	D	
	κ	daily	24 hours	Bulk	Cond. meter	B	
	Air:						
	SO2(g)	daily	24 hours	filter 2 -pack	IC	B	W40, NaOH, 10-15m3/day
	NO2(g)	daily	24 hours	KI method	NEDA IC	A	Abs. tubes, 0.3 m3/day
	HNO3(g)						not measured
	NH3(g)						not measured
	SO4(p)	daily	24 hours	filter 2 –pack	IC	B	W40, 10-15 m3/day
	NO3(p)	daily	24 hours	filter 2 –pack	IC	unknown	W40, 10-15 m3/day
	NH4(p)	daily	24 hours	filter 2 -pack	IC	unknown	W40, 10-15 m3/day
	HNO3(g)+NO3(p)						not measured
	NH3(g)+NH4(p)						not measured

Comments: Completeness of air/aerosol components at Pinega was low; NH4(p), NO3(p), SO4(p), SO2 ≈ 63%, NO2 ≈ 57%. NH4(p) and NO3(p) measurements with filter packs are biased.

Recommendations: There is a need to measure all N components in EMEP's programme. The results reveal that the QA/QC procedures should be reviewed. Preferably change to denuders to obtain individual concentrations of gasses and particles. In general there is also a need for more measurement stations in the European part of Russia

Russian Federation

Site code and name	Component	Sampling frequency	Sampling period	Methods in field	Methods in laboratory	Data quality	Comments
	Precipitation:						
Janiskoski RU1	amount	daily	24 hours	Bulk			
	SO4	daily	24 hours	Bulk	IC	A	
	H						not measured
	pH	daily	24 hours	Bulk	pH meter	B	
	NH4	daily	24 hours	Bulk	IC	A	
	NO3	daily	24 hours	Bulk	IC	B	
	Na	daily	24 hours	Bulk	IC	A	
	Mg	daily	24 hours	Bulk	AAS	A	
	Cl	daily	24 hours	Bulk	IC	B	
	Ca	daily	24 hours	Bulk	AAS	B	
	K	daily	24 hours	Bulk	IC	D	
	κ	daily	24 hours	Bulk	Cond. meter	B	
	Air:						
	SO2(g)		continuous			D	UV fluorescence
	NO2(g)	daily	24 hours	KI method	NEDA IC	A	Abs. tubes, 0.3 m3/day
	HNO3(g)						not measured
	NH3(g)						not measured
	SO4(p)	daily	24 hours	filter	IC	A	W40, 10-15 m3/day
	NO3(p)	daily	24 hours	filter	IC	unknown	W40, 10-15 m3/day
	NH4(p)	daily	24 hours	filter	IC	unknown	W40, 10-15 m3/day
	HNO3(g)+NO3(p)	daily	24 hours				not measured
	NH3(g)+NH4(p)	daily	24 hours	filter	IC	A	W40, H2OX imp, 10-15 m3/day

Comments: Completeness of all air components is < 50%. NH4(p) and NO3(p) measurements with filter packs are biased – only sums should be given.

Recommendations: There is a need to measure all N components in EMEP's programme. The results reveals that the QA/QC procedures should be reviewed. Preferably change to denuders to obtain individual concentrations of gasses and particles. In general there is also a need for more measurement stations in the European part of Russia.

Slovakia

Site code and name	Component	Sampling frequency	Sampling period	Methods in field	Methods in laboratory	Data quality	Comments
	Precipitation:						
Chopok SK2	amount	daily	24 hours	wet only			
Stara Lesna SK4	SO4	daily	24 hours	wet only	IC	A	
Liesek SK5	H						not measured
Starina SK6	pH	daily	24 hours	wet only	pH meter	D	
	NH4	daily	24 hours	wet only	IC	A	
	NO3	daily	24 hours	wet only	IC	B	
	Na	daily	24 hours	wet only	IC	C	
	Mg	daily	24 hours	wet only	IC	A	
	Cl	daily	24 hours	wet only	IC	B	
	Ca	daily	24 hours	wet only	IC	A	
	K	daily	24 hours	wet only	IC	B	
	κ	daily	24 hours	wet only	Cond. meter	A	
	Air:						
	SO2(g)	daily	24 hours	filter 2-pack	IC	B	W41 KOH 6-8 m3/day
	NO2(g)	daily	24 hours	abs. solution	IC	B	NaOH & guajacol, 0.5 m3/day
	HNO3(g)						(not measured)
	NH3(g)						not measured
	SO4(p)	daily	24 hours	filter 2 pack	IC	B	W40 6-8m3/day
	NO3(p)						(not measured)
	NH4(p)						not measured
	HNO3(g)+NO3(p)	daily	24 hours	filter 2- pack	NEDA / IC	B	W40 + W41 KOH 6-8m3/day
	NH3(g)+NH4(p)						not measured

Comments: Filter pack are not able to separate HNO3(g) and NO3(p) properly and are not accepted as a method for the individual components. Completeness < 80 % for all components at SK6.

