

# **VOC measurements 1998**

**Sverre Solberg**



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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

This report presents measurements of VOC performed during 1998 at the EMEP-VOC monitoring sites, as well as at other sites voluntarily reported to EMEP-CCC. In line with the recommendations the national laboratories are gradually taking over the chemical analyses of the samples. In 1998 the official measurement data for hydrocarbons have been analysed by Umweltbundesamt (UBA) in Germany, Ecole des Mines de Douai (EMD) in France, Czech Hydrometeorological Institute (CHMI) in the Czech Republic and Slovakian Hydrometeorological Institute (SHMI) in Slovakia for these countries' monitoring stations, respectively. The official data for the carbonyls are analysed by the national laboratory in France for FR008 Donon, whereas EMEP-CCC at Norwegian Institute for Air Research (NILU) is responsible for the carbonyl analyses at all the other sites. Hydrocarbon measurement data from stations outside the EMEP VOC network have been voluntarily submitted to this report by The Finnish Meteorological Institute (FMI) (for Pallas and Utö) and from Swiss Federal Laboratory for Materials Testing and Research (EMPA) in Switzerland (for Tänikon).

The number of monitoring sites for VOC have dropped in the last few years, however, the "performance" of the remaining stations (i.e. the sampling frequency, reliability etc.) have increased. Results of parallel sampling at hydrocarbons at Waldhof (Germany) in 1998 show very encouraging results, although a slight systematic difference of 10-20% is revealed for some components. The parallel analyses of carbonyls at Donon (France) continued in 1998.

Compared to previous years' EMEP VOC report the present report is slightly different and should be regarded as a technical report. The emphasis is on a short presentation of the monitoring programme as well as tables of monthly statistics and plots showing the daily measurement values. A more extensive analysis of the VOC data in general (from previous years) relative to model calculations is included in this year's joint oxidant report from MSC-W and CCC.





# VOC measurements 1998

## 1. Introduction

Volatile organic compounds (VOC) have been sampled at a number of EMEP sites since 1992, based on the recommendations from the EMEP Workshop on Measurements of Hydrocarbons/VOC in Lindau 1989. Collection of grab samples of light hydrocarbons in canisters started in the middle of 1992, whereas measurements of carbonyls started in 1993 using 8 h sampling in DNPH cartridges. The main aim is to collect data as a support to the photochemical modelling of ozone, but the VOC measurements are also useful for evaluating the emission inventories, process studies and, eventually, for trend analysis.

The co-operation and exchange of data between laboratories outside the EMEP-VOC monitoring network is encouraged in order to increase the geographical coverage of the VOC measurements. The measurements are reported annually and officially made public by the Steering Body of EMEP. Compared to the reporting of other atmospheric constituents, ozone and acidifying compounds, the reporting of VOC is one year ahead, implying that whereas this report presents results from the measurements in 1998, the measurements of ozone and acidifying compounds are reported for 1997.

## 2. Status of the measurement programme in 1998

### 2.1 Status of station network

EMEP's programme for VOC monitoring was substantially revised in 1997 and the revised monitoring programme was continued in 1998. The revision in 1997 implied that the monitoring was stopped at several sites and focussed to a few remaining stations. The selection of the remaining sites was based on an overall evaluation taking into account the sampling frequency and reliability, the assumed regional representativity, the geographical coverage etc. The location of the monitoring sites for VOC presented in this report is shown in Figure 1. An overview of the EMEP-VOC measurement programme and the accompanying measurements presented in this report is given in Table 1.

As indicated by Table 1, VOC measurements from 7 sites are included in this report, of which 4 measure carbonyls in addition to the hydrocarbons. Extensive parallel sampling is carried out when the responsibility for chemical analyses are transferred to local laboratories. At Waldhof and Donon, the parallel sampling was continued through the whole year. The analyses of hydrocarbons at Kosetice have previously been taken over by CHMI, following parallel sampling and analyses between NILU and CHMI with good results. Parallel analyses between NILU's and CHMI's laboratories were carried out for Kosetice in 1998 as well, but only for a few short periods. This work serves as an ongoing check for the laboratories, and the data for these periods are not presented in this report.



Figure 1: Monitoring sites for VOC in 1998.

Table 1: Status of the VOC monitoring programme in 1998 within EMEP and as reported to EMEP from other sites. The columns give the station names, site code, and the sampling frequencies for hydrocarbons (HC) and carbonyl compounds (Carb). The laboratory analysing the samples of hydrocarbons and carbonyls, respectively, is also given.

| Station   | Code   | HC     | Lab.         | Carb   | Lab.         | Comments   |
|-----------|--------|--------|--------------|--------|--------------|--|
| Pallas    | -      | Reg.   | FMI          | n.m.   | -            | Not an EMEP site   |
| Utö       | FI09   | Reg.   | FMI          | n.m.   | -            | Not an EMEP-VOC site   |
| Birkenes  | NO1    | Reg.   | NILU         | Reg.   | NILU         | Not an EMEP-VOC site   |
| Waldhof   | DE02   | Reg.   | UBA/<br>NILU | Reg.   | NILU         | Parallel analyses of HC by UBA and NILU through the year                 |
| Kosetice  | CS03   | Reg.   | CHMI         | Reg.   | NILU         |  |
| Starina   | SK06   | Reg.   | SHMI         | n.m.   | -            |  |
| Donon     | FR08   | Reg.   | EMD          | Reg.   | EMD/<br>NILU | Parallel analysis of carbonyls by EMD and NILU through the year          |
| (Tänikon) | (CH03) | (Con.) | (EMPA)       | (n.m.) |              | Data delivered to CCC but not included in the report due to lack of time |

Reg. = regularly, Scat. = scattered, Con. = continuous, n.m. = not measured.

As in previous years, EMPA kindly shared their results from the continuous hydrocarbon monitoring at Tännikon with EMEP. Unfortunately, the time did not allow these data to be included in this years report. A detailed comparison between the continuous monitoring and grab sampling at Tännikon was given by Solberg et al. (1996) and Solberg et al. (1997).

Table 2 gives the sampling frequencies and the data coverage for the sites reported in this report. The term 'raw data' refers to the total number of samples reported to the CCC, and the fraction of rejected data is relative to this number. Note that 'rejected data' in this context refers to samples which are classified as outliers and rejected by inspection of the CCC. Outliers may arise due to either local pollution episodes close to the monitoring site, contamination of the samples or errors in the chemical analyses. Normally the responsible laboratory removes samples which are wrong due to technical problems, thus there is always a screening (and rejection of samples) prior to the outlier detection carried out by the CCC.

*Table 2: The number of samples of hydrocarbons (HC) and carbonyls (Carb) in 1998 available to NILU/CCC, relative to a recommendation of two samples/week (raw data coverage), as well as the fraction of data rejected by CCC due to assumed local contamination. The percentage of concurrent sampling of hydrocarbons and carbonyls (i.e. on the same days) is also given.*

| Station <sup>a)</sup>      | Raw data coverage |      | Data rejected due to local contamination |      | Net data coverage |      | Concurrence (HC and Carb) |
|----------------------------|-------------------|------|--|------|-------------------|------|---------------------------|
|                            | (%)               |      | (%)                                      |      | (%)               |      | (%)                       |
|                            | HC                | Carb | HC                                       | Carb | HC                | Carb | -                         |
| <i>Pallas<sup>b)</sup></i> | 82                | -    | 0  | -    | 82                | -    | -                         |
| <i>Utö<sup>b)</sup></i>    | 73                | -    | 0  | -    | 73                | -    | -                         |
| <i>Birkenes</i>            | 142               | 83   | 1 <sup>c)</sup>                          | 0    | 141               | 83   | 92                        |
| Waldhof <sup>d)</sup>      | 78                | 83   | 0  | 0    | 78                | 83   | 82                        |
| Kosetice                   | 99                | 70   | 0  | 0    | 96                | 76   | 95                        |
| Starina                    | 94                | -    | -  | -    | 94                | -    | -                         |
| Donon <sup>e)</sup>        | 101               | 101  | 1 <sup>f)</sup>                          | 0    | 100               | 101  | 100                       |

<sup>a)</sup> Non EMEP VOC sites are given in italic.

<sup>b)</sup> 3-methylpentane co-eluted with 2-methylpentane since 4 September.

<sup>c)</sup> Data for 15 June rejected due to extreme value of i-butane.

<sup>d)</sup> Refers to UBA's analyses for the hydrocarbons.

<sup>e)</sup> Refers to EMDs analyses.

<sup>f)</sup> Data for 29 September rejected due to extreme values of i-butane and i-pentane.

The net data coverage of Table 2 is the total number of samples reported from the local laboratory to the CCC subtracted the number of samples rejected by CCC. 'Concurrence', given in the last column of Table 2, denotes the fraction of hydrocarbon and carbonyl samples which were collected at the same days relative

to the maximum possible number (based on the raw data). According to EMEP's recommendations, the samples should be taken twice a week, and the hydrocarbons and carbonyls should be sampled on the same days. The data in Table 2 are given relative to this recommendation, i.e. 104 samples/year. In practice, however, the sampling frequency will vary at the sites due to the removal of outliers occurring as a result of e.g. local pollution episodes or technical problems. Furthermore, VOC measurements reported for non-EMEP-VOC sites do not necessarily follow EMEP's guidelines.

When compared to the VOC monitoring in previous years, Table 2 indicates a general improvement in performance. Both the sampling frequency, the data coverage and the concurrence was higher on average in 1998 than in previous years. This could partly be explained by the revision in the VOC monitoring programme focussing the activity at a few sites. However, it is also likely that the increased performance is due to increased experience by the responsables carrying out the sampling and analyses. It is particularly encouraging that problems with outliers diminished significantly in 1998.

## **2.2 Quality control and detection of outliers**

The detection of outliers and rejection of data by the CCC was performed similar to the procedures described in more detail in previous EMEP-VOC reports (Solberg et al., 1997). All measurement data for 1998 were taken together with the previous years' of data and checked by a Rosner's test (Gilbert, 1987), suitable for detecting multiple outliers, as described in more detail by Solberg et al. (1997). In addition the time series of hydrocarbons and carbonyls are mostly sufficiently large that each concentration value for the year reported could be checked against the centred running mean and standard deviation using the data for previous years only, and assuming a log-normal distribution. If the value was found to be more than  $4\sigma$  from the mean, it was flagged as an outlier and not used in the further presentation of the data.

## **3. Procedures for sampling and chemical analyses**

The procedures for sampling and chemical analyses were similar in 1998 to previous years, and are not discussed in this report. A detailed description of the procedures used by NILU are given in the EMEP manual (EMEP/CCC, 1995). The technical procedures for the sampling and analysis of hydrocarbons by FMI at the two Finnish stations, as well as a site description and data interpretation, are given by Laurila and Hakola (1996). As noted previously, a NIST certified standard was used for the calibration of the samples in 1998 as opposed to the description in that paper. A detailed presentation of the sampling and analyses performed by the local laboratories at EMD (France), CHMI (Czech Republic) and (SHMI) (Slovakia) was given the last year's EMEP VOC report (Solberg et al., 1998) and is not repeated in the present report.

## **4. Results from parallel analysis**

### **4.1 Parallel sampling and analysis of hydrocarbons at Waldhof by NILU and UBA**

Umweltbundesamt (UBA) in Germany started their first sampling and analyses of hydrocarbons at Waldhof in parallel with NILU in 1997. The parallel sampling and analyses continued in 1998. Figure 2 shows the scatter diagram for all samples except two at Waldhof in 1998 from NILU (x-axis) and UBA (y-axis) for 14 individual hydrocarbons. The correlation analysis revealed an obvious discrepancy at 9 March and 12 March when NILU's analyses were much higher than the analyses by UBA. When the results from these two dates were removed, the agreement between the data from UBA and NILU was in general very good. For several of the components, e.g. propane, acetylene, n-butane and i-pentane, the correlation was almost perfect. However, in spite of the excellent correlation, a slope larger than 1 was found for these components, indicating 10-20% higher concentrations as analysed by UBA compared to NILU. The reason for this systematic difference is not clear. As UBA is taking over the responsibility for the analyses of the hydrocarbon samples at Waldhof the systematic differences between the two laboratories should be investigated further to minimize any possible shifts in concentration level.

For the other components the correlation was slightly poorer, but still clearly acceptable, even for the most volatile compounds, n-heptane and 1,3-butadiene. In general the scatter in the data was highest at the lowest concentrations, which is quite natural.

### **4.2 Parallel analysis of carbonyls between NILU and EMD at Donon**

The first results of the parallel analysis of carbonyls at Donon by EMD and NILU were reported in the previous EMEP VOC report (Solberg et al., 1998). Figure 3 shows the scatter plot of NILU's carbonyl analyses (x-axis) vs. EMD's analyses (y-axis) for 14 individual carbonyls at Donon in 1998.

Best agreement between the two laboratories was found for formaldehyde and acetone. For acetaldehyde the concentrations analysed by EMD was significantly less than analysed by NILU. For higher order carbonyls, the correlation between the results from NILU and EMD was poorer. For the higher order carbonyls, the number of samples below or close to the detection limit was so high that the correlation analysis was not very useful. Furthermore, much more samples were classified as below detection limit by NILU than by EMD. These samples show up as vertical lines of dots in the diagrams, when the x-values (NILU's values) give 0.5 times the detection limit. However, in general the differences between the analysed concentrations from the two laboratories varied over a wide range. This clearly underlines the need for a more detailed evaluation of the monitoring procedures for higher order carbonyls to strengthen the reliability of these measurements.

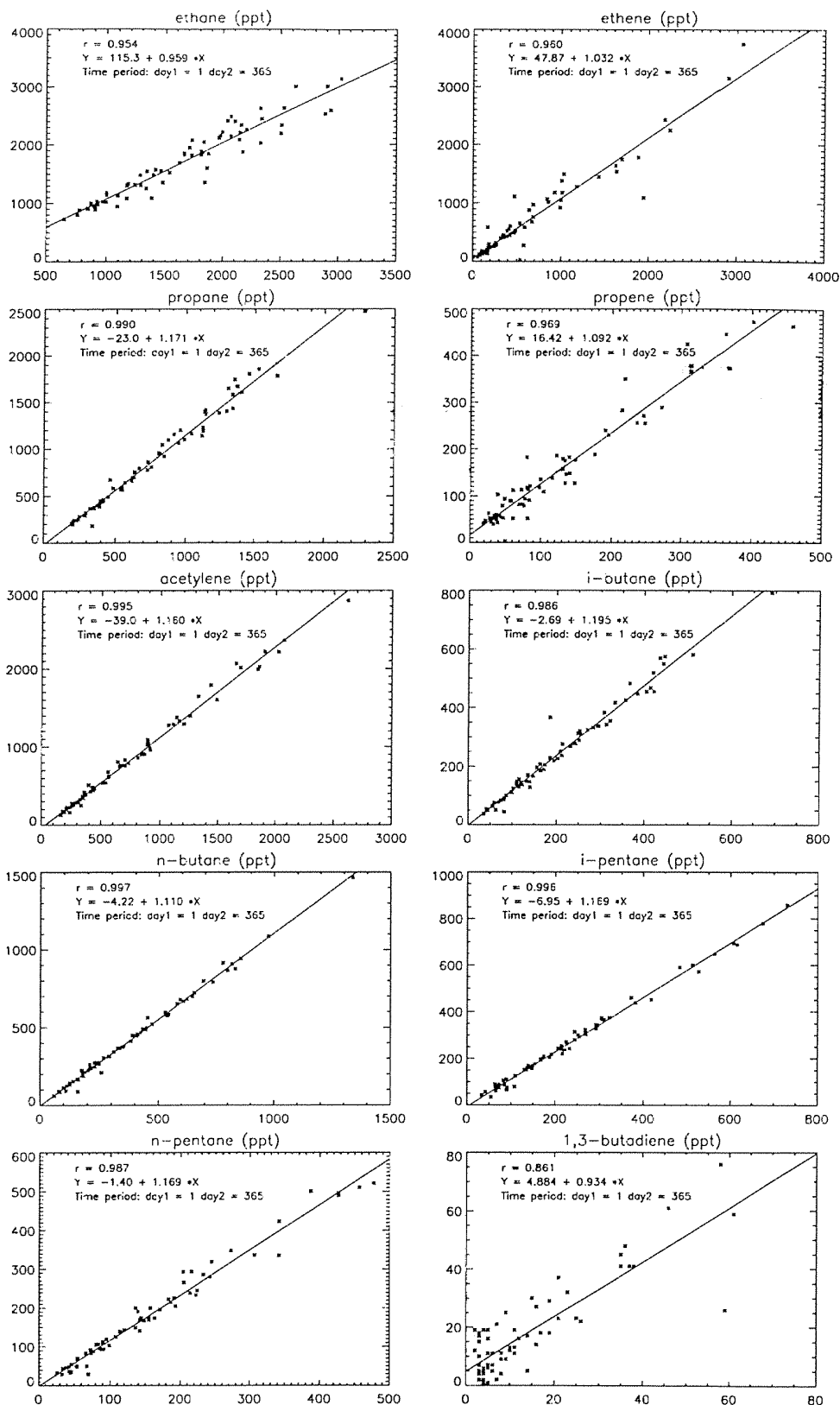


Figure 2: Scatter diagram showing grab samples of hydrocarbons at Waldhof in 1998 as analysed by NILU (x-axis) and UBA (y-axis). The samples at 9 March and 22 March were taken out from the scatter plot due to obvious discrepancies between the two laboratories. The linear regression lines are also shown.

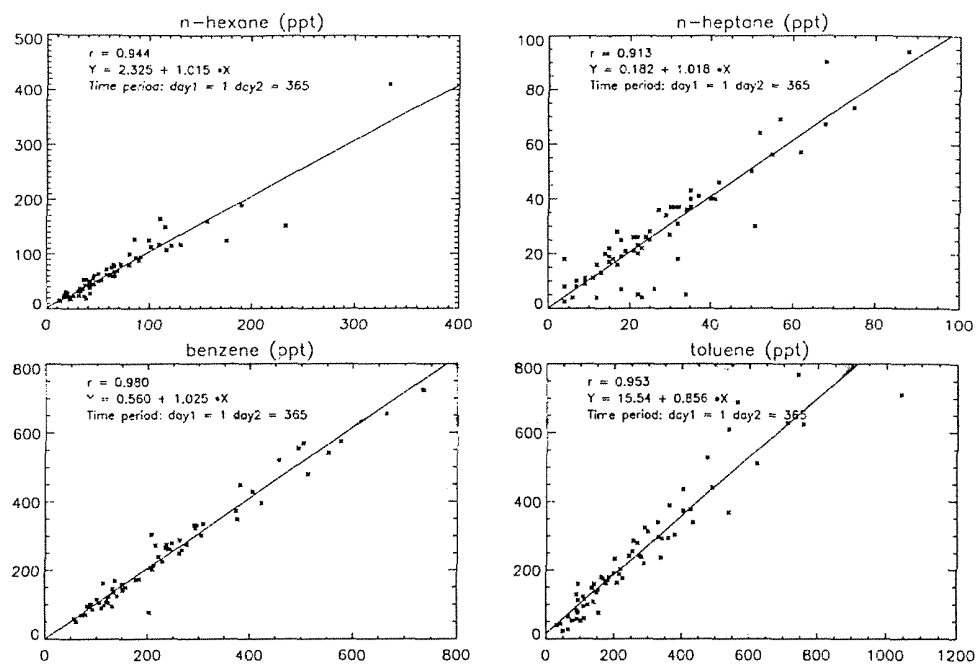


Figure 2 (contd.)

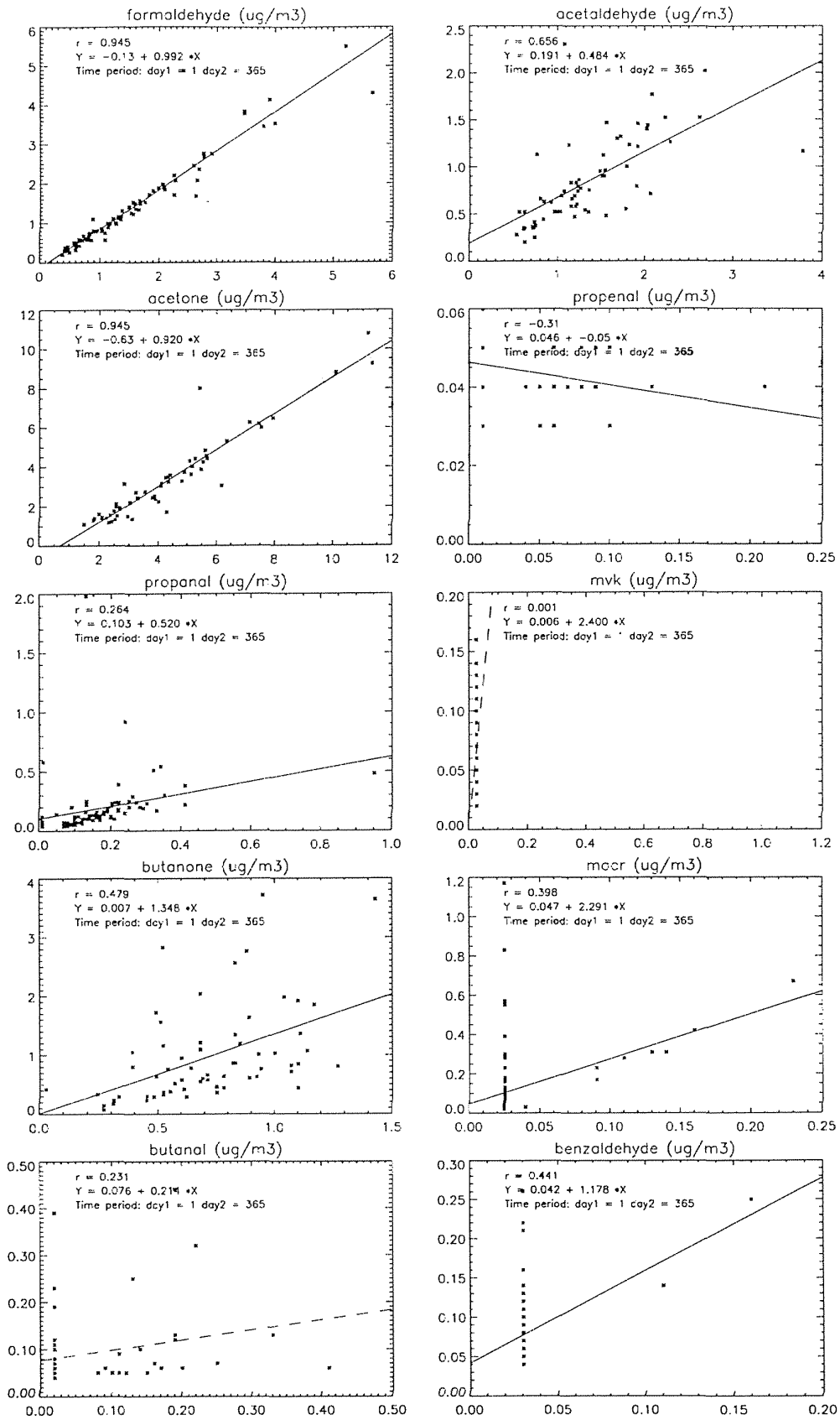


Figure 3: Scatter diagram showing samples of carbonyls at Donon in 1998 as analysed by NILU (x-axis) and EMD (y-axis). The linear regression lines are also shown.



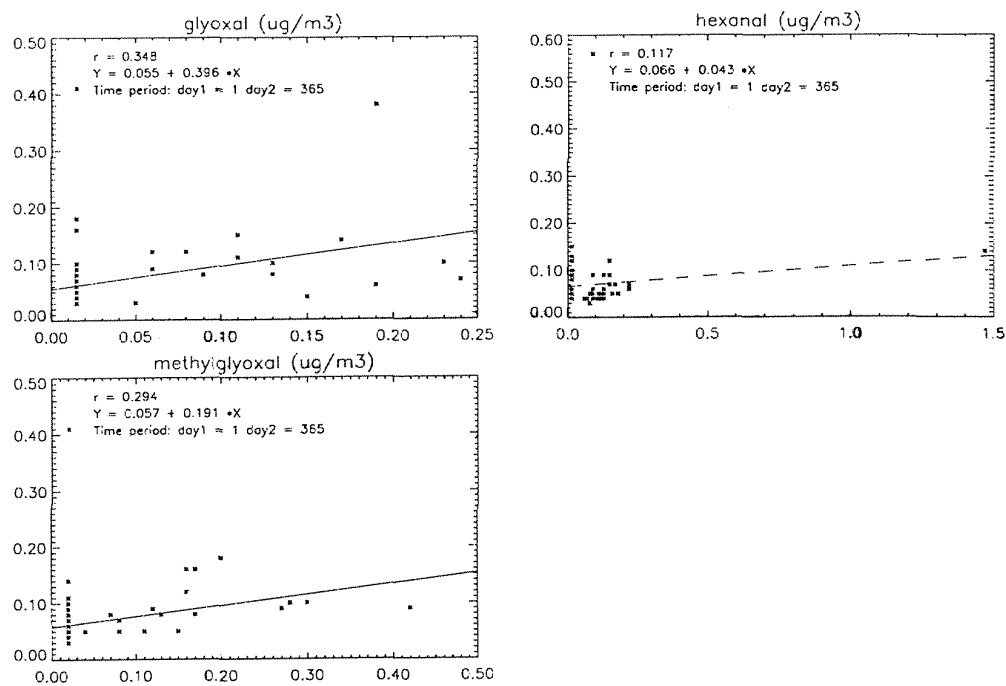


Figure 3 (contd.)

## 5. Concentrations of VOC in 1998

Monthly mean and median concentrations of the individual hydrocarbons and carbonyls for 1998 are given in Appendix A. The monthly statistics were not calculated if the number of samples were below four. The figures in Appendix B present the time series of all compounds during 1998.

## 6. Conclusions and recommendations

The results of VOC measurements within EMEP and from other sites voluntarily reported to EMEP in 1998 have been presented. Compared to previous years a general improvement in the VOC measurements is apparent. The sampling frequency has increased whereas problems with outliers and local contamination is diminished. Parallel sampling and analyses of hydrocarbons at Waldhof between the laboratories at UBA and NILU show a very good correlation for the individual components, however, the concentrations analysed by UBA was systematically 10-20% higher than analysed by NILU for several of the components. As UBA will take over the official analyses of hydrocarbons it is important to clarify the reason for these differences to minimize shifts in the concentration levels when changing laboratory.

The parallel sampling and analyses of carbonyls at Donon between the laboratories at EMD and NILU continued in 1998, and show best agreement for formaldehyde. For acetaldehyde the concentrations analysed by EMD was

significantly less than analysed by NILU. For higher order carbonyls, the correlation between the results from NILU and EMD was poorer. However, for many of the compounds, the number of samples below or close to the detection limit, was so high that the correlation analysis was of limited value. It is recommended to study these results in more detail in order to reveal the causes for the differences. It is highly important for the reliability and application of the carbonyl measurement to find out whether the discrepancies are due to technical equipment, sampling procedures and/or chemical analyses. As the largest differences between the two laboratories are seen for higher order carbonyls, the procedures for measurements of these compounds should be given particular emphasis. Parallel studies focussed on these components are recommended.

## 7. Acknowledgement

We would like to thank all people involved in the sampling and shipment of hydrocarbon canisters and DNPH tubes. We are very grateful for the hydrocarbon measurement data from the Finnish sites Pallas and Utö, kindly provided by Katri Puhto at FMI, as well as for the continuous hydrocarbon measurements from Tänäkon kindly provided by Stefan Reimann at EMPA. Special thanks to Patrice Coddeville (EMD), Jiri Honzak (CHMI), Rita Juneck (UBA) and Marta Mitosinkova (SHMI) as well as Christian Dye and Norbert Schmidbauer (NILU) who are responsible for the chemical analyses at the different EMEP VOC sites and who have reported the data to CCC.

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## 9. Abbreviations

|      |   |   |
|------|---|---|
| CHMI | – | Czech Hydrometeorological Institute                   |
| EMD  | – | Ecole des Mines de Douai (France)                     |
| EMPA | – | Swiss Federal Lab. for Materials Testing and Research |
| FMI  | – | Finnish Meteorological Institute                      |
| SHMI | – | Hydrometeorological Institute in Slovakia             |
| NILU | – | Norwegian Institute for Air Research                  |
| UBA  | – | Umweltbundesamt                                       |

mvk - methylvinylketone

macr - methacrolein



## **Appendix A**

**Monthly mean and median concentrations  
(first and second line, respectively)  
of hydrocarbons (pptv) and carbonyls (ng/m<sup>3</sup>)  
in 1998**



| <b>ETHANE</b>  |      |      |      |      |      |      |      |      |      |      |      |      |
|----------------|------|------|------|------|------|------|------|------|------|------|------|------|
|                | JAN  | FEB  | MAR  | APR  | MAY  | JUN  | JUL  | AUG  | SEP  | OCT  | NOV  | DEC  |
| Pallas         | 2012 | 2480 | 2102 | 1775 | 1238 | 953  | 791  | 823  | 1296 | 1772 | -    | 1703 |
|                | 1927 | 2521 | 2066 | 1745 | 1273 | 910  | 783  | 832  | 1301 | 1862 | -    | 1661 |
| Utö            | 2431 | 2210 | 2124 | 2159 | 1281 | 978  | 750  | 823  | 1521 | -    | -    | 2670 |
|                | 2271 | 2013 | 2100 | 2154 | 1221 | 979  | 707  | 815  | 1600 | -    | -    | 2751 |
| Birkenes       | 1832 | 1989 | 1960 | 1808 | 1376 | 1063 | 892  | 891  | 1077 | 1342 | 2005 | 1940 |
|                | 1738 | 1766 | 1967 | 1895 | 1359 | 1062 | 832  | 815  | 1077 | 1300 | 1662 | 1754 |
| Waldhof (NILU) | 2244 | 2346 | 1987 | -    | 1405 | 1162 | 957  | 953  | 1303 | 1800 | 2080 | 2281 |
|                | 2330 | 2161 | 2073 | -    | 1402 | 1133 | 951  | 910  | 1287 | 1729 | 2073 | 2188 |
| Waldhof (UBA)  | 2084 | 2320 | 2095 | 2189 | 1485 | 1325 | 935  | 993  | 1288 | 1754 | 2959 | 2329 |
|                | 2074 | 2305 | 2116 | 2150 | 1449 | 1131 | 972  | 962  | 1195 | 1689 | 2401 | 2244 |
| Kosetice       | 2623 | 2789 | 2821 | 2406 | 1804 | 1260 | 964  | 1137 | 1510 | 1634 | 2870 | 3451 |
|                | 2390 | 2702 | 2756 | 2378 | 1718 | 1232 | 953  | 1040 | 1436 | 1476 | 2439 | 2400 |
| Donon          | 2249 | 2274 | 2633 | 1991 | 1556 | 1089 | 1166 | 1270 | 1359 | 1832 | 2599 | 2669 |
|                | 1940 | 2460 | 2270 | 1990 | 1600 | 1070 | 970  | 1245 | 1335 | 1680 | 2560 | 2450 |
| Starina        | 1968 | 2131 | 1290 | 996  | 873  | 866  | 571  | 588  | 976  | 806  | 727  | 1560 |
|                | 2230 | 1965 | 1150 | 880  | 730  | 850  | 630  | 610  | 925  | 700  | 770  | 1585 |
| <b>ETHENE</b>  |      |      |      |      |      |      |      |      |      |      |      |      |
|                | JAN  | FEB  | MAR  | APR  | MAY  | JUN  | JUL  | AUG  | SEP  | OCT  | NOV  | DEC  |
| Pallas         | 804  | 415  | 167  | 99   | 42   | 61   | 85   | 69   | 104  | 285  | -    | 280  |
|                | 282  | 261  | 161  | 65   | 41   | 54   | 97   | 72   | 104  | 165  | -    | 199  |
| Utö            | 965  | 645  | 594  | 475  | 164  | 195  | 184  | 149  | 408  | -    | -    | 854  |
|                | 871  | 316  | 389  | 418  | 133  | 141  | 181  | 137  | 375  | -    | -    | 920  |
| Birkenes       | 539  | 413  | 236  | 342  | 231  | 187  | 182  | 214  | 267  | 285  | 954  | 612  |
|                | 284  | 267  | 174  | 366  | 216  | 161  | 125  | 203  | 266  | 217  | 604  | 342  |
| Waldhof (NILU) | 1149 | 1033 | 412  | -    | 226  | 205  | 236  | 176  | 442  | 862  | 1429 | 1461 |
|                | 992  | 1000 | 396  | -    | 146  | 183  | 219  | 162  | 465  | 752  | 1229 | 894  |
| Waldhof (UBA)  | 1007 | 1157 | 576  | 470  | 230  | 291  | 246  | 201  | 430  | 744  | 2590 | 1789 |
|                | 973  | 1167 | 655  | 397  | 129  | 235  | 197  | 202  | 471  | 536  | 1870 | 1148 |
| Kosetice       | 2285 | 1692 | 724  | 348  | 368  | 226  | 203  | 384  | 407  | 1030 | 2113 | 2576 |
|                | 2498 | 1581 | 703  | 308  | 193  | 200  | 192  | 207  | 377  | 652  | 1502 | 2857 |
| Donon          | 887  | 1033 | 613  | 329  | 236  | 182  | 356  | 316  | 490  | 814  | 1433 | 1510 |
|                | 550  | 1135 | 420  | 135  | 180  | 180  | 210  | 195  | 310  | 510  | 1535 | 1600 |
| Starina        | 1753 | 2490 | 2502 | 2410 | 2236 | 1211 | 860  | 1622 | 1744 | 1949 | 1528 | 1438 |
|                | 1930 | 2280 | 2130 | 2360 | 2310 | 1060 | 650  | 1720 | 1610 | 1975 | 1740 | 1400 |

| <b>ACETYLENE</b> |      |      |      |      |     |     |     |     |     |      |      |      |
|------------------|------|------|------|------|-----|-----|-----|-----|-----|------|------|------|
|                  | JAN  | FEB  | MAR  | APR  | MAY | JUN | JUL | AUG | SEP | OCT  | NOV  | DEC  |
| Pallas           | 946  | 811  | 585  | 460  | 185 | 84  | 83  | 78  | 199 | 388  | -    | 372  |
|                  | 573  | 694  | 589  | 379  | 199 | 84  | 73  | 90  | 168 | 375  | -    | 410  |
| Utö              | 950  | 765  | 853  | 703  | 302 | 197 | 173 | 146 | 334 | -    | -    | 931  |
|                  | 891  | 555  | 787  | 747  | 267 | 161 | 165 | 128 | 278 | -    | -    | 907  |
| Birkenes         | 718  | 684  | 659  | 666  | 326 | 195 | 181 | 227 | 343 | 397  | 1173 | 856  |
|                  | 584  | 561  | 617  | 638  | 319 | 188 | 123 | 215 | 340 | 368  | 811  | 654  |
| Waldhof (NILU)   | 1258 | 1096 | 851  | -    | 402 | 323 | 292 | 301 | 611 | 1013 | 1365 | 1355 |
|                  | 1330 | 1114 | 897  | -    | 424 | 330 | 304 | 290 | 703 | 887  | 1374 | 890  |
| Waldhof (UBA)    | 1523 | 1533 | 768  | 849  | 416 | 372 | 257 | 282 | 610 | 883  | 2432 | 1485 |
|                  | 1643 | 1311 | 680  | 832  | 445 | 323 | 277 | 283 | 611 | 628  | 1812 | 948  |
| Kosetice         | 2482 | 1968 | 1355 | 916  | 687 | 381 | 324 | 536 | 735 | 1314 | 2204 | 2623 |
|                  | 2895 | 1728 | 1389 | 881  | 557 | 370 | 284 | 449 | 681 | 847  | 1676 | 2441 |
| Donon            | 841  | 1090 | 801  | 501  | 351 | 173 | 232 | 268 | 498 | 724  | 1081 | 1255 |
|                  | 640  | 1095 | 710  | 400  | 375 | 160 | 190 | 255 | 265 | 470  | 830  | 1205 |
| Starina          | 1720 | 1783 | 1176 | 790  | 570 | 461 | 357 | 470 | 603 | 731  | 132  | 156  |
|                  | 1745 | 1590 | 1160 | 530  | 560 | 430 | 320 | 470 | 460 | 665  | 140  | 130  |
| <b>PROPANE</b>   |      |      |      |      |     |     |     |     |     |      |      |      |
|                  | JAN  | FEB  | MAR  | APR  | MAY | JUN | JUL | AUG | SEP | OCT  | NOV  | DEC  |
| Pallas           | 1303 | 1603 | 1157 | 751  | 267 | 121 | 158 | 108 | 249 | 612  | -    | 718  |
|                  | 1030 | 1548 | 1164 | 732  | 259 | 132 | 145 | 77  | 259 | 764  | -    | 674  |
| Utö              | 1384 | 1344 | 1288 | 1044 | 337 | 213 | 231 | 188 | 422 | -    | -    | 1304 |
|                  | 1201 | 1109 | 1301 | 1000 | 230 | 157 | 171 | 177 | 440 | -    | -    | 1460 |
| Birkenes         | 873  | 918  | 822  | 616  | 296 | 223 | 206 | 288 | 397 | 483  | 964  | 893  |
|                  | 837  | 847  | 786  | 653  | 279 | 205 | 173 | 273 | 311 | 429  | 812  | 826  |
| Waldhof (NILU)   | 1181 | 1245 | 862  | -    | 401 | 353 | 356 | 333 | 501 | 816  | 1099 | 1335 |
|                  | 1307 | 1147 | 806  | -    | 380 | 366 | 338 | 353 | 547 | 678  | 1083 | 1211 |
| Waldhof (UBA)    | 1474 | 1751 | 738  | 894  | 438 | 418 | 365 | 356 | 511 | 767  | 1950 | 1448 |
|                  | 1648 | 1499 | 794  | 748  | 410 | 387 | 368 | 379 | 508 | 686  | 1309 | 1298 |
| Kosetice         | 1581 | 1208 | 1195 | 752  | 493 | 293 | 299 | 472 | 596 | 685  | 1281 | 1622 |
|                  | 1892 | 1136 | 1237 | 749  | 484 | 253 | 269 | 356 | 511 | 539  | 1148 | 1129 |
| Donon            | 1154 | 1190 | 1103 | 628  | 453 | 271 | 359 | 344 | 498 | 641  | 1141 | 1184 |
|                  | 970  | 1175 | 910  | 620  | 525 | 250 | 180 | 340 | 385 | 520  | 1100 | 1060 |
| Starina          | 1373 | 1144 | 1063 | 597  | 504 | 326 | 278 | 339 | 353 | 538  | 799  | 928  |
|                  | 1520 | 1035 | 930  | 450  | 460 | 340 | 270 | 350 | 340 | 470  | 630  | 920  |



|                | PROPENE |     |     |     |     |     |     |     |     |     |     |     |
|----------------|---------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|                | JAN     | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
| Pallas         | 69      | 25  | 20  | 20  | 21  | 24  | 34  | 31  | 26  | 40  | -   | 33  |
|                | 25      | 19  | 19  | 21  | 19  | 19  | 35  | 27  | 25  | 33  | -   | 19  |
| Utö            | 106     | 76  | 79  | 78  | 44  | 43  | 44  | 37  | 69  | -   | -   | 71  |
|                | 71      | 64  | 63  | 48  | 47  | 39  | 42  | 34  | 67  | -   | -   | 76  |
| Birkenes       | 108     | 108 | 70  | 80  | 83  | 65  | 68  | 70  | 82  | 71  | 176 | 148 |
|                | 76      | 95  | 62  | 74  | 79  | 68  | 52  | 62  | 73  | 56  | 154 | 134 |
| Waldhof (NILU) | 202     | 222 | 92  | -   | 63  | 45  | 46  | 43  | 92  | 142 | 262 | 223 |
|                | 148     | 196 | 82  | -   | 44  | 47  | 37  | 37  | 84  | 131 | 234 | 203 |
| Waldhof (UBA)  | 234     | 321 | 70  | 90  | 66  | 84  | 65  | 69  | 111 | 139 | 431 | 278 |
|                | 175     | 260 | 63  | 79  | 48  | 79  | 53  | 58  | 115 | 103 | 407 | 262 |
| Kosetice       | 281     | 212 | 100 | 48  | 68  | 45  | 44  | 83  | 62  | 352 | 298 | 327 |
|                | 227     | 215 | 87  | 38  | 37  | 44  | 39  | 53  | 65  | 174 | 231 | 296 |
| Donon          | 184     | 208 | 180 | 119 | 64  | 87  | 142 | 101 | 139 | 156 | 259 | 309 |
|                | 120     | 190 | 90  | 100 | 60  | 80  | 90  | 95  | 115 | 120 | 255 | 235 |
| Starina        | 200     | 305 | 321 | 249 | 90  | 258 | 80  | 87  | 180 | 154 | 196 | 168 |
|                | 200     | 295 | 200 | 200 | 90  | 170 | 70  | 80  | 130 | 90  | 190 | 175 |

|                | N-BUTANE |     |     |     |     |     |     |     |     |     |      |      |
|----------------|----------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|
|                | JAN      | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV  | DEC  |
| Pallas         | 637      | 655 | 426 | 199 | 123 | 23  | 42  | 27  | 71  | 295 | -    | 298  |
|                | 515      | 661 | 410 | 183 | 71  | 19  | 45  | 18  | 66  | 321 | -    | 280  |
| Utö            | 688      | 567 | 524 | 372 | 95  | 88  | 95  | 78  | 196 | -   | -    | 687  |
|                | 613      | 410 | 480 | 373 | 75  | 75  | 63  | 70  | 193 | -   | -    | 659  |
| Birkenes       | 463      | 491 | 351 | 288 | 94  | 164 | 99  | 165 | 205 | 198 | 484  | 428  |
|                | 404      | 376 | 330 | 297 | 88  | 89  | 58  | 120 | 168 | 157 | 401  | 369  |
| Waldhof (NILU) | 659      | 610 | 395 | -   | 147 | 199 | 227 | 171 | 273 | 443 | 590  | 681  |
|                | 654      | 608 | 345 | -   | 122 | 189 | 194 | 127 | 334 | 355 | 587  | 583  |
| Waldhof (UBA)  | 734      | 841 | 288 | 373 | 158 | 239 | 231 | 183 | 281 | 393 | 1058 | 751  |
|                | 720      | 683 | 275 | 305 | 133 | 210 | 224 | 144 | 290 | 366 | 735  | 631  |
| Kosetice       | 741      | 528 | 460 | 285 | 232 | 149 | 180 | 273 | 277 | 366 | 594  | 772  |
|                | 831      | 536 | 422 | 258 | 191 | 136 | 157 | 190 | 223 | 243 | 524  | 440  |
| Donon          | 576      | 673 | 490 | 277 | 225 | 120 | 211 | 179 | 345 | 648 | 553  | 1179 |
|                | 390      | 555 | 450 | 190 | 265 | 100 | 120 | 175 | 175 | 240 | 500  | 675  |
| Starina        | 1085     | 571 | 519 | 301 | 426 | 246 | 233 | 244 | 250 | 380 | 516  | 1289 |
|                | 1160     | 525 | 490 | 230 | 460 | 240 | 220 | 240 | 230 | 330 | 350  | 1290 |

| <b>I-BUTANE</b>  |     |     |     |     |     |     |     |     |     |     |     |     |
|------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|                  | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
| Pallas           | 310 | 339 | 221 | 103 | 37  | 11  | 22  | 13  | 34  | 132 | -   | 146 |
|                  | 220 | 327 | 216 | 92  | 33  | 11  | 25  | 6   | 32  | 167 | -   | 134 |
| Utö              | 328 | 323 | 274 | 175 | 46  | 39  | 50  | 34  | 98  | -   | -   | 341 |
|                  | 292 | 218 | 244 | 167 | 31  | 34  | 38  | 27  | 105 | -   | -   | 331 |
| Birkenes         | 238 | 240 | 178 | 174 | 46  | 74  | 52  | 79  | 108 | 104 | 255 | 235 |
|                  | 199 | 183 | 156 | 160 | 44  | 48  | 35  | 66  | 89  | 79  | 218 | 184 |
| Waldhof (NILU)   | 332 | 327 | 214 | -   | 88  | 117 | 125 | 108 | 155 | 235 | 365 | 381 |
|                  | 332 | 308 | 186 | -   | 81  | 112 | 117 | 70  | 174 | 199 | 395 | 317 |
| Waldhof (UBA)    | 419 | 502 | 173 | 217 | 96  | 147 | 149 | 121 | 166 | 216 | 601 | 437 |
|                  | 417 | 404 | 170 | 196 | 91  | 128 | 136 | 77  | 164 | 215 | 461 | 349 |
| Kosetice         | 425 | 306 | 254 | 166 | 132 | 76  | 90  | 145 | 161 | 197 | 326 | 478 |
|                  | 450 | 297 | 240 | 152 | 109 | 71  | 89  | 102 | 134 | 128 | 292 | 245 |
| Donon            | 374 | 341 | 246 | 162 | 129 | 98  | 110 | 100 | 200 | 184 | 303 | 344 |
|                  | 220 | 310 | 230 | 140 | 150 | 90  | 70  | 100 | 90  | 130 | 300 | 290 |
| Starina          | 558 | 353 | 242 | 159 | 254 | 123 | 118 | 118 | 125 | 181 | 230 | 276 |
|                  | 600 | 305 | 240 | 140 | 210 | 130 | 100 | 120 | 120 | 145 | 170 | 255 |
| <b>N-PENTANE</b> |     |     |     |     |     |     |     |     |     |     |     |     |
|                  | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
| Pallas           | 170 | 163 | 77  | 37  | 14  | 6   | 12  | 12  | 26  | 93  | -   | 86  |
|                  | 131 | 135 | 71  | 30  | 11  | 3   | 13  | 13  | 24  | 117 | -   | 74  |
| Utö              | 169 | 170 | 142 | 98  | 19  | 25  | 23  | 28  | 87  | -   | -   | 252 |
|                  | 146 | 116 | 144 | 93  | 11  | 16  | 17  | 21  | 69  | -   | -   | 252 |
| Birkenes         | 140 | 139 | 101 | 108 | 39  | 51  | 35  | 48  | 74  | 69  | 190 | 147 |
|                  | 119 | 100 | 90  | 84  | 39  | 41  | 30  | 51  | 53  | 54  | 149 | 122 |
| Waldhof (NILU)   | 224 | 233 | 123 | -   | 92  | 92  | 83  | 68  | 117 | 200 | 304 | 269 |
|                  | 204 | 216 | 114 | -   | 54  | 81  | 84  | 68  | 143 | 151 | 293 | 219 |
| Waldhof (UBA)    | 295 | 335 | 99  | 133 | 90  | 100 | 81  | 74  | 131 | 178 | 522 | 298 |
|                  | 293 | 290 | 70  | 109 | 50  | 94  | 93  | 50  | 138 | 134 | 368 | 242 |
| Kosetice         | 297 | 201 | 159 | 113 | 183 | 71  | 85  | 136 | 127 | 194 | 247 | 338 |
|                  | 328 | 195 | 149 | 80  | 103 | 62  | 91  | 80  | 110 | 139 | 226 | 209 |
| Donon            | 177 | 163 | 142 | 77  | 84  | 34  | 78  | 49  | 123 | 132 | 186 | 193 |
|                  | 160 | 180 | 130 | 50  | 85  | 40  | 50  | 45  | 50  | 70  | 170 | 170 |
| Starina          | 356 | 444 | 709 | 474 | 404 | 213 | 272 | 153 | 443 | 239 | 108 | 102 |
|                  | 465 | 410 | 580 | 280 | 250 | 200 | 290 | 210 | 225 | 205 | 80  | 105 |

| <b>I-PENTANE</b> |     |     |     |     |     |     |     |     |     |     |     |     |
|------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|                  | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
| Pallas           | 267 | 227 | 130 | 57  | 42  | 9   | 15  | 16  | 27  | 127 | -   | 121 |
|                  | 231 | 205 | 121 | 47  | 23  | 5   | 13  | 15  | 26  | 141 | -   | 118 |
| Utö              | 287 | 255 | 245 | 153 | 32  | 44  | 49  | 46  | 125 | -   | -   | 375 |
|                  | 276 | 174 | 218 | 127 | 27  | 41  | 39  | 48  | 125 | -   | -   | 306 |
| Birkenes         | 247 | 244 | 170 | 174 | 108 | 131 | 82  | 74  | 115 | 92  | 278 | 252 |
|                  | 209 | 171 | 151 | 140 | 92  | 99  | 55  | 74  | 110 | 69  | 213 | 201 |
| Waldhof (NILU)   | 366 | 333 | 183 | -   | 124 | 121 | 127 | 124 | 193 | 264 | 406 | 409 |
|                  | 306 | 304 | 174 | -   | 88  | 125 | 138 | 92  | 214 | 219 | 371 | 301 |
| Waldhof (UBA)    | 435 | 488 | 144 | 217 | 118 | 183 | 124 | 136 | 212 | 233 | 654 | 474 |
|                  | 367 | 406 | 105 | 176 | 76  | 161 | 151 | 90  | 203 | 189 | 501 | 355 |
| Kosetice         | 498 | 325 | 230 | 194 | 187 | 117 | 142 | 256 | 207 | 296 | 346 | 480 |
|                  | 536 | 323 | 206 | 132 | 122 | 97  | 139 | 167 | 196 | 238 | 289 | 266 |
| Donon            | 267 | 325 | 246 | 160 | 159 | 78  | 156 | 113 | 258 | 246 | 296 | 351 |
|                  | 190 | 310 | 180 | 100 | 170 | 70  | 120 | 110 | 125 | 190 | 295 | 350 |
| Starina          | 520 | 368 | 297 | 261 | 200 | 213 | 264 | 188 | 286 | 315 | 3   | 3   |
|                  | 615 | 320 | 300 | 230 | 220 | 180 | 170 | 200 | 165 | 280 | 3   | 3   |
| <b>BENZENE</b>   |     |     |     |     |     |     |     |     |     |     |     |     |
|                  | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
| Pallas           | 305 | 261 | 199 | 147 | 57  | 29  | 32  | 35  | 72  | 123 | -   | 104 |
|                  | 190 | 234 | 194 | 139 | 56  | 32  | 36  | 29  | 72  | 119 | -   | 121 |
| Utö              | 343 | 286 | 446 | 220 | 84  | 52  | 54  | 52  | 121 | -   | -   | 258 |
|                  | 290 | 211 | 294 | 221 | 74  | 46  | 48  | 56  | 102 | -   | -   | 262 |
| Birkenes         | 206 | 186 | 182 | 188 | 88  | 75  | 69  | 92  | 115 | 137 | 351 | 247 |
|                  | 166 | 150 | 177 | 191 | 83  | 60  | 44  | 92  | 111 | 128 | 259 | 181 |
| Waldhof (NILU)   | 352 | 304 | 227 | -   | 123 | 139 | 109 | 123 | 197 | 311 | 414 | 402 |
|                  | 382 | 292 | 239 | -   | 122 | 123 | 120 | 122 | 178 | 290 | 399 | 271 |
| Waldhof (UBA)    | 398 | 410 | 196 | 239 | 113 | 136 | 116 | 112 | 192 | 252 | 726 | 408 |
|                  | 429 | 329 | 169 | 239 | 106 | 107 | 123 | 97  | 159 | 207 | 469 | 290 |
| Kosetice         | 469 | 356 | 365 | 168 | 131 | 84  | 96  | 156 | 172 | 327 | 476 | 621 |
|                  | 538 | 319 | 280 | 155 | 110 | 81  | 73  | 126 | 148 | 187 | 365 | 591 |
| Donon            | 279 | 330 | 243 | 148 | 109 | 59  | 129 | 120 | 173 | 252 | 375 | 420 |
|                  | 190 | 315 | 200 | 130 | 120 | 60  | 70  | 110 | 120 | 170 | 325 | 375 |
| Starina          | 773 | 725 | 438 | 267 | 231 | 188 | 167 | 247 | 159 | 189 | 239 | 361 |
|                  | 830 | 685 | 380 | 240 | 220 | 140 | 120 | 160 | 145 | 175 | 210 | 360 |

|                | TOLUENE |     |     |     |     |     |     |     |     |     |     |     |
|----------------|---------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|                | JAN     | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
| Pallas         | -       | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   |
|                | -       | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   |
| Utö            | -       | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   |
|                | -       | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   |
| Birkenes       | 168     | 159 | 108 | 104 | 102 | 108 | 82  | 100 | 124 | 94  | 273 | 218 |
|                | 101     | 101 | 80  | 96  | 72  | 79  | 69  | 105 | 114 | 69  | 204 | 149 |
| Waldhof (NILU) | 348     | 334 | 143 | -   | 157 | 198 | 136 | 225 | 203 | 262 | 532 | 506 |
|                | 290     | 329 | 143 | -   | 123 | 131 | 139 | 177 | 219 | 232 | 558 | 407 |
| Waldhof (UBA)  | 384     | 508 | 104 | 146 | 112 | 170 | 102 | 188 | 180 | 200 | 633 | 410 |
|                | 323     | 365 | 98  | 122 | 67  | 135 | 99  | 161 | 186 | 179 | 585 | 321 |
| Kosetice       | 322     | 267 | 220 | 170 | 190 | 101 | 127 | 249 | 178 | 304 | 320 | 369 |
|                | 378     | 280 | 213 | 109 | 98  | 95  | 105 | 210 | 180 | 300 | 270 | 330 |
| Donon          | 243     | 279 | 212 | 132 | 120 | 64  | 139 | 91  | 210 | 237 | 305 | 339 |
|                | 150     | 255 | 130 | 90  | 130 | 60  | 110 | 85  | 115 | 180 | 280 | 355 |
| Starina        | 1053    | 776 | 472 | 229 | 286 | 336 | 247 | 245 | 293 | 284 | 332 | 501 |
|                | 1245    | 830 | 490 | 230 | 300 | 270 | 190 | 210 | 200 | 285 | 340 | 500 |

**FORMALDEHYDE**

|              | JAN  | FEB  | MAR | APR  | MAY  | JUN  | JUL  | AUG  | SEP  | OCT | NOV  | DEC  |
|--------------|------|------|-----|------|------|------|------|------|------|-----|------|------|
| Birkenes     | 230  | 246  | 397 | 519  | 945  | 610  | 630  | 473  | 491  | 330 | 300  | 248  |
|              | 215  | 195  | 275 | 490  | 900  | 560  | 650  | 480  | 520  | 240 | 240  | 260  |
| Waldhof      | 581  | 1130 | 916 | 958  | -    | 1383 | 1400 | 1608 | 1203 | 593 | 759  | 827  |
|              | 540  | 1045 | 770 | 920  | -    | 1420 | 1250 | 1440 | 1235 | 550 | 760  | 850  |
| Kosetice     | 1240 | 1590 | -   | 1254 | 1185 | 951  | 1434 | 1426 | 763  | 677 | 1244 | 1000 |
|              | 1310 | 1340 | -   | 1080 | 1025 | 940  | 1460 | 1470 | 760  | 550 | 1370 | 1030 |
| Donon (NILU) | 839  | 1664 | -   | 1164 | 2534 | 2350 | 2223 | 3223 | 1724 | 835 | 868  | 837  |
|              | 770  | 1520 | -   | 860  | 1750 | 2270 | 2060 | 2595 | 1290 | 705 | 780  | 830  |
| Donon (EMD)  | 708  | 1296 | 863 | 930  | 2180 | 2033 | 1832 | 3166 | 1166 | 683 | 806  | 726  |
|              | 610  | 1285 | 720 | 580  | 1680 | 1890 | 1490 | 3205 | 980  | 640 | 740  | 720  |

**ACETALDEHYDE**

|              | JAN  | FEB  | MAR  | APR  | MAY  | JUN  | JUL  | AUG  | SEP  | OCT | NOV  | DEC  |
|--------------|------|------|------|------|------|------|------|------|------|-----|------|------|
| Birkenes     | 287  | 352  | 535  | 603  | 1200 | 792  | 842  | 585  | 727  | -   | 437  | -    |
|              | 280  | 310  | 445  | 610  | 1160 | 710  | 810  | 595  | 715  | -   | 400  | -    |
| Waldhof      | 637  | 1240 | 850  | 856  | -    | 854  | 1018 | -    | 833  | 651 | 1254 | 1134 |
|              | 580  | 1205 | 710  | 890  | -    | 860  | 945  | -    | 765  | 780 | 1120 | 990  |
| Kosetice     | 1047 | 1430 | 1100 | 1090 | 1073 | 946  | 1093 | 1315 | 664  | 712 | 1313 | 1100 |
|              | 1000 | 1205 | 1000 | 975  | 1025 | 870  | 920  | 1355 | 670  | 695 | 1370 | 860  |
| Donon (NILU) | -    | 1914 | -    | 963  | 1896 | 1064 | 1328 | 1754 | 1166 | 984 | 1386 | 1343 |
|              | -    | 1790 | -    | 740  | 1820 | 1150 | 1245 | 1150 | 960  | 830 | 1680 | 1215 |
| Donon (EMD)  | 601  | 1005 | 752  | 779  | 919  | 533  | 591  | 1039 | 598  | 437 | 680  | 592  |
|              | 520  | 870  | 710  | 520  | 975  | 520  | 690  | 955  | 360  | 440 | 585  | 565  |

**ACETONE**

|              | JAN  | FEB  | MAR  | APR  | MAY  | JUN  | JUL  | AUG  | SEP  | OCT  | NOV  | DEC  |
|--------------|------|------|------|------|------|------|------|------|------|------|------|------|
| Birkenes     | 801  | 1051 | 1529 | 2511 | 6318 | 4224 | 4941 | 4408 | 3636 | 1433 | 1567 | 1014 |
|              | 800  | 1010 | 1410 | 1920 | 6665 | 3470 | 4270 | 4430 | 3610 | 1700 | 1190 | 1020 |
| Waldhof      | 2352 | 4069 | 4406 | 3968 | -    | 3693 | 3380 | 4618 | 5292 | 3261 | 3103 | 3661 |
|              | 1540 | 3600 | 4190 | 3950 | -    | 3480 | 3670 | 4650 | 5060 | 2770 | 2550 | 2950 |
| Kosetice     | 1530 | 2105 | 2365 | 3110 | 2610 | 2424 | 2759 | 4126 | 2365 | 1980 | 2689 | 1630 |
|              | 1425 | 2130 | 2545 | 2665 | 2505 | 2520 | 2550 | 4140 | 2455 | 1960 | 1830 | 1520 |
| Donon (NILU) | 2155 | 3100 | -    | -    | 7184 | 4784 | 5539 | 6568 | 5702 | 3182 | 2650 | 2359 |
|              | 1955 | 3020 | -    | -    | 5660 | 4390 | 5600 | 5420 | 5460 | 2570 | 2575 | 2440 |
| Donon (EMD)  | 1152 | 1840 | 2067 | 2159 | 5630 | 3764 | 3399 | 5682 | 3644 | 1669 | 1274 | 1397 |
|              | 1040 | 2065 | 1640 | 1680 | 4785 | 3535 | 3170 | 6235 | 3250 | 1410 | 1360 | 1395 |

| <b>PROPANAL</b> |     |     |     |     |      |      |      |      |     |     |     |     |
|-----------------|-----|-----|-----|-----|------|------|------|------|-----|-----|-----|-----|
|                 | JAN | FEB | MAR | APR | MAY  | JUN  | JUL  | AUG  | SEP | OCT | NOV | DEC |
| Birkenes        | 41  | 47  | 48  | 54  | 105  | 67   | 97   | 57   | 74  | 46  | 63  | 50  |
|                 | 40  | 40  | 40  | 50  | 95   | 70   | 90   | 60   | 70  | 40  | 50  | 50  |
| Waldhof         | 103 | 218 | 118 | 117 | -    | 131  | 162  | 141  | 100 | 93  | 160 | 159 |
|                 | 100 | 210 | 100 | 120 | -    | 120  | 180  | 140  | 110 | 100 | 150 | 110 |
| Kosetice        | 190 | 190 | 104 | 180 | 190  | 174  | 229  | 261  | 108 | 112 | 203 | 168 |
|                 | 170 | 155 | 130 | 135 | 170  | 140  | 160  | 270  | 115 | 100 | 220 | 130 |
| Donon (NILU)    | 129 | 210 | -   | 122 | 226  | 104  | 251  | 328  | 148 | 132 | 188 | 133 |
|                 | 100 | 205 | -   | 100 | 200  | 130  | 220  | 245  | 130 | 100 | 190 | 130 |
| Donon (EMD)     | 96  | 137 | 99  | 87  | 236  | 162  | 179  | 320  | 524 | 136 | 121 | 110 |
|                 | 60  | 125 | 90  | 70  | 210  | 140  | 190  | 210  | 280 | 120 | 95  | 100 |
| <b>BUTANONE</b> |     |     |     |     |      |      |      |      |     |     |     |     |
|                 | JAN | FEB | MAR | APR | MAY  | JUN  | JUL  | AUG  | SEP | OCT | NOV | DEC |
| Birkenes        | 105 | 151 | 264 | 326 | 305  | 173  | 239  | -    | 190 | -   | 190 | -   |
|                 | 105 | 130 | 240 | 310 | 270  | 160  | 270  | -    | 185 | -   | 140 | -   |
| Waldhof         | 238 | 668 | 420 | 431 | -    | 407  | 450  | 374  | 347 | 319 | 570 | 479 |
|                 | 220 | 715 | 420 | 390 | -    | 380  | 390  | 330  | 335 | 300 | 490 | 390 |
| Kosetice        | 351 | 515 | 404 | 556 | 390  | 359  | 341  | 483  | 203 | 262 | 584 | 472 |
|                 | 310 | 510 | 440 | 525 | 350  | 370  | 340  | 410  | 165 | 220 | 680 | 360 |
| Donon (NILU)    | -   | 873 | -   | 878 | 820  | 481  | 745  | 838  | 686 | 465 | 788 | 654 |
|                 | -   | 835 | -   | 855 | 820  | 490  | 755  | 805  | 640 | 390 | 940 | 620 |
| Donon (EMD)     | 311 | 540 | 493 | 553 | 1282 | 1202 | 1041 | 2055 | 741 | 330 | 425 | 337 |
|                 | 290 | 580 | 470 | 500 | 905  | 1050 | 1090 | 1755 | 600 | 290 | 395 | 360 |
| <b>BUTANAL</b>  |     |     |     |     |      |      |      |      |     |     |     |     |
|                 | JAN | FEB | MAR | APR | MAY  | JUN  | JUