EMEP/CCC-Report 12/2001

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

Analytical intercomparison of heavy metals in precipitation 2000

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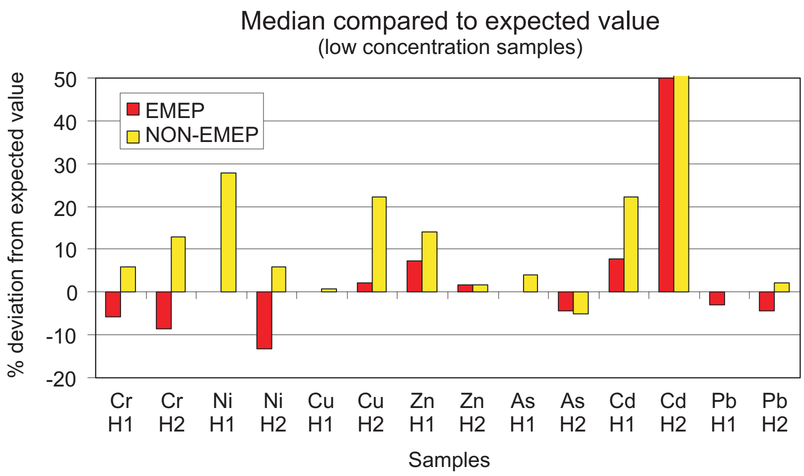

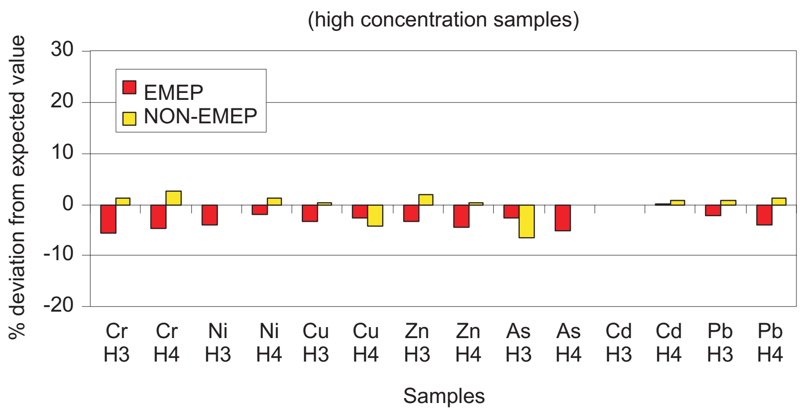

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1. Introduction

Heavy metals were included in the EMEP's monitoring programme in 1999. 21 laboratories are reporting data to the heavy metal data base. Since EMEP's measurement programme is based on individual national networks, different sampling and analytical methods are applied by the participating laboratories. In order to ensure data comparability, interlaboratory tests are organized by the Chemical Co-ordinating Centre (CCC) at the Norwegian Institute for Air Research. So far two intercomparisons have been arranged (Berg and Semb, 1995; Berg and Aas, 1999).

This report presents results from the third analytical intercomparison of heavy metals in precipitation which was carried out during 2000. Seven heavy metals were included: Pb, Cd, Cu, Zn, As, Cr, and Ni.

2. Organization of the intercomparison

The samples for the third intercomparison were prepared and distributed to 37 laboratories. In addition to the 21 EMEP laboratories, 16 other laboratories, most of them connected to the ICP-forest measurement programme, also received samples. A total of 29 laboratories, 18 from the EMEP network and 11 from other measurement programmes, reported within the end of October. In accordance with the decision of the Steering Body of EMEP, the results are presented in such a way that the different laboratories are identified. Tables A.1.1a and A1.1b give the names of the participating laboratories together with the number used when presenting the results in tables and figures.

3. Intercomparison samples

The four synthetic precipitation samples distributed, were made from multi-element standards traceable to NIST-standards. The multi-element standards were conserved with 2.5% HNO_3. The distributed synthetic precipitation samples contained Pb, Cd, Cu, Zn, As, Cr, and Ni in 0.5% HNO_3. Sample H1 and H2 contained concentrations similar to what is normally found in Southern Scandinavia. Sample H3 and H4 contained the elements in concentrations normally found in Central Europe.

All equipment in contact with the samples were soaked in 3% HNO_3 for 4 days. Preparation of the intercomparison samples was carried out in a clean room area.

4. Presentation of data

Tables A.1.2-A.1.8 present the reported results in decreasing order together with the laboratory numbers. The theoretical value, the number of results, the arithmetic mean value, the median, the standard deviation and the relative standard deviation are also given. In the first statistic run only values below detection limit were excluded. In the second run also outliers were excluded. The outliers were defined as values more than two standard deviations from the mean value in the first run.

In Figures A2.1-A2.7 the results are presented in plots showing the relative percentage deviation from expected value for each participating laboratory. There is one plot for every single sample.

The median calculated from the results reported from EMEP laboratories and other participating laboratories respectively, are compared to expected value in Figure A.2.8.

A summary of the results is presented in Table A1.9. The results reported from each laboratory are divided in three percent intervals. The number of results reported by the laboratories in each percent interval are also shown.

Table A.1.10 gives information of the analytical techniques used by each laboratory.

5. Results

The analytical results from the intercomparison are presented in Figures A2.1-A2.8, Tables A1.2-A1.8 and Table A.1.9. The results reported from the participating laboratories were generally in accordance with the theoretical values, with a good agreement between the median from the second runs and the expected values.

5.1 Chromium (Cr)

A total of 26 laboratories have reported results for Cr, which included 5 values below detection limits for the low concentration samples and two for the high concentration samples. Six laboratories reported results from the low concentration samples that were more than 25% from expected value, whereas one laboratory reported results that deviated more than 25% from expected value for the high concentration samples. The relative standard deviations were 11.5%–24.8% for the low concentration samples, when outliers were excluded. This was higher than in the last intercomparison. For the high concentration samples the relative standard deviation was 9.4%–11.9% when outliers were excluded, which was slightly better than in the last intercomparison.

5.2 Nickel (Ni)

26 laboratories have reported results for Ni. This included 7 values below limits of detection for the low concentration samples and 2 values below limit of detection for high concentration samples. 8 laboratories reported values that deviate more

than 25% from expected value. The relative standard deviations for the low concentration samples were 18.3%–29.5%. The relative standard deviations for the high concentration samples were 15.8%–12.4%. For both high and low concentrations this was about the same as reported in the last intercomparison.

5.3 Copper (Cu)

Results are obtained from 28 laboratories. This included 8 values below detection limit for the low concentration samples. Six laboratories reported values that deviate more than 25% from expected value. The relative standard deviation for the low concentration samples H1 and H2 were 15.9% and 51.9%, respectively. The relative standard deviation for the high concentration samples H3 and H4 were 10.2% and 9.7%, respectively. With the exception of H2, this was an improvement compared to the results obtained last year.

5.4 Zinc (Zn)

27 laboratories reported results for Zn. This included 8 values below detection limit for the low concentration samples. Seven laboratories reported values that deviate more than 25% from expected value. The relative standard deviation for the low concentration samples was 17.6%–25.4%. This was higher than last year's results. For the high concentration samples, the relative standard deviation was 8.5%–10.0%. This was an improvement compared to the results reported last year.

5.5 Arsenic (As)

A total of 21 laboratories reported results for As. This included 10 values below detection limit for the low concentration samples. Four laboratories report values that deviate more than 25% from expected value. The relative standard deviation for the low concentration samples was 19.0%–21.2%. This was higher than reported in the last intercomparison. The relative standard deviation for the high concentration samples was 7.9%–16.1%. This was about the same as reported last year.

5.6 Cadmium (Cd)

A total of 29 laboratories reported results for Cd. This included 18 values below detection limit for the low concentration samples. It should be noted that the Cd concentration given in sample H2 was extremely low and that 16 of the results below detection limit were reported for this sample. The relative standard deviation for the low concentration samples was 18.5%–66.2%. The relative standard deviation for the high concentration samples was 19.8%–20.9%. This was better than in the last intercomparison.

5.7 Lead (Pb)

29 laboratories reported results for Pb. This included 5 values below detection limit. 7 laboratories report results that deviate more than 25% from expected value. The relative standard deviation is 23.2%–17.2% for the low concentration samples when outliers are excluded. This was slightly higher than last year's result. The relative standard deviation for the high concentration samples was 6.8%–6.6% when outliers were excluded. This was better than in the last intercomparison.

6. Conclusions and further work

A total of 30 laboratories participated in the intercomparison on heavy metals.

The elements showed the following order of success: Pb>Cr>Zn>As>Ni>Cu>Cd. This is a different order than last years results which showed Zn as the least and Cr as the most successful element. For all the samples analysed the deviations from the theoretical values were calculated. The median deviations for the EMEP laboratories were below 13.3% (exclusive the median value for Cd in sample H2) and below 5.7% for the low- and high concentration samples, respectively. This is a marked improvement from last year's results. The median deviations for the rest of the participating laboratories were below 27.8% (exclusive the median value for Cd in sample H2) and below 6.5% for the low- and high concentration samples, respectively.

In 2001 the non-European laboratories within WMO/GAW will also participate in the intercomparison of heavy metals in precipitation.

It is in course of preparation to arrange a field intercomparison on Hg in precipitation and air during 2002. Germany has offered to be the host country.

7. References

Berg, T., Hjellbrekke, A.-G. and Larsen, R. (2000) Heavy metals and POPs within Europe 1998. Kjeller, Norwegian Institute for Air Research (EMEP/CCC-Report 2/2000).

Berg, T. and Semb, A. (1995) Preliminary results from HELCOM-EMEP-PARCOM-AMAP analytical intercomparison of heavy metals in precipitation. Kjeller, Norwegian Institute for Air Research (EMEP/CCC-Note 1/95).

Berg, T. and Aas, W. (1999) Analytical intercomparison of heavy metals in precipitation 1999. Kjeller, Norwegian Institute for Air Research (EMEP/CCC-Report 8/2000).

Appendix 1

Tables

Table A1.1a: Participating laboratories in the EMEP network. The numbers in front are used in tables.

No	Laboratory identification
1	Federal Environmental Agency, Austria
3	Czech Hydrometeorological Institute, Czech Republic
5	Finnish Meteorological Institute, Finland
6	Laboratories Wollf, France
7	IfE Leipzig GmbH, Umweltlaborator., Germany
8	Umweltbundesamt, Germany
14	RIVM Laboratory of Inorganic Analytical Chemistry, The Netherlands
15	The Norwegian Institute for Air Research, Norway
16	Inst. Of Meteorology and Water Management, Poland
19	Instituto de Salud Carlos III, Centro Nacional de Sanidad Ambiental Area de Contaminacion Atmosferica, Spain
23	AEA Technology, National Environmental Techn. Centre, United Kingdom
24	Federal Hydrometeorological Institute, Yugoslavia
26	Ontario Ministry of Environment, Canada
31	Slovak Hydrometeorological Institute, Slovakia
32	Institute of physics, Aerosol research laboratory, Lithuania
33	Latvian Hydrometeorological Agency, Latvia
36	Hydrometeorological Institute of Slovenia, Slovenia
38	Estonian Environmental Research Centre, Estonia
39	Institute of Environmental Protection, Poland

Table A1.1b: Participating laboratories outside the EMEP network. The number in front of the names is used in tables and figures.

No	Laboratory identification
108	Institut f. Bondenkunde und Standortlehre, Germany
110	Thüringer Landesanstalt für Landwirtschaft (TTL), Germany
112	Niedersächsische Forstliche Versuchsanstalt (NVF), Germany
115	Bayerishe Landesanstalt f. Wald- und Forstwirtschaft, Germany
117	Sächsische Landesanstalt für Forsten, Germany
118	Forstliche Versuchs- und Forschungsanstalt Baden-Württemberg, Germany
119	Landesumweltamt (LUA)
120	Landwirtschaftliche Untersuchungs- und Forschungsanstalt (LUFA), Germany
121	Landesamt für Natur und Umwelt, Germany
123	Limnological Institute, Russia

Table A1.2: Analytical results for Cr in synthetic precipitation samples.

Cr
SAMPLE NO.: H1
THEORETICAL VALUE 1.700
UNIT: ng/ml

RUN 1:
NUMBER OF LABORATORIES: 25
ARITHMETIC MEAN VALUE: 1.758
MEDIAN: 1.720
STANDARD DEVIATON: 0.295
REL. ST. DEVIATION (%): 16.773

RUN 2:
NUMBER OF LABORATORIES: 21
ARITHMETIC MEAN VALUE: 1.690
MEDIAN: 1.700
STANDARD DEVIATON: 0.194
REL. ST. DEVIATION (%): 11.512

RESULTS IN DECREASING ORDER:
6 < 10
118 < 3

3	2.500 *	1	1.720
31	2.470 *	5	1.700
123	2.150	14	1.700
110	1.900	23	1.700
38	1.860	16	1.600
119	1.840	32	1.600
112	1.800	120	1.600
117	1.800	15	1.500
121	1.800	39	1.500
8	1.790	26	1.440
115	1.770	7	1.400
		36	1.300

< : DATA UNUSED IN RUN 1 AND 2
* : DATA UNUSED IN RUN 2

Cr
SAMPLE NO.: H2
THEORETICAL VALUE 0.700
UNIT: ng/ml

RUN 1:
NUMBER OF LABORATORIES: 24
ARITHMETIC MEAN VALUE: 0.752
MEDIAN: 0.700
STANDARD DEVIATON: 0.229
REL. ST. DEVIATION (%): 30.380

RUN 2:
NUMBER OF LABORATORIES: 20
ARITHMETIC MEAN VALUE: 0.721
MEDIAN: 0.700
STANDARD DEVIATON: 0.179
REL. ST. DEVIATION (%): 24.797

RESULTS IN DECREASING ORDER:
6 <10
38 < 1
39 < 1

3	1.400 *	5	0.700
31	1.130	14	0.700
123	1.080	120	0.700
115	0.910	1	0.680
110	0.800	23	0.640
117	0.800	32	0.640
121	0.780	26	0.610
112	0.760	16	0.600
8	0.730	15	0.580
119	0.730	36	0.500
		7	0.340

< : DATA UNUSED IN RUN 1 AND 2
* : DATA UNUSED IN RUN 2

Cr
SAMPLE NO.: H3
THEORETICAL VALUE 5.300
UNIT: ng/ml

RUN 1:
NUMBER OF LABORATORIES: 26
ARITHMETIC MEAN VALUE: 5.310
MEDIAN: 5.300
STANDARD DEVIATON: 0.897
REL. ST. DEVIATION (%): 16.902

RUN 2:
NUMBER OF LABORATORIES: 24
ARITHMETIC MEAN VALUE: 5.177
MEDIAN: 5.250
STANDARD DEVIATON: 0.616
REL. ST. DEVIATION (%): 11.899

RESULTS IN DECREASING ORDER:
6 < 10

108	8.500 *	110	5.300
38	6.520	120	5.200
3	6.000	1	5.190
31	5.950	39	5.100
		5	5.000
117	5.800	16	5.000
115	5.530	32	4.900
112	5.470	15	4.800
8	5.440	26	4.790
		7	4.710
121	5.400	36	4.400
119	5.370	118	4.000
123	5.370	23	3.700
14	5.300		

< : DATA UNUSED IN RUN 1 AND 2
* : DATA UNUSED IN RUN 2

Cr
SAMPLE NO.: H4
THEORETICAL VALUE 4.200
UNIT: ng/ml

RUN 1:
NUMBER OF LABORATORIES: 26
ARITHMETIC MEAN VALUE: 4.195
MEDIAN: 4.200
STANDARD DEVIATON: 0.524
REL. ST. DEVIATION (%): 12.481

RUN 2:
NUMBER OF LABORATORIES: 23
ARITHMETIC MEAN VALUE: 4.191
MEDIAN: 4.200
STANDARD DEVIATON: 0.397
REL. ST. DEVIATION (%): 9.483

RESULTS IN DECREASING ORDER:
6 < 10

38	5.490 *	108	4.200
31	5.050	120	4.100
3	4.900	1	4.080
115	4.840	16	4.000
123	4.580	23	4.000
		32	4.000
117	4.400	5	3.900
121	4.400	39	3.900
		15	3.800
8	4.360	26	3.780
112	4.310	7	3.670
110	4.300	36	3.400
119	4.220	118	3.000 *
14	4.200		

< : DATA UNUSED IN RUN 1 AND 2
* : DATA UNUSED IN RUN 2

Table A1.3: Analytical results for Ni in synthetic precipitation samples.

```
Ni
SAMPLE NO.:  H1
THEORETICAL VALUE  0.700
UNIT: ng/ml

RUN 1:
NUMBER OF LABORATORIES:       21
ARITHMETIC MEAN VALUE:     0.728
MEDIAN:                    0.700
STANDARD DEVIATON:         0.237
REL. ST. DEVIATION (%):   32.501

RUN 2:
NUMBER OF LABORATORIES:       17
ARITHMETIC MEAN VALUE:     0.720
MEDIAN:                    0.700
STANDARD DEVIATON:         0.132
REL. ST. DEVIATION (%):   18.277

RESULTS IN DECREASING ORDER:
  6 < 10
117   1.400 *              1   0.700
 39 < 1.000
121   1.000                5   0.700
123   0.990               14   0.700
                          16   0.630
  3   0.800               15   0.620
110   0.800               26   0.620
112   0.780               23   0.600
 31   0.750               36   0.600
 32   0.740                7   0.497
  8   0.710              120   0.200 *

< : DATA UNUSED IN RUN 1 AND 2
* : DATA UNUSED IN RUN 2
```

```
Ni
SAMPLE NO.:  H2
THEORETICAL VALUE  0.600
UNIT: ng/ml

RUN 1:
NUMBER OF LABORATORIES:       24
ARITHMETIC MEAN VALUE:     0.592
MEDIAN:                    0.570
STANDARD DEVIATON:         0.218
REL. ST. DEVIATION (%):   36.800

RUN 2:
NUMBER OF LABORATORIES:       16
ARITHMETIC MEAN VALUE:     0.556
MEDIAN:                    0.550
STANDARD DEVIATON:         0.164
REL. ST. DEVIATION (%):   29.568

RESULTS IN DECREASING ORDER:
  6 < 10
118 < 2
115 < 1.35                  8   0.580
123   1.170*              112   0.570
 39 < 1.000
117   1.000                26   0.530
119 < 0.9                  15   0.510
110   0.700               121 < 0.5
 32   0.650                 3   0.500
  1   0.600                23   0.500
  5   0.600                36   0.500
 14   0.600                16   0.460
                            7 < 0.4
                           31   0.400
                          120   0.200

< : DATA UNUSED IN RUN 1 AND 2
* : DATA UNUSED IN RUN 2
```

```
Ni
SAMPLE NO.:  H3
THEORETICAL VALUE  7.700
UNIT: ng/ml

RUN 1:
NUMBER OF LABORATORIES:       26
ARITHMETIC MEAN VALUE:     7.186
MEDIAN:                    7.410
STANDARD DEVIATON:         1.351
REL. ST. DEVIATION (%):   18.797

RUN 2:
NUMBER OF LABORATORIES:       24
ARITHMETIC MEAN VALUE:     7.333
MEDIAN:                    7.480
STANDARD DEVIATON:         1.159
REL. ST. DEVIATION (%):   15.810

RESULTS IN DECREASING ORDER:
  6 < 10
108   9.800                5   7.400
117   9.400               16   7.400
115   8.130               39   7.400
                          32   7.100
119   7.950              120   7.100
 14   7.900
 38   7.840               26   6.980
  8   7.830               15   6.600
110   7.700               36   6.500
112   7.700                7   5.300
121   7.700               23   5.200
  3   7.600              118   4.500
  1   7.550              123   3.670 *
 31   7.410

< : DATA UNUSED IN RUN 1 AND 2
* : DATA UNUSED IN RUN 2
```

```
Ni
SAMPLE NO.:  H4
THEORETICAL VALUE  9.800
UNIT: ng/ml

RUN 1:
NUMBER OF LABORATORIES:       26
ARITHMETIC MEAN VALUE:     9.149
MEDIAN:                    9.620
STANDARD DEVIATON:         1.463
REL. ST. DEVIATION (%):   15.990

RUN 2:
NUMBER OF LABORATORIES:       24
ARITHMETIC MEAN VALUE:     9.333
MEDIAN:                    9.660
STANDARD DEVIATON:         1.160
REL. ST. DEVIATION (%):   12.425

RESULTS IN DECREASING ORDER:
108   11.700                5   9.400
121   11.000               32   9.200
115   10.450
  8   10.200              120   9.000
119   10.100               26   8.810
  6 < 10
112    9.930               15   8.300
 14    9.900               23   8.300
 38    9.890               36   8.300
 31    9.790              118   7.400
 16    9.700                7   7.110
110    9.700              117   6.900
 39    9.700
  1    9.620              123   4.720 *
  3    9.600

< : DATA UNUSED IN RUN 1 AND 2
* : DATA UNUSED IN RUN 2
```

Table A1.4: Analytical results for Cu in synthetic precipitation samples.

```
Cu
SAMPLE NO.:  H1
THEORETICAL VALUE  1.400
UNIT:  ng/ml

RUN 1:
NUMBER OF LABORATORIES:       27
ARITHMETIC MEAN VALUE:     1.668
MEDIAN:                    1.400
STANDARD DEVIATON:         1.290
REL. ST. DEVIATION (%):   77.316

RUN 2:
NUMBER OF LABORATORIES:       22
ARITHMETIC MEAN VALUE:     1.403
MEDIAN:                    1.400
STANDARD DEVIATON:         0.223
REL. ST. DEVIATION (%):   15.906

RESULTS IN DECREASING ORDER:
  6 < 10
 24    7.500 *             14   1.400
 33    2.030               16   1.350
118 <  2                  121   1.340
 73    1.690               15   1.300
119 <  1.68                23   1.300
  3    1.600              117   1.300
 39    1.600               26   1.230
110    1.600              120   1.200
 31    1.580               32   1.100
  8    1.470               36   1.100
115    1.420               38 < 1
112    1.410                7   1.050
  1    1.400
  5    1.400

< : DATA UNUSED IN RUN 1 AND 2
* : DATA UNUSED IN RUN 2
```

```
Cu
SAMPLE NO.:  H2
THEORETICAL VALUE  0.900
UNIT: ng/ml

RUN 1:
NUMBER OF LABORATORIES:       27
ARITHMETIC MEAN VALUE:     1.224
MEDIAN:                    0.970
STANDARD DEVIATON:         1.087
REL. ST. DEVIATION (%):   88.763

RUN 2:
NUMBER OF LABORATORIES:       22
ARITHMETIC MEAN VALUE:     1.025
MEDIAN:                    0.960
STANDARD DEVIATON:         0.533
REL. ST. DEVIATION (%):   51.981

RESULTS IN DECREASING ORDER:
  6  < 10
118  <  2
 24     5.600*              1   0.970
120     3.100              16   0.950
119  <  1.68              121   0.950
  8     1.360              23   0.920
123     1.350              14   0.900
  5     1.100              15   0.900
110     1.100              26   0.900
117     1.100             112   0.820
 31     1.030              36   0.800
115     1.010               7   0.640
 38  <  1                  39   0.600
  3     1.000              33   0.060
 32     1.000

< : DATA UNUSED IN RUN 1 AND 2
* : DATA UNUSED IN RUN 2
```

```
Cu
SAMPLE NO.:  H3
THEORETICAL VALUE 15.000
UNIT: ng/ml

RUN 1:
NUMBER OF LABORATORIES:       28
ARITHMETIC MEAN VALUE:    14.697
MEDIAN:                   14.650
STANDARD DEVIATON:         2.178
REL. ST. DEVIATION (%):   14.816

RUN 2:
NUMBER OF LABORATORIES:       25
ARITHMETIC MEAN VALUE:    14.861
MEDIAN:                   14.800
STANDARD DEVIATON:         1.515
REL. ST. DEVIATION (%):    10.197

RESULTS IN DECREASING ORDER:
 24  20.000 *             16  14.500
123  19.000              118  14.500
 38  17.800               32  14.200
108  17.500              119  14.100
117  16.300              112  14.070
  8  15.600               26  14.040
 14  15.300                7  14.000
115  15.140              110  13.900
  3  15.100                6  13.300
110  15.100               15  13.000
 31  15.020               39  12.900
121  15.000               33  12.550
  1  14.800                6  10.000*
  5  14.800               23  10.000*


< : DATA UNUSED IN RUN 1 AND 2
* : DATA UNUSED IN RUN 2
```

```
Cu
SAMPLE NO.:  H4
THEORETICAL VALUE 12.000
UNIT: ng/ml

RUN 1:
NUMBER OF LABORATORIES:       28
ARITHMETIC MEAN VALUE:    11.537
MEDIAN:                   11.600
STANDARD DEVIATON:         1.595
REL. ST. DEVIATION (%):   13.824

RUN 2:
NUMBER OF LABORATORIES:       26
ARITHMETIC MEAN VALUE:    11.563
MEDIAN:                   11.600
STANDARD DEVIATON:         1.122
REL. ST. DEVIATION (%):    9.700

RESULTS IN DECREASING ORDER:
123  15.500 *             16  11.700
 38  13.600                7  11.500
108  13.300              118  11.500
117  12.800              119  11.500
  8  12.700              121  11.500
 14  12.500               26  11.280
 32  12.300               62  11.230
 31  12.280               15  11.000
115  12.210               36  10.700
  3  12.200               39  10.300
  1  12.000               33  10.040
110  12.000                6  10.000
  5  11.900               23   9.700
                         120   8.900
                          24   6.900 *

< : DATA UNUSED IN RUN 1 AND 2
* : DATA UNUSED IN RUN 2
```

Table A1.5: Analytical results for Zn in synthetic precipitation samples.

```
Zn
SAMPLE NO.:  H1
THEORETICAL VALUE  5.000
UNIT: ng/ml

RUN 1:
NUMBER OF LABORATORIES:       27
ARITHMETIC MEAN VALUE:     7.635
MEDIAN:                    5.565
STANDARD DEVIATON:        11.324
REL. ST. DEVIATION (%):  148.325

RUN 2:
NUMBER OF LABORATORIES:       21
ARITHMETIC MEAN VALUE:     5.236
MEDIAN:                    5.430
STANDARD DEVIATON:         1.330
REL. ST. DEVIATION (%):   25.402

RESULTS IN DECREASING ORDER:
 23   58.000 *              26   5.430
119 < 30                    16   5.300
  6 < 10                   121   5.200
 38 < 10                     5   5.000
108 <  8.5
 32    6.600                15   5.000
  7    6.530               123   4.900
112    6.330                 1   4.890
  8    6.100                39   4.400
118 <  6.000               117   4.280
 14    6.000                36   4.000
 31    6.000                24   0.400
115    6.000
120    6.000
  3    5.900
110    5.700

< : DATA UNUSED IN RUN 1 AND 2
* : DATA UNUSED IN RUN 2
```

```
Zn
SAMPLE NO.:  H2
THEORETICAL VALUE  6.200
UNIT: ng/ml

RUN 1:
NUMBER OF LABORATORIES:       27
ARITHMETIC MEAN VALUE:     6.307
MEDIAN:                    6.300
STANDARD DEVIATON:         1.115
REL. ST. DEVIATION (%):   17.677

RUN 2:
NUMBER OF LABORATORIES:       22
ARITHMETIC MEAN VALUE:     6.307
MEDIAN:                    6.300
STANDARD DEVIATON:         1.115
REL. ST. DEVIATION (%):   17.677

RESULTS IN DECREASING ORDER:
119 < 30
  6 < 10                    32    6.400
 38 < 10                     5    6.300
108 <  8.5
115    8.340               111    6.300
  3    7.800                16    6.200
 31    7.700                 1    6.020
  8    7.400               118  < 6.000
112    7.170                15    6.000
 14    7.000               120    6.000
  7    6.990                23    5.800
110    6.500
 26    6.430                39    5.600
                           123    5.430
                           117    5.280
                            36    5.000
                            24    3.100

< : DATA UNUSED IN RUN 1 AND 2
* : DATA UNUSED IN RUN 2
```

```
Zn
SAMPLE NO.:  H3
THEORETICAL VALUE  103.000
UNIT: ng/ml

RUN 1:
NUMBER OF LABORATORIES:       27
ARITHMETIC MEAN VALUE:    95.986
MEDIAN:                  100.000
STANDARD DEVIATON:        20.117
REL. ST. DEVIATION (%):   20.959

RUN 2:
NUMBER OF LABORATORIES:        26
ARITHMETIC MEAN VALUE:      99.37
MEDIAN:                   101.000
STANDARD DEVIATON:          9.966
REL. ST. DEVIATION (%):    10.029

RESULTS IN DECREASING ORDER:
  8 115.000                26 100.000
 65 112.330                 1  99.000
 62 110.000                 7  98.500
 70 108.000                15  98.000
 58 107.000                36  95.000
 39 105.000                38  95.000
 60 105.000                68  95.000
 69 105.000                67  90.390
 71 105.000                32  90.000
 31 104.500                24  86.100
  5 104.000                23  78.000
 14 104.000                73  71.800
  3 102.000                 6   8.000 *
 16 100.000

< : DATA UNUSED IN RUN 1 AND 2
* : DATA UNUSED IN RUN 2
```

```
Zn
SAMPLE NO.:  H4
THEORETICAL VALUE  115.000
UNIT:ng/ml

RUN 1:
NUMBER OF LABORATORIES:       27
ARITHMETIC MEAN VALUE:   111.841
MEDIAN:                  115.000
STANDARD DEVIATON:        12.206
REL. ST. DEVIATION (%):   10.914

RUN 2:
NUMBER OF LABORATORIES:       26
ARITHMETIC MEAN VALUE:   113.327
MEDIAN:                  115.000
STANDARD DEVIATON:         9.640
REL. ST. DEVIATION (%):    8.507

RESULTS IN DECREASING ORDER:
 16 132.000
  8 129.000                  1 110.000
115 125.180                 23 110.000
112 124.000                 15 109.000
  5 122.000                  7 108.500
 14 121.000                 38 106.000
120 121.000                118 106.000
121 119.000                 36 105.000
 39 117.000                117 100.920
110 116.000                  6 100.000
 31 115.500                 32  99.000
  3 115.000                 24  92.400
108 115.000                123  73.200 *
119 115.000
 26 113.000

 < : DATA UNUSED IN RUN 1 AND 2
  * : DATA UNUSED IN RUN 2
```

Table A1.6: Analytical results for As in synthetic precipitation samples.

```
As
SAMPLE NO.:  H1
THEORETICAL VALUE  0.500
UNIT: ng/ml

RUN 1:
NUMBER OF LABORATORIES:       21
ARITHMETIC MEAN VALUE:     0.491
MEDIAN:                    0.500
STANDARD DEVIATON:         0.094
REL. ST. DEVIATION (%):   19.048

RUN 2:
NUMBER OF LABORATORIES:       15
ARITHMETIC MEAN VALUE:     0.491
MEDIAN:                    0.500
STANDARD DEVIATON:         0.093
REL. ST. DEVIATION (%):   19.048

RESULTS IN DECREASING ORDER:
  6 < 3
119 < 1.05
 38 < 1
120 < 1                     5   0.500
  1   0.680                 8   0.460
115   0.620                26   0.450
110   0.600               121   0.440
 24   0.540                23   0.410
 14   0.520                32   0.400
 15   0.510                36   0.400
  3   0.500               123   0.330
                            7 < 0.1
                          117 < 0.1

< : DATA UNUSED IN RUN 1 AND 2
* : DATA UNUSED IN RUN 2
```

```
As
SAMPLE NO.:  H2
THEORETICAL VALUE  0.900
UNIT: ng/ml

RUN 1:
NUMBER OF LABORATORIES:       21
ARITHMETIC MEAN VALUE:     0.754
MEDIAN:                    0.840
STANDARD DEVIATON:         0.265
REL. ST. DEVIATION (%):   35.215

RUN 2:
NUMBER OF LABORATORIES:       15
ARITHMETIC MEAN VALUE:     0.828
MEDIAN:                    0.860
STANDARD DEVIATON:         0.176
REL. ST. DEVIATION (%):   21.230

RESULTS IN DECREASING ORDER:
  6 < 3                    26   0.840
115   1.060               121   0.810
119 < 1.05                 24   0.800
 38 < 1                    36   0.800
120 < 1                    23   0.660
  3   1.000               123   0.470
  1   0.980                 7   0.465
 15   0.960                32   0.200 *
 14   0.910               117   0.200 *
  5   0.900
110   0.900
  8   0.860

< : DATA UNUSED IN RUN 1 AND 2
* : DATA UNUSED IN RUN 2
```

```
As
SAMPLE NO.:  H3
THEORETICAL VALUE  6.200
UNIT: ng/ml

RUN 1:
NUMBER OF LABORATORIES:       21
ARITHMETIC MEAN VALUE:     5.585
MEDIAN:                    5.960
STANDARD DEVIATON:         1.253
REL. ST. DEVIATION (%):   22.428

RUN 2:
NUMBER OF LABORATORIES:       20
ARITHMETIC MEAN VALUE:     5.775
MEDIAN:                    6.035
STANDARD DEVIATON:         0.927
REL. ST. DEVIATION (%):   16.058

RESULTS IN DECREASING ORDER:
                           26   5.960
 24   6.830                 5   5.800
  1   6.540                32   5.600
  3   6.500                38   5.590
115   6.500                 7   5.410
119   6.430               120   5.400
 14   6.350               121   5.400
  6   6.300                36   5.300
 15   6.300                23   4.100
110   6.200               123   2.870
  8   6.110               117   1.800 *

< : DATA UNUSED IN RUN 1 AND 2
* : DATA UNUSED IN RUN 2
```

```
As
SAMPLE NO.:  H4
THEORETICAL VALUE  5.900
UNIT: ng/ml

RUN 1:
NUMBER OF LABORATORIES:       21
ARITHMETIC MEAN VALUE:     5.294
MEDIAN:                    5.530
STANDARD DEVIATON:         1.073
REL. ST. DEVIATION (%):   20.278

RUN 2:
NUMBER OF LABORATORIES:       19
ARITHMETIC MEAN VALUE:     5.605
MEDIAN:                    5.660
STANDARD DEVIATON:         0.443
REL. ST. DEVIATION (%):    7.901

RESULTS IN DECREASING ORDER:
                           38   5.530
115   6.310                 5   5.500
  1   6.180                24   5.440
  3   6.100               120   5.400
 14   6.000                32   5.200
119   5.920                36   5.100
110   5.900                 7   5.080
  8   5.870               121   5.000
  6   5.800                23   4.700
 15   5.800               123   2.680 *
 26   5.660               117   2.000 *

< : DATA UNUSED IN RUN 1 AND 2
* : DATA UNUSED IN RUN 2
```

Table A1.7: Analytical results for Cd in synthetic precipitation samples.

```
Cd
SAMPLE NO.:  H1
THEORETICAL VALUE  0.090
UNIT: ng/ml

RUN 1:
NUMBER OF LABORATORIES:       28
ARITHMETIC MEAN VALUE:     0.127
MEDIAN:                    0.100
STANDARD DEVIATON:         0.140
REL. ST. DEVIATION (%):  110.001

RUN 2:
NUMBER OF LABORATORIES:       23
ARITHMETIC MEAN VALUE:     0.099
MEDIAN:                    0.100
STANDARD DEVIATON:         0.018
REL. ST. DEVIATION (%):   18.581

RESULTS IN DECREASING ORDER:
  6 < 2
 24   0.780 *
 39 < 0.3                  15   0.099
 19 < 0.2                  31   0.098
115   0.140                 3   0.097
118   0.140                 5   0.090
119   0.117                26   0.090
 14   0.110                36   0.090
112   0.110               123   0.086
117   0.110                33   0.081
  7   0.105                23   0.075
  8   0.104                32   0.075
110 < 0.1                  16   0.061
  1   0.100
 38   0.100
120   0.100
121   0.100

< : DATA UNUSED IN RUN 1 AND 2
* : DATA UNUSED IN RUN 2
```

```
Cd
SAMPLE NO.:  H2
THEORETICAL VALUE  0.007
UNIT: ng/ml

RUN 1:
NUMBER OF LABORATORIES:       28
ARITHMETIC MEAN VALUE:     0.035
MEDIAN:                    0.014
STANDARD DEVIATON:         0.068
REL. ST. DEVIATION (%):  193.915

RUN 2:
NUMBER OF LABORATORIES:       11
ARITHMETIC MEAN VALUE:     0.016
MEDIAN:                    0.011
STANDARD DEVIATON:         0.010
REL. ST. DEVIATION (%):   66.267

RESULTS IN DECREASING ORDER:
  6 < 2
 39 < 0.3
 24   0.250 *              36 < 0.02
 19 < 0.2                 121 < 0.02
110 < 0.1                   8   0.006
112 < 0.1                  33   0.020
118 < 0.1                  31   0.019
120 < 0.1                   7   0.016
115 < 0.06                 15   0.011
117 < 0.05                  5   0.010
 26 < 0.05                 14   0.010
  3 < 0.04                 16   0.008
  1 < 0.04                 23   0.005
 73   0.038
119 < 0.03
 32 < 0.03
 38   0.03

< : DATA UNUSED IN RUN 1 AND 2
* : DATA UNUSED IN RUN 2
```

```
Cd
SAMPLE NO.:  H3
THEORETICAL VALUE  1.000
UNIT: ng/ml

RUN 1:
NUMBER OF LABORATORIES:       29
ARITHMETIC MEAN VALUE:     1.207
MEDIAN:                    1.000
STANDARD DEVIATON:         1.441
REL. ST. DEVIATION (%):  119.418

RUN 2:
NUMBER OF LABORATORIES:       27
ARITHMETIC MEAN VALUE:     0.937
MEDIAN:                    1.000
STANDARD DEVIATON:         0.186
REL. ST. DEVIATION (%):   19.847

RESULTS IN DECREASING ORDER:
 24   8.500 *              39   1.000
  6 < 2                   108   1.000
 19   1.150                70   1.000
112   1.090                26   0.980
 31   1.062                 1   0.970
115   1.060                33   0.957
 16   1.030                38   0.920
118   1.020                36   0.900
119   1.020               110   0.900
  7   1.017               121   0.900
  8   1.010                32   0.850
  3   1.000                23   0.620
  5   1.000               123   0.610
 14   1.000               117   0.220
 15   1.000

< : DATA UNUSED IN RUN 1 AND 2
* : DATA UNUSED IN RUN 2
```

```
Cd
SAMPLE NO.:  H4
THEORETICAL VALUE  1.400
UNIT: ng/ml

RUN 1:
NUMBER OF LABORATORIES:       29
ARITHMETIC MEAN VALUE:     1.478
MEDIAN:                    1.407
STANDARD DEVIATON:         0.852
REL. ST. DEVIATION (%):   57.669

RUN 2:
NUMBER OF LABORATORIES:       27
ARITHMETIC MEAN VALUE:     1.325
MEDIAN:                    1.403
STANDARD DEVIATON:         0.277
REL. ST. DEVIATION (%):   20.873

RESULTS IN DECREASING ORDER:
 24   5.600 *
  6 < 2                    15   1.400
108   1.600               120   1.400
 16   1.540                 1   1.360
 19   1.500                26   1.350
 39   1.500                 5   1.300
 31   1.486                36   1.300
118   1.470               110   1.300
  3   1.450               121   1.300
 14   1.450                32   1.260
115   1.450                38   1.240
  7   1.440                23   1.000
112   1.440               123   0.810
119   1.420               117   0.200
  8   1.410
 33   1.403

< : DATA UNUSED IN RUN 1 AND 2
* : DATA UNUSED IN RUN 2
```

Table A1.8: Analytical results for Pb in synthetic precipitation samples.

```
Pb
SAMPLE NO.:  H1
THEORETICAL VALUE  2.000
UNIT: ng/ml

RUN 1:
NUMBER OF LABORATORIES:       29
ARITHMETIC MEAN VALUE:     2.397
MEDIAN:                    2.000
STANDARD DEVIATON:         2.746
REL. ST. DEVIATION (%):  114.579

RUN 2:
NUMBER OF LABORATORIES:       25
ARITHMETIC MEAN VALUE:     1.865
MEDIAN:                    2.000
STANDARD DEVIATON:         0.434
REL. ST. DEVIATION (%):   23.251

RESULTS IN DECREASING ORDER:
 24   15.700 *
  6 < 10
 39 < 3                  120   2.000
118   2.400              121   2.000
119   2.320               38   1.980
  3   2.200              115   1.940
  8   2.170               15   1.900
 31   2.110              123   1.900
  5   2.100               26   1.700
 14   2.100               36   1.700
112   2.100               32   1.600
117   2.100               23   1.500
  1   2.050                7   1.420
 16   2.000              108 < 1.4
110   2.000               19   0.850
                          33   0.480

< : DATA UNUSED IN RUN 1 AND 2
* : DATA UNUSED IN RUN 2
```

```
Pb
SAMPLE NO.:  H2
THEORETICAL VALUE  4.500
UNIT: ng/ml

RUN 1:
NUMBER OF LABORATORIES:       29
ARITHMETIC MEAN VALUE:     4.857
MEDIAN:                    4.500
STANDARD DEVIATON:         2.494
REL. ST. DEVIATION (%):   51.346

RUN 2:
NUMBER OF LABORATORIES:       26
ARITHMETIC MEAN VALUE:     4.398
MEDIAN:                    4.470
STANDARD DEVIATON:         0.756
REL. ST. DEVIATION (%):   17.193

RESULTS IN DECREASING ORDER:
 24   16.770 *
  6 < 10
 39    7.000                38   4.440
120    5.000                31   4.420
 23    4.930                 3   4.400
119    4.890                15   4.300
  5    4.800               118   4.200
  8    4.750                16   4.100
122    4.740                32   4.100
 14    4.700                26   3.850
110    4.600                 7   3.740
117    4.600                36   3.600
115    4.550                33   3.580
  1    4.500                19   3.170
121    4.500                23   2.900
                           108 < 1.4

< : DATA UNUSED IN RUN 1 AND 2
* : DATA UNUSED IN RUN 2
```

```
Pb
SAMPLE NO.:  H3
THEORETICAL VALUE 58.000
UNIT: ng/ml

RUN 1:
NUMBER OF LABORATORIES:       29
ARITHMETIC MEAN VALUE:    57.013
MEDIAN:                   57.600
STANDARD DEVIATON:         6.292
REL. ST. DEVIATION (%):   11.036

RUN 2:
NUMBER OF LABORATORIES:       27
ARITHMETIC MEAN VALUE:    57.274
MEDIAN:                   57.600
STANDARD DEVIATON:         3.910
REL. ST. DEVIATION (%):    6.826

RESULTS IN DECREASING ORDER:
117  72.000 *             33  57.560
123  68.000                1  57.000
 14  64.000              120  57.000
  5  61.000                7  56.600
  8  60.800               19  56.150
  3  59.900               32  55.000
118  59.800               26  54.700
119  59.300               15  54.000
112  58.670              108  53.900
110  58.500               38  53.700
 16  58.000               24  51.630
121  58.000               39  51.000
115  57.810               36  49.000
 31  57.770               23  35.000 *
  6  57.600

< : DATA UNUSED IN RUN 1 AND 2
* : DATA UNUSED IN RUN 2
```

```
Pb
SAMPLE NO.:  H4
THEORETICAL VALUE 45.000
UNIT: ng/ml

RUN 1:
NUMBER OF LABORATORIES:       29
ARITHMETIC MEAN VALUE:    43.794
MEDIAN:                   45.000
STANDARD DEVIATON:         3.782
REL. ST. DEVIATION (%):    8.635

RUN 2:
NUMBER OF LABORATORIES:       28
ARITHMETIC MEAN VALUE:    44.251
MEDIAN:                   45.000
STANDARD DEVIATON:         2.924
REL. ST. DEVIATION (%):    6.608

RESULTS IN DECREASING ORDER:
123  50.500              121  45.000
117  48.600                1  44.400
  8  47.800              120  44.000
 14  47.200               33  43.410
  5  47.000               15  43.000
 31  46.540               32  42.600
  3  45.800                7  42.500
112  45.800               26  42.300
115  45.620               19  42.100
110  45.600               24  41.750
119  45.500              108  39.400
 38  45.200                6  39.300
118  45.100               36  39.000
 16  45.000               39  39.000
                          23  31.000 *

< : DATA UNUSED IN RUN 1 AND 2
* : DATA UNUSED IN RUN 2
```

Table A1.9 Percentage deviation from theoretical concentration value.

Element and percent interval	**No. of laboratories**			**Lab. Identification** *The number in brackets are number of results reported in the particular percent interval by the laboratory*
	EMEP	Other	Total	
Cr				
0-10%	9	9	18	1(4), 5(4), 8(4), 14(4), 15(2), 16(3), 23(3), 26(2), 32(2), 39(2), 110(29), 112(4), 115(2), 117(39), 119(4), 120(4), 121(3), 123(2)
10-25%	8	6	14	3(2), 7(3), 15(2), 16(1), 26(2), 31(1), 36(2), 38(2), 39(1), 110(2), 115(1), 117(1), 118(1), 121(1)
>25%	6	4	10	3(2), 7(1), 23(1), 31(3), 36(2), 38(1), 108(1), 115(1), 118(1), 123(2)
Ni				
0-10%	11	7	18	1(4), 3(2), 5(4), 8(3), 14(3), 15(1), 16(3), 26(2), 31(3), 32(4), 38(2), 39(2), 110(2), 112(3), 115(2), 119(2), 120(2)
10-25%	5	5	10	3(2), 15(3), 16(1), 23(3), 26(2), 36(4), 108(1), 110(2), 112(1), 121(1)
>25%				7(3), 23(1), 31(3), 108(1), 117(4), 118(2), 120(2), 121(1), 123(4)
Cu				
0-10%	11	10	20	1(4), 3(2), 5(3), 7(2), 8(3), 14(4), 15(3), 16(4), 23(2), 26(3), 31(2), 32(2), 110(2), 112(4), 115(3), 117(3), 118(2), 119(2), 120(1), 121(4)
10-25%	11	7	18	3(2), 5(1), 6(1), 15(1), 23(1), 26(1), 31(2), 32(2), 33(2), 36(4), 38(2), 39(3), 108(2), 115(1), 110(2), 117(1), 120(1), 123(1)
>25%	7	2	9	6(1), 7(2), 8(1), 23(1), 24(4), 33(2), 39(1), 120(2), 123(3)
Zn				
0-10%	13	10	23	1(4), 3(2), 5(3), 7(1), 14(2), 15(4), 16(3), 23(2), 26(4), 31(2), 32(1), 36(1), 38(2), 39(3), 108(2), 110(3), 112(2), 115(2), 118(2), 119(2), 120(3), 121(4), 123(1)
10-25%	12	6	18	3(1), 6(1), 7(1), 8(4), 14(2), 16(1), 24(2), 31(2), 32(1), 36(2), 39(1), 110(1), 112(1), 115(1), 117(4), 120(1), 123(1)
>25%	6	3	9	3(1), 6(1), 7(1), 23(1), 24(2), 32(1), 112(1), 115(1), 123(2)
Cd				
0-10%	14	10	24	1(2), 3(3), 5(3), 8(2), 14(2), 15(2), 16(1), 19(1), 26(3), 31(3), 33(3), 36(2), 38(1), 39(2), 108(1), 110(1), 112(2), 115(2), 118(2), 119(2), 120(2), 121(1)
10-25%	11	5	16	1(1), 8(2), 14(1), 15(1), 16(2), 19(1), 23(1), 108(1), 32(3), 36(1), 38(2), 110(1), 112(1), 117(1), 120(1), 121(2)
>25%	10	5	15	5(1), 7(1), 14(1), 15(1), 16(1), 23(3), 24(4), 31(1), 33(1), 38(1), 115(1), 117(2), 118(1), 119(1), 123(3)
Pb				
0-10%	15	11	26	1(4), 3(3), 5(4), 6(1), 7(2), 8(4), 14(3), 15(4), 16(4), 19(2), 24(2), 26(2), 31(4), 32(4), 33(2), 38(4), 108(1), 110(4), 112(4), 115(4), 117(3), 118(3), 119(3), 120(3), 121(4), 123(2)
10-25%	9	6	15	3(1), 6(1), 7(1), 14(1), 24(1), 26(2), 32(1), 36(3), 39(2), 108(1), 117(1), 118(1), 119(1), 120(1), 123(2)
>25%	6	0	6	7(1), 19(2), 23(4), 24(2), 33(2), 39(1)

Table A1.10: Analytical technique used at the participating laboratories for the different elements.

Lab. no.	Elements	Technique
1	Cr, Ni, Cu, Zn, As, Cd, Pb	ICP-MS
3	Ni, Cd, Cu, Pb, Cr, As Zn	GF-AAS ICP-MS F-AAS
5	Cr, Ni, Cu, Zn, As, Cd, Pb	ICP-MS
6	Cr, Ni, Cu, Zn, Cd, Pb As	USN-ICP-OES ICP-MS
7	Cr, Ni, Cu, Zn, As, Cd, Pb	GF-AAS
8	Cr, Ni, Cu, Zn, As, Cd, Pb	ICP-MS
14	Cr, Ni, Cu, Zn, As, Cd, Pb	ICP-MS
15	Cr, Ni, Cu, Zn, As, Cd, Pb	ICP-MS
16	Cr, Ni, Cu, Zn, Cd, Pb	GF-AAS
19	Cd, Pb	GF-AAS
23	Cr, Ni, Cu, Zn, As, Cd, Pb	ICP-MS
24	Cu, Zn, Cd As, Pb	F-AAS HG-F-AAS
26	Cr, Ni, Cu, Zn, As, Cd, Pb	ICP-MS
31	Cr, Ni, Cu, Cd, Pb Zn	GF-AAS F-AAS
32	Cr, Ni, Cu, Zn, As, Cd, Pb	GF-AAS
33	Cu, Cd, Pb	GF-AAS
36	Cr, Ni, Cu, Zn, As, Cd, Pb	ICP-MS
38	Cr, Ni, Cu, As, Cd, Pb Zn	GF-AAS F-AAS
39	Cr, Ni, Cu, Zn, Cd, Pb	USN-ICP-OES
108	Cr, Ni, Cu, Zn, Cd, Pb	GF-AAS
110	Cr, Ni, Cu, Zn, As, Cd, Pb	ICP-MS
112	Cr, Ni, Cu, Zn, Cd, Pb	USN-ICP-MS
115	Cr, Ni, Cu, Zn, As, Cd, Pb	ICP-MS
117	Cr, Ni, Cu, As, Cd, Pb Zn	GF-AAS USN-ICP-OES
118	Cr, Ni, Cu, Cd, Pb Zn	GF-AAS ICP-OES
119	Cr, Ni, Cu, As, Cd, Pb Zn	GF-AAS F-AAS
120	Cr, Ni, Cu, Cd, Pb Zn As	GF-AAS ICP-OES HG-AAS
121	Cr, Ni, Cu, Cd, Pb As Zn	GF-AAS FIA-AAS Voltammetry
123	Cr, Ni, Cu, Zn, As, Cd, Pb	ICP-MS

Appendix 2

Figures

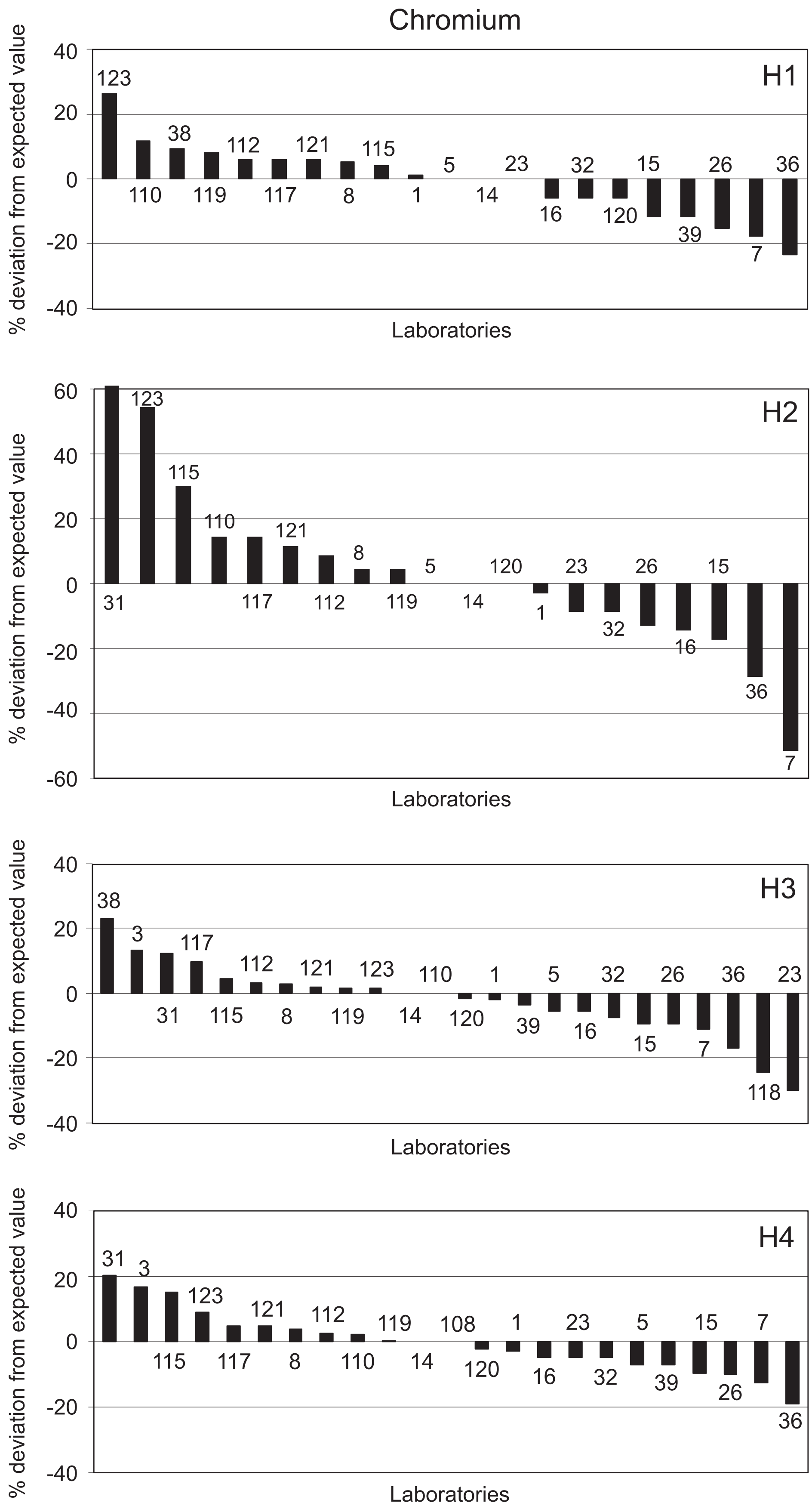

Figure A2.1: Results from determination of Cr.

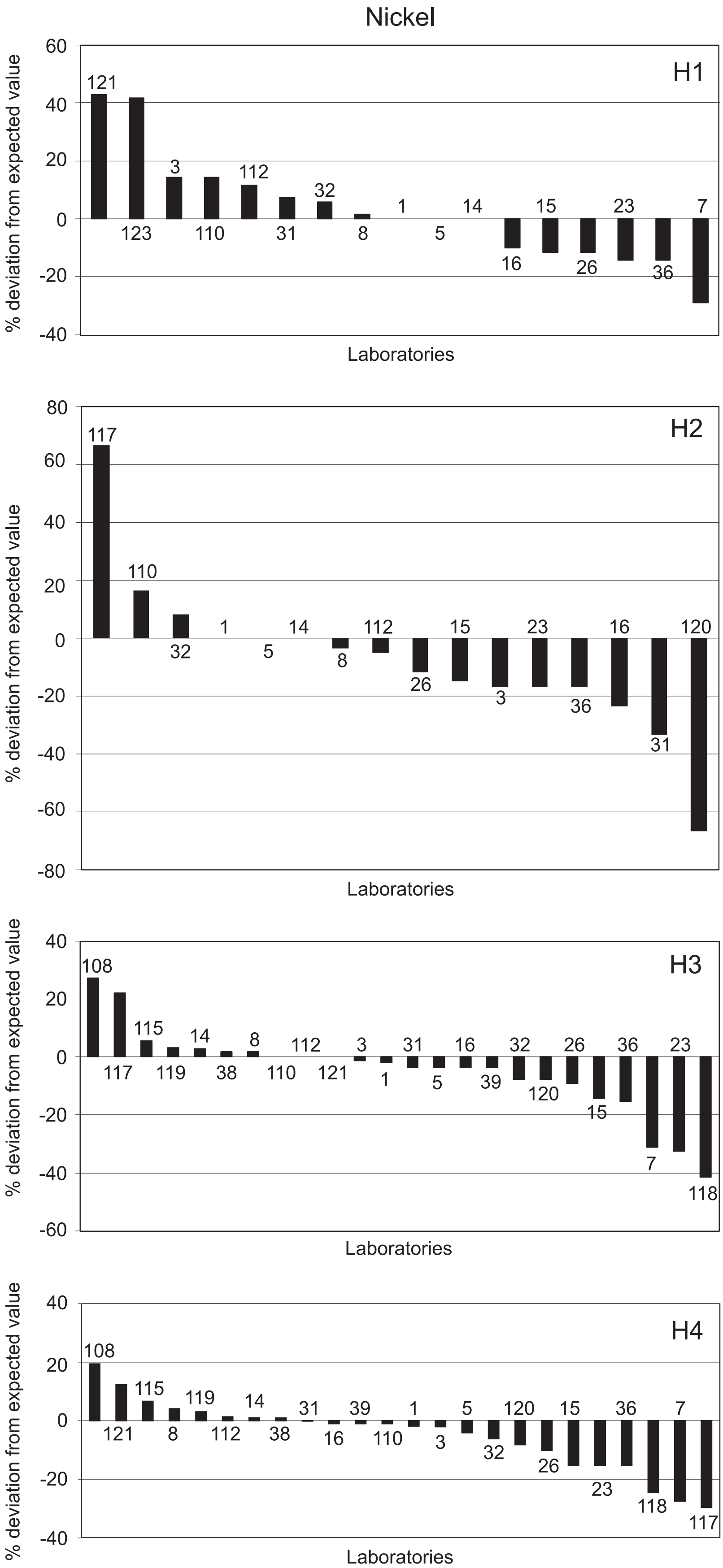

Figure A2.2: Results from determination of Ni.

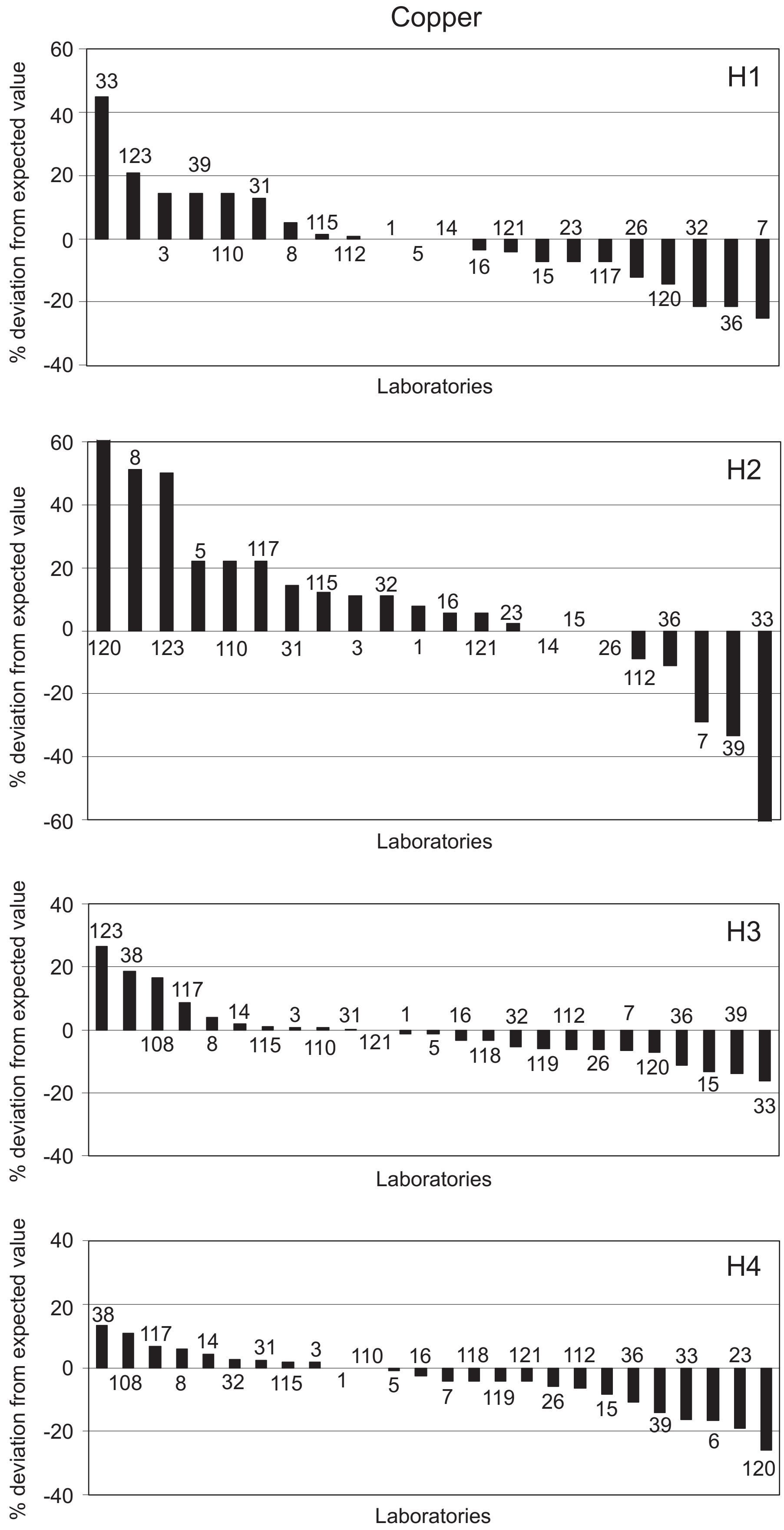

Figure A2.3: Results from determination of Cu.

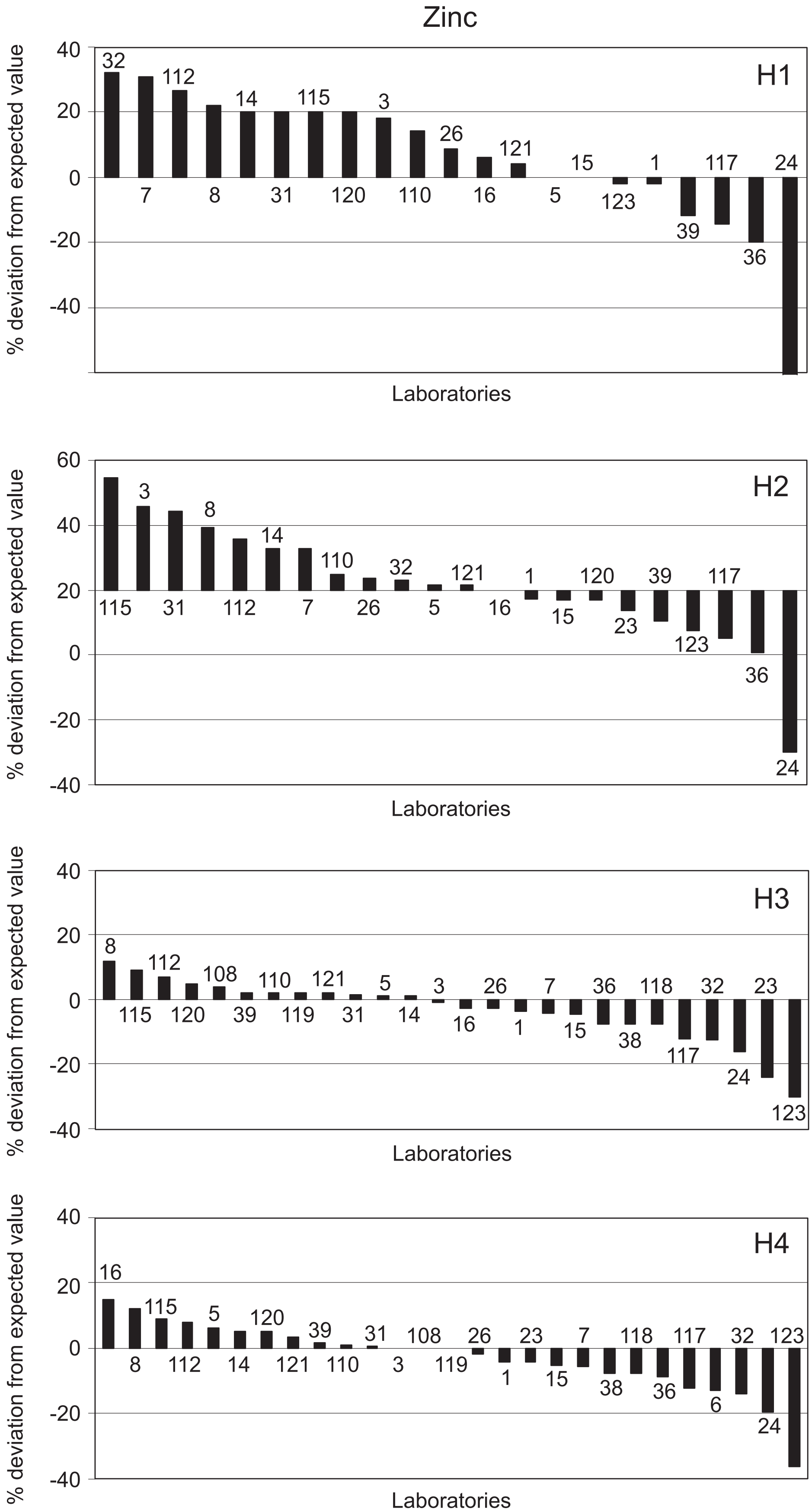

Figure A2.4: Results from determination of Zn.

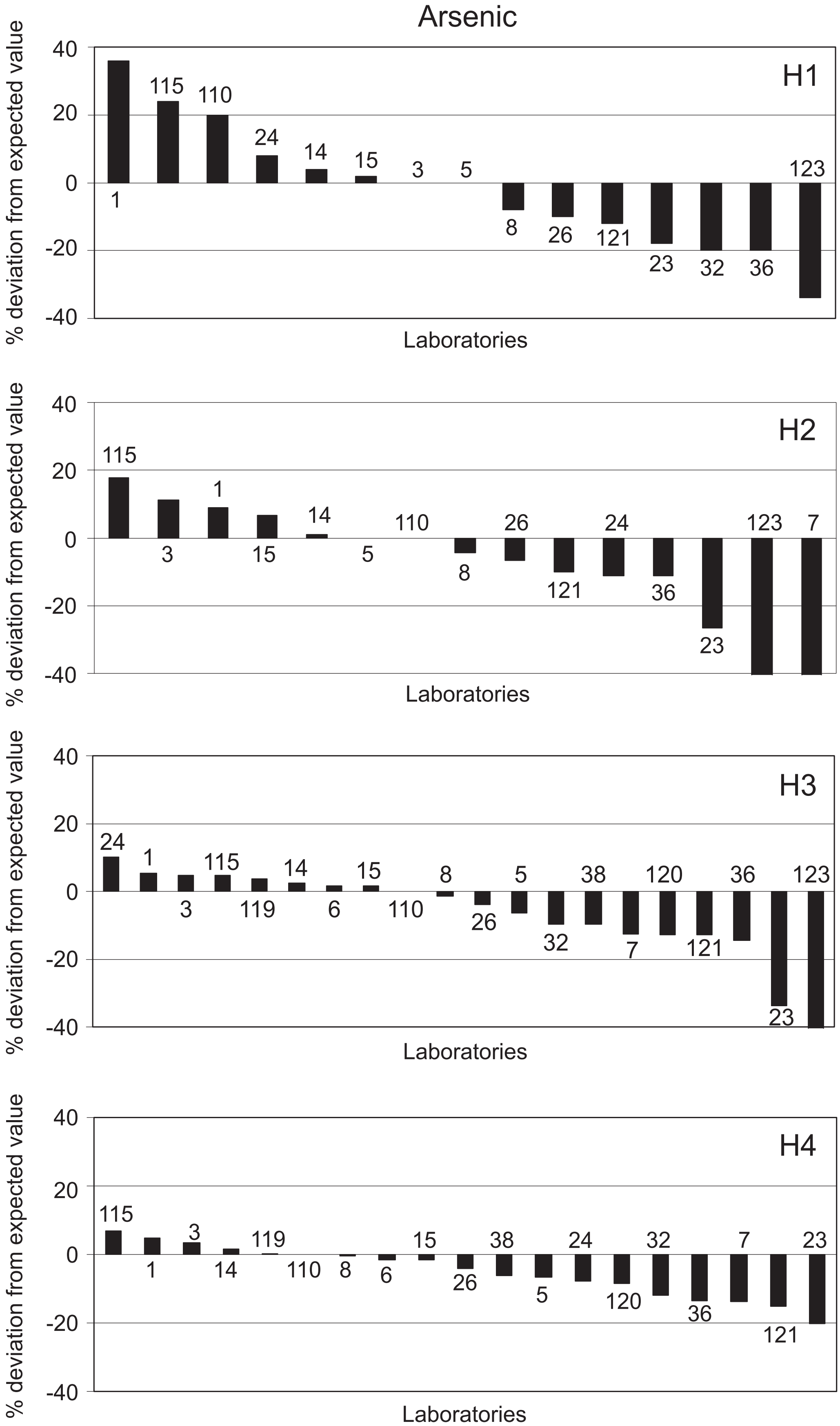

Figure A2.5: Results from determination of As.

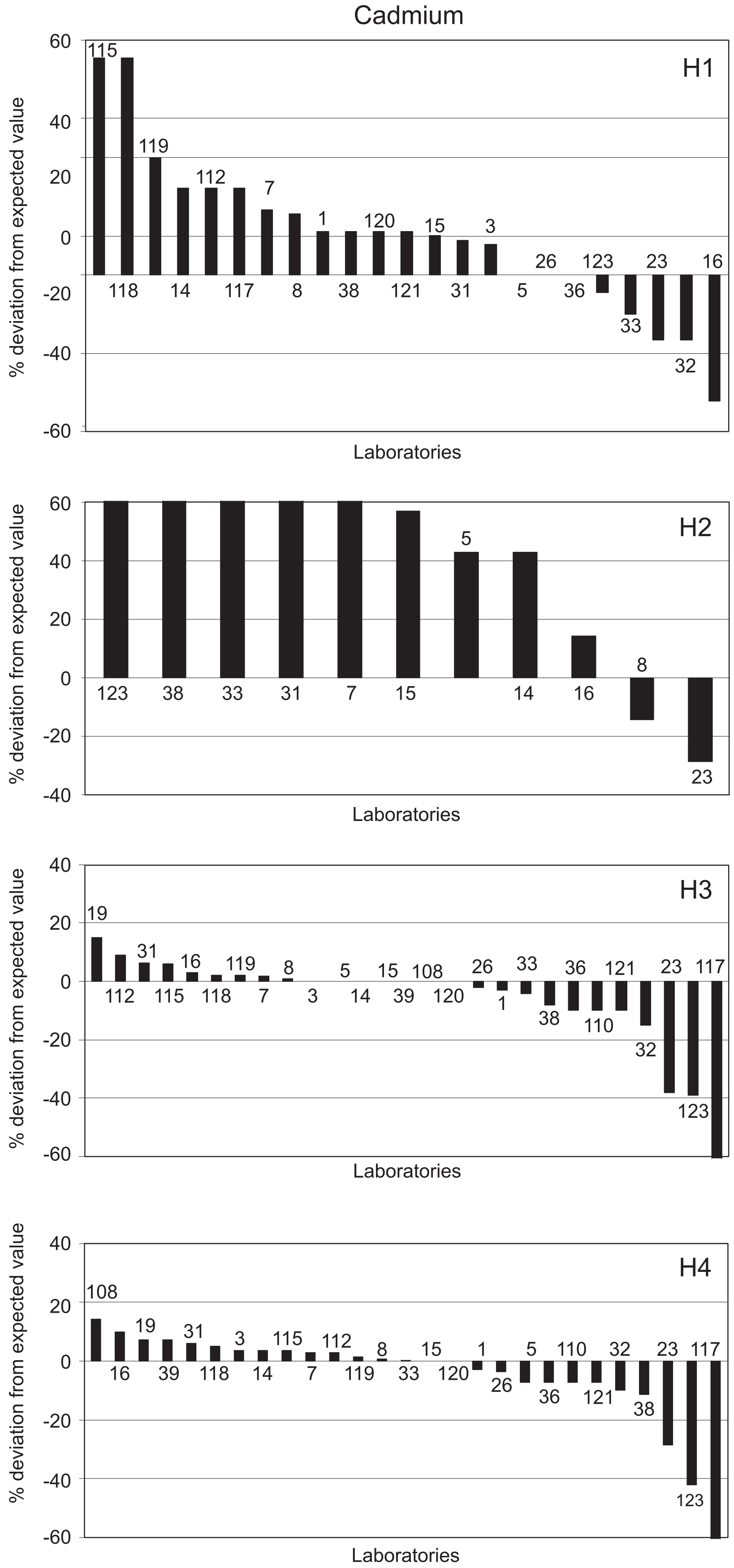

Figure A2.6: Results from determination of Cd.

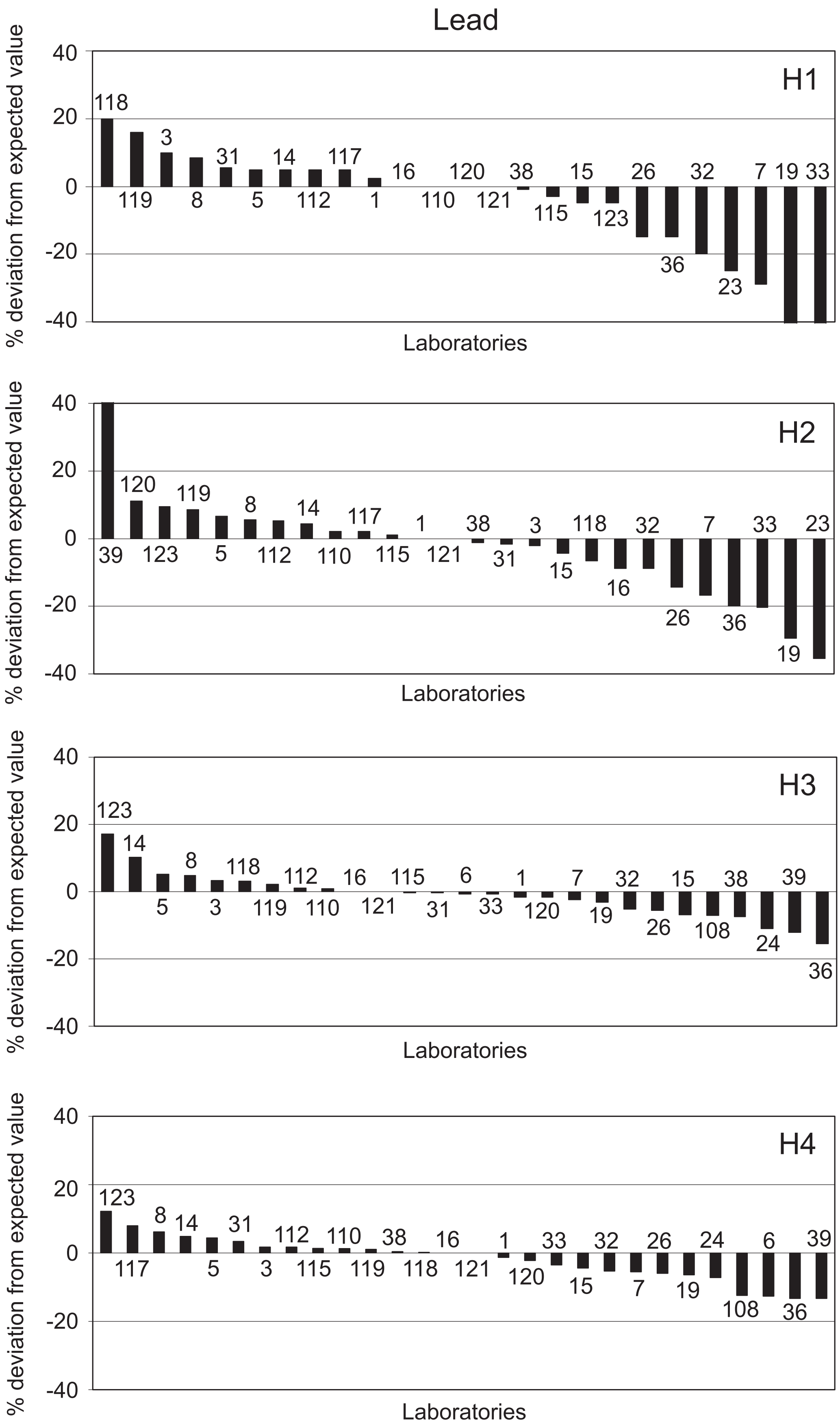

Figure A2.7: Results from determination of Pb.

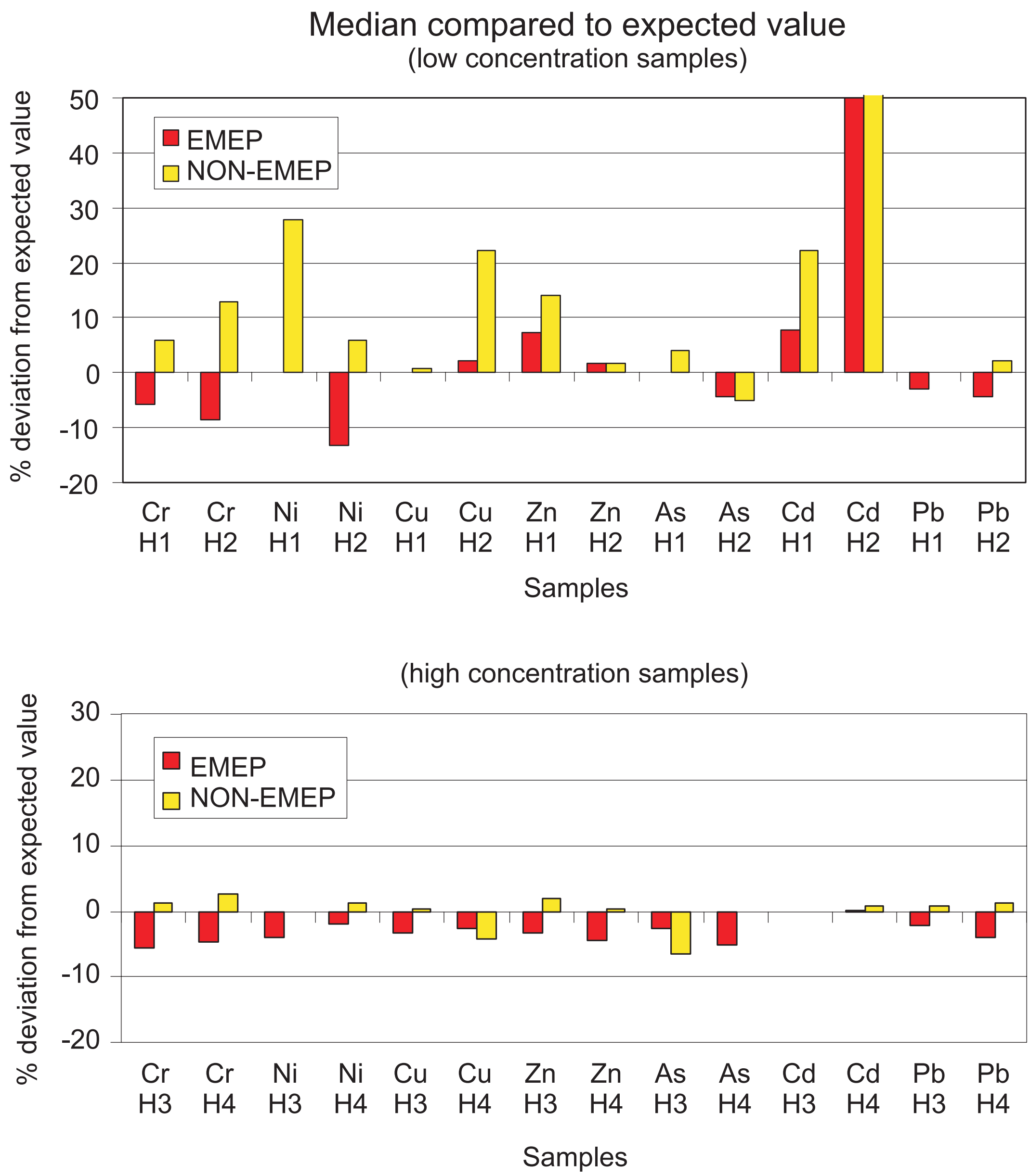

Figure A2.8: The median compared to theoretical value for low- and high concentration samples, respectively.