Recommendations: The measurements of NO3(p) and HNO3(g) should be reported as HNO3(g)+NO3(p) since filter measurements give biased results of the individual components,preferably use denuders. Start measurements of NH3(g) / NH4(p). A need to review and strengthen the QA/QC procedures.

Slovenia

Site code and name	Component	Sampling frequency	Sampling period	Methods in field	Methods in laboratory	Data quality	Comments
	Precipitation:						
Iskrba S18	amount	daily					not measured
	SO4						not measured
	H						not measured
	pH						not measured
	NH4						not measured
	NO3						not measured
	Na						not measured
	Mg						not measured
	Cl						not measured
	Ca						not measured
	K						not measured
	κ						not measured
	Air:						
	SO2(g)	daily	24 hours	filter 3 pack	IC	A	W40, KOH 22 m3/day
	NO2(g)						not measured
	HNO3(g)						not measured
	NH3(g)						not measured
	SO4(p)	daily	24 hours	filter 3 pack	IC	A	Teflon GZ 2um 22 m3/day
	NO3(p)						not measured
	NH4(p)						not measured
	HNO3(g)+NO3(p)	daily	24 hours	filter 3 pack	IC	A	Teflon GZ 2um+W40KOH.22m3/day
	NH3(g)+NH4(p)	daily	24 hours	filter 3 pack	IC	A	Teflon GZ 2um+W40H2OX 22m3/day

Comments: No precipitation measurements carried out at the site.

Recommendations: To include precipitation and NO2 measurements according to the EMEP program at one site.

Spain

Site code and name	Component	Sampling frequency	Sampling period	Methods in field	Methods in laboratory	Data quality	Comments
	Precipitation:						
San Pablo ES1	amount	daily	24 hours	wet only			
Roquetas ES3	SO4	daily	24 hours	wet only	IC	A	
Logrono ES4	H						not measured
Mahon ES6	pH	daily	24 hours	wet only	pH meter	A	
Viznar ES 7	NH4	daily	24 hours	wet only	Berthelot	B	
	NO3	daily	24 hours	wet only	IC	A	
	Na	daily	24 hours	wet only	AES	A	
	Mg	daily	24 hours	wet only	AAS	A	
	Cl	daily	24 hours	wet only	IC	A	
	Ca	daily	24 hours	wet only	AAS	A	
	K	daily	24 hours	wet only	AAS	A	
	κ	daily	24 hours	wet only	Cond. meter	A	
	Air:						
	SO2(g)	daily	24 hours	abs	IC	A	H2O2 2 m3/ day
	NO2(g)	daily	24 hours	abs	NEDA / IC	A	Trietanolamine 1m3/day
	HNO3(g)						not measured
	NH3(g)						not measured
	SO4(p)	daily	24 hours	Filter pack	IC	B	?W GF/A 770 m3/day
	NO3(p)						not measured
	NH4(p)	daily	24 hours	Filter pack	Berthelot	unknown	?W GF/A 770 m3/day
	HNO3(g)+NO3(p)	daily	24 hours	Filter pack	IC	B	NaOH impr W40 35 m3/day
	NH3(g)+NH4(p)	daily	24 hours	Filter pack	Berthelot	B	H2Ox impr. W40 35 m3/day

Comments: Completeness NH3(g)+NH4(p) <50 %, and HNO3(g)+NO3(p) and NH4 precip. ≈ 76 - 77 % at ES6. Generally there is a poor correspondence between measurements and model results. In particular NH4(p) results from filter may be biased.

Recommendations: SO2 already sampled on NaOH filter –the SO2 concentrations should be determined from the filter. Preferably start using denuders. Titration of acids in precipitation is.strongly recommended. There is a need for field comparisons of air components with reference methods. It is necessary to review and strengthen the QA/QC procedures.

Spain

Site code and name	Component	Sampling frequency	Sampling period	Methods in field	Methods in laboratory	Data quality	Comments
	Precipitation:						
Noya ES5	amount	daily	24 hours	Wet only			
	SO4	daily	24 hours	Wet only	IC	A	
	H						not measured
	pH	daily	24 hours	Wet only	pH meter	A	
	NH4	daily	24 hours	Wet only	Berthelot	B	
	NO3	daily	24 hours	Wet only	IC	A	
	Na	daily	24 hours	Wet only	AES	A	
	Mg	daily	24 hours	Wet only	AAS	A	
	Cl	daily	24 hours	Wet only	IC	A	
	Ca	daily	24 hours	Wet only	AAS	A	
	K	daily	24 hours	Wet only	AAS	A	
	κ	daily	24 hours	Wet only	Cond. meter	A	
	Air:						
	SO2(g)	daily	24 hours	abs	IC	B	H2O2 2 m3/ day
	NO2(g)	daily	24 hours	abs	NEDA / IC	D	Trietanolamine 1m3/day
	HNO3(g)						not measured
	NH3(g)						not measured
	SO4(p)	daily	24 hours	Filter pack	IC	B	W GF/A 770 m3/day
	NO3(p)						not measured
	NH4(p)	daily	24 hours	Filter pack	Berthelot	unknown	W GF/A 770 m3/day
	HNO3(g)+NO3(p)	daily	24 hours	Filter pack	IC	B	NaOH W40 35 m3/day
	NH3(g)+NH4(p)	daily	24 hours	Filter pack	Berthelot	B	H2OX W40 35 m3/day

Comments: Completeness NH4(p), SO4(p), and HNO3(g)+NO3(p) are < 70%, NH3(g)+NH4(p) ≈ 75%. NH4(p) results from filter may be biased, only the sum should be reported.

Recommendations: SO2 already sampled on NaOH filter –SO2 concentrations should be determined from the filter. It is necessary to review and strengthen the QA/QC procedures. Titration of acids in precipitation is strongly recommended.

Sweden

Site code and name	Component	Sampling frequency	Sampling period	Methods in field	Methods in laboratory	Data quality	Comments
	Precipitation:						
Bredkaelen SE5	amount	weekly	weekly	Wet only			
Vavihill SE11	SO4	weekly	weekly	Wet only	IC	A	
Aspvreten SE12	H						not measured
	pH	weekly	weekly	Wet only	pH meter	A	
	NH4	weekly	weekly	Wet only	FIA	A	
	NO3	weekly	weekly	Wet only	IC	A	
	Na	weekly	weekly	Wet only	AAS	A	
	Mg	weekly	weekly	Wet only	AAS	B	
	Cl	weekly	weekly	Wet only	IC	A	
	Ca	weekly	weekly	Wet only	AAS	A	
	K	weekly	weekly	Wet only	AAS	B	
	κ	weekly	weekly	Wet only	Cond. meter	A	
	Air:						
	SO2(g)	daily	24 hours	Filter 3 pack	IC	A	W40, KOH, 20m3/day
	NO2(g)	daily	24 hours	NaI method	NEDA, IC	A	Glass sinter ~0.7 m3/day
	HNO3(g)						not measured
	NH3(g)						not measured
	SO4(p)	daily	24 hours	Filter 3 pack	IC	A	Gelman Zefluor 2µm, 20 m3/day
	NO3(p)						not measured
	NH4(p)						not measured
	HNO3(g)+NO3(p)	daily	24 hours	Filter 3 pack	IC	A	Zefluor + W40 KOH 20m3/day
	NH3(g)+NH4(p)	daily	24 hours	Filter 3 pack	FIA	A	Zefluor + W40 0x acid, 20m3/day

Comments: Weekly precipitation measurements are not in EMEP’s programme.

Recommendations: It is recommended to follow EMEP’s sampling periods and frequencies.

Sweden

Site code and name	Component	Sampling frequency	Sampling period	Methods in field	Methods in laboratory	Data quality	Comments
	Precipitation:						
Roervik SE2	amount	daily	24 hours	wet only			
	SO4	daily	24 hours	wet only	IC	A	
	H						not measured
	pH	daily	24 hours	wet only	pH meter	A	
	NH4	daily	24 hours	wet only	FIA	A	
	NO3	daily	24 hours	wet only	IC	A	
	Na	daily	24 hours	wet only	AAS	A	
	Mg	daily	24 hours	wet only	AAS	B	
	Cl	daily	24 hours	wet only	IC	A	
	Ca	daily	24 hours	wet only	AAS	A	
	K	daily	24 hours	wet only	AAS	B	
	κ	daily	24 hours	wet only	Cond. meter	A	
	Air:						
	SO2(g)	daily	24 hours	filter 3 pack	IC	A	W40, KOH, 20m3/day
	NO2(g)	daily	24 hours	NaI method	NEDA, IC	A	Glass sinter ~0.7 m3/day
	HNO3(g)						not measured
	NH3(g)						not measured
	SO4(p)	daily	24 hours	filter 3 pack	IC	A	Gelman Zefluor 2µm, 20 m3/day
	NO3(p)						not measured
	NH4(p)						not measured
	HNO3(g)+NO3(p)	daily	24 hours	filter 3 pack	IC	A	Zefluor + W40 KOH 20m3/day
	NH3(g)+NH4(p)	daily	24 hours	filter 3 pack	FIA	A	Zefluor + W40 0x acid, 20m3/day

Comments:

Recommendations:

Sweden

Site code and name	Component	Sampling frequency	Sampling period	Methods in field	Methods in laboratory	Data quality	Comments
	Precipitation:						
Hoburg SE8	amount						not measured
Esrange SE13	SO4						not measured
	H						not measured
	pH						not measured
	NH4						not measured
	NO3						not measured
	Na						not measured
	Mg						not measured
	Cl						not measured
	Ca						not measured
	K						not measured
	κ						not measured
	Air:						
	SO2(g)	daily	24 hours	Filter 3 pack	IC	A	W40, KOH, 20m3/day
	NO2(g)	daily	24 hours	NaI method	NEDA, IC	A	Glass sinter ~0.7 m3/day
	HNO3(g)						not measured
	NH3(g)						not measured
	SO4(p)	daily	24 hours	Filter 3 pack	IC	A	Gelman Zefluor 2µm, 20 m3/day
	NO3(p)						not measured
	NH4(p)						not measured
	HNO3(g)+NO3(p)						not measured
	NH3(g)+NH4(p)						not measured

Comments:

Recommendations: Measurements of all nitrogen components in air is strongly recommended.

Switzerland

Site code and name	Component	Sampling frequency	Sampling period	Methods in field	Methods in laboratory	Data quality	Comments
	Precipitation:						
Taernikon CH3	amount	daily	24 hours	wet only			
Chaumont CH4	SO4	daily	24 hours	wet only	IC	A	
Rigi CH5	H						not measured
	pH	daily	24 hours	wet only	pH meter	A	
	NH4	daily	24 hours	wet only	IC	A	
	NO3	daily	24 hours	wet only	IC	A	
	Na	daily	24 hours	wet only	IC	A	
	Mg	daily	24 hours	wet only	IC	A	
	Cl	daily	24 hours	wet only	IC	A	
	Ca	daily	24 hours	wet only	IC	A	
	K	daily	24 hours	wet only	IC	A	
	κ	daily	24 hours	wet only	Cond meter	A	
	Air:						
	SO2(g)		continuous	monitor		D	UV-Fluorescence
	NO2(g)		continuous	monitor		C	Chemiluminescence
	HNO3(g)						not measured
	NH3(g)						not measured
	SO4(p)	daily	24 hours	filter 3 pack	IC	A	Schleicher 589/4 3.6 m3/day
	NO3(p)						not measured
	NH4(p)						not measured
	HNO3(g)+NO3(p)						not measured
	NH3(g)+NH4(p)						not measured

Comments:

Recommendations: It is highly recommended to change the monitoring of SO2 and NO2 to recommended sampling on filter and glass frit, and to include all nitrogen components in air in the measurement programme

Switzerland

Site code and name	Component	Sampling frequency	Sampling period	Methods in field	Methods in laboratory	Data quality	Comments
	Precipitation:						
Jungfraujoch CH1	amount						not measured
	SO4						not measured
	H						not measured
	pH						not measured
	NH4						not measured
	NO3						not measured
	Na						not measured
	Mg						not measured
	Cl						not measured
	Ca						not measured
	K						not measured
	κ						not measured
	Air:						
	SO2(g)	daily	24 hours	abs. solution	IC	D	H2O2, 4.1 m3/day
	NO2(g)		continuous	monitor		A	Cranox
	HNO3(g)						not measured
	NH3(g)						not measured
	SO4(p)	daily	24 hours	filter	IC	A	Schleicher 589/4 3.6 m3/day
	NO3(p)						not measured
	NH4(p)						not measured
	HNO3(g)+NO3(p)						not measured
	NH3(g)+NH4(p)						not measured

Comments: Completeness NO2 is only 75 %. H2O2 absorbing solution method for SO2 will be biased at the very low concentrations at Jungfraujoch.

Recommendations: Replace the method for SO2 with recommended EMEP procedure and measure all N components in air.

Switzerland

Site code and name	Component	Sampling frequency	Sampling period	Methods in field	Methods in laboratory	Data quality	Comments
	Precipitation:						
Payerne CH2	amount	daily	24 hours	wet only			
	SO4	daily	24 hours	wet only	IC	A	
	H						not measured
	pH	daily	24 hours	wet only	pH meter	A	
	NH4	daily	24 hours	wet only	IC	A	
	NO3	daily	24 hours	wet only	IC	A	
	Na	daily	24 hours	wet only	IC	A	
	Mg	daily	24 hours	wet only	IC	A	
	Cl	daily	24 hours	wet only	IC	A	
	Ca	daily	24 hours	wet only	IC	A	
	K	daily	24 hours	wet only	IC	A	
	κ	daily	24 hours	wet only	Cond. meter	A	
	Air:						
	SO2(g)	daily	24 hours	monitor		D	UV-Fluorescence
	NO2(g)		continuous	monitor		C	Chemiluminescence
	HNO3(g)						not measured
	NH3(g)						not measured
	SO4(p)	daily	24 hours	filter 3 pack	IC	A	Schleicher 589/4 3.6 m3/day
	NO3(p)						not measured
	NH4(p)						not measured
	HNO3(g)+NO3(p)	daily	24 hours	filter 3 pack	IC	A	NaOH, 6 m3/day
	NH3(g)+NH4(p)	daily	24 hours	filter 3 pack	IC	A	Citric acid, 6 m3/day (20 in winter)

Comments:

Recommendations: It is highly recommended to change the monitor measurements to sampling on filter and glass frit

Turkey

Site code and name	Component	Sampling frequency	Sampling period	Methods in field	Methods in laboratory	Data quality	Comments
	Precipitation:						
Cubuk II TR 1	amount	daily	24 hours	wet-only			
	SO4	daily	24 hours	wet-only	IC	A	
	H						not measured
	pH	daily	24 hours	wet-only	pH meter	C	
	NH4	daily	24 hours	wet-only	Berthelot	A	
	NO3	daily	24 hours	wet-only	IC	A	
	Na	daily	24 hours	wet-only	AAS	A	
	Mg	daily	24 hours	wet-only	AAS	B	
	Cl	daily	24 hours	wet-only	IC	A	
	Ca	daily	24 hours	wet-only	AAS	A	
	K	daily	24 hours	wet-only	AAS	A	
	κ	daily	24 hours	wet-only	Cond. meter	A	
	Air:						
	SO2(g)	daily	24 hours	absorbing sol.	Pararosanilin	C	TCM 1 m3/day
	NO2(g)	daily	24 hours	absorbing sol.	Saltzmann	B	1 m3/day
	HNO3(g)						not measured
	NH3(g)						not measured
	SO4(p)	daily	24 hours	filter-3-pack	IC	B	W40 35 m3/day
	NO3(p)						not measured
	NH4(p)						not measured
	HNO3(g)+NO3(p)	daily	24 hours	filter-3-pack	IC	A	W40 H2OX impr. 35 m3/day
	NH3(g)+NH4(p)	daily	24 hours	filter-3-pack	Berthelot	A	W40 KOH impr. 35 m3/day

Comments:

Recommendations: It is strongly recommended to replace methods for SO2 and NO2 with methods from the Manual. Review and strengthen the QA/QC procedures, particularly for pH measurements Titration of acids in precipitation is recommended. More sites in Turkey would be useful for EMEP

United Kingdom

Site code and name	Component	Sampling frequency	Sampling period	Methods in field	Methods in laboratory	Data quality	Comments
	Precipitation:						
GB15 Strath Vaich D.	amount	daily	24 hours	Wet only			
	SO4	daily	24 hours	Wet only	IC	A	
	H						not measured
	pH	daily	24 hours	Wet only	pH meter	A	
	NH4	daily	24 hours	Wet only	IC	B	
	NO3	daily	24 hours	Wet only	IC	A	
	Na	daily	24 hours	Wet only	IC	A	
	Mg	daily	24 hours	Wet only	IC	B	
	Cl	daily	24 hours	Wet only	IC	A	
	Ca	daily	24 hours	Wet only	IC	B	
	K	daily	24 hours	Wet only	IC	A	
	κ	daily	24 hours	Wet only	Cond. meter	A	
	Air:						
	SO2(g)	daily	24 hours	Abs	IC	B	H2O2 2-4 m^3/day
	NO2(g)		continuous	monitor		D	Chemiluminescence
	HNO3(g)						not measured
	NH3(g)						not measured
	SO4(p)	daily	24 hours	Filter	IC	A	W40, 2-4 m^3/day
	NO3(p)						not measured
	NH4(p)						not measured
	HNO3(g)+NO3(p)						not measured
	NH3(g)+NH4(p)						not measured

Comments:

Recommendations: Start sampling the nitrogen air components. Change to recommended EMEP methods for SO2 and NO2.

United Kingdom

Site code and name	Component	Sampling frequency	Sampling period	Methods in field	Methods in laboratory	Data quality	Comments
	Precipitation:						
GB2 Eskdalemuir	amount	daily	24 hours	Bulk			
GB14 High Muffles	SO4	daily	24 hours	Bulk	IC	A	
	H						not measured
	pH	daily	24 hours	Bulk	pH meter	A	
	NH4	daily	24 hours	Bulk	IC	B	
	NO3	daily	24 hours	Bulk	IC	A	
	Na	daily	24 hours	Bulk	IC	A	
	Mg	daily	24 hours	Bulk	IC	B	
	Cl	daily	24 hours	Bulk	IC	A	
	Ca	daily	24 hours	Bulk	IC	B	
	K	daily	24 hours	Bulk	IC	A	
	κ	daily	24 hours	Bulk	Cond. meter	A	
	Air:						
	SO2(g)	daily	24 hours	Abs	IC	B	H2O2 2-4 m^3/day
	NO2(g)						not measured
	HNO3(g)						not measured
	NH3(g)						not measured
	SO4(p)	daily	24 hours	Filter	IC	A	W40, 2-5 m^3/day
	NO3(p)						not measured
	NH4(p)						not measured
	HNO3(g)+NO3(p)	daily	24 hours	Filter-3 pack	IC	A	W40, NaOH, 25 m^3/day
	NH3(g)+NH4(p)	daily	24 hours	Filter-3 pack	IC	A	W40, Citric acid, 25 m^3/day

Comments:

Recommendations: Change to recommended EMEP methods for SO2, it is already sampled on the NaOH impregnated filter in the filter-3-pack.

United Kingdom

Site code and name	Component	Sampling frequency	Sampling period	Methods in field	Methods in laboratory	Data quality	Comments
	Precipitation:						
GB7 Barcombe Mills	amount						not measured
GB4 Stoke Ferry	SO4						not measured
	H						not measured
	pH						not measured
	NH4						not measured
	NO3						not measured
	Na						not measured
	Mg						not measured
	Cl						not measured
	Ca						not measured
	K						not measured
	κ						not measured
	Air:						
	SO2(g)	daily	24 hours	abs.	IC	A	H2O2 2-4 m^3/day
	NO2(g)						not measured
	HNO3(g)						not measured
	NH3(g)						not measured
	SO4(p)	daily	24 hours	filter	IC	A	W40, 2-5 m^3/day
	NO3(p)						not measured
	NH4(p)						not measured
	HNO3(g)+NO3(p)						not measured
	NH3(g)+NH4(p)						not measured

Comments:

Recommendations: Start sampling the nitrogen air components

United Kingdom

Site code and name	Component	Sampling frequency	Sampling period	Methods in field	Methods in laboratory	Data quality	Comments
	Precipitation:						
GB6 Lough Navar	amount	daily	24 hours	wet only			
	SO4	daily	24 hours	wet only	IC	A	
	H						not measured
	pH	daily	24 hours	wet only	pH meter	A	
	NH4	daily	24 hours	wet only	IC	B	
	NO3	daily	24 hours	wet only	IC	A	
	Na	daily	24 hours	wet only	IC	A	
	Mg	daily	24 hours	wet only	IC	B	
	Cl	daily	24 hours	wet only	IC	A	
	Ca	daily	24 hours	wet only	IC	B	
	K	daily	24 hours	wet only	IC	A	
	κ	daily	24 hours	wet only	Cond. meter	A	
	Air:						
	SO2(g)	daily	24 hours	Abs	IC	B	H2O2 2-4 m^3/day
	NO2(g)						not measured
	HNO3(g)						not measured
	NH3(g)						not measured
	SO4(p)	daily	24 hours	filter	IC	A	W40, 2-5 m^3/day
	NO3(p)						not measured
	NH4(p)						not measured
	HNO3(g)+NO3(p)						not measured
	NH3(g)+NH4(p)						not measured

Comments:

Recommendations: Start sampling the nitrogen air components, change to recommended EMEP methods for SO2.

United Kingdom

Site code and name	Component	Sampling frequency	Sampling period	Methods in field	Methods in laboratory	Data quality	Comments
	Precipitation:						
GB13 Yarner Wood	amount	daily	24 hours	wet only			
	SO4	daily	24 hours	wet only	IC	A	
	H						not measured
	pH	daily	24 hours	wet only	pH meter	A	
	NH4	daily	24 hours	wet only	IC	B	
	NO3	daily	24 hours	wet only	IC	A	
	Na	daily	24 hours	wet only	IC	A	
	Mg	daily	24 hours	wet only	IC	B	
	Cl	daily	24 hours	wet only	IC	A	
	Ca	daily	24 hours	wet only	IC	B	
	K	daily	24 hours	wet only	IC	A	
	κ	daily	24 hours	wet only	Cond. meter	A	
	Air:						
	SO2(g)	daily	24 hours	Abs	IC	A	H2O2 2-4 m^3/day
	NO2(g)						not measured
	HNO3(g)						not measured
	NH3(g)						not measured
	SO4(p)	daily	24 hours	filter	IC	A	W40, 2-5 m^3/day
	NO3(p)						not measured
	NH4(p)						not measured
	HNO3(g)+NO3(p)						not measured
	NH3(g)+NH4(p)						not measured

Comments:

Recommendations: Start sampling the nitrogen air components

Yugoslavia

Site code and name	Component	Sampling frequency	Sampling period	Methods in field	Methods in laboratory	Data quality	Comments
	Precipitation:						
Kamenicki vis YU5	amount	daily	24 hours	bulk			
Zabljak YU 8	SO4	daily	24 hours	bulk	Thorin	B	
	H						not measured
	pH	daily	24 hours	bulk	pH meter	A	
	NH4	daily	24 hours	bulk	Berthelot	B	
	NO3	daily	24 hours	bulk	Griess met.	C	
	Na	daily	24 hours	bulk	AAS	A	measurements only ≈ Jan - June
	Mg	daily	24 hours	bulk	AAS	B	measurements only ≈ Jan - June
	Cl	daily	24 hours	bulk	HgSCN/Fe	D	
	Ca	daily	24 hours	bulk	AAS	B	measurements only ≈ Jan - June
	K	daily	24 hours	bulk	AAS	A	measurements only ≈ Jan - June
	κ	daily	24 hours	bulk	Cond. meter	A	
	Air:						
	SO2(g)	daily	24 hours	absorbing sol.	pararosanilim	D	TCM method, ≈ 2 m3/day
	NO2(g)	daily	24 hours	absorbing sol.	Griess met.	B	TGS method, ≈ 2 m3/day
	HNO3(g)						not measured
	NH3(g)						not measured
	SO4(p)						not measured
	NO3(p)						not measured
	NH4(p)						not measured
	HNO3(g)+NO3(p)						not measured
	NH3(g)+NH4(p)						not measured

Comments: Completeness for Ca, Mg, K, Na lower than 50 per cent. Precipitation part in accordance with EMEP programme. Thorin method for SO2 is no longer a recommended method. **Recommendations: Need for an updating of measurement methods both in laboratory and in field. IC is recommended for the laboratory, and wet-only sampler for precipitation. There is also a need for new air sampling equipment and measurements of N-compounds in air. The impregnated filter method is recommended for SO2. QA/QC procedures are not satisfactory.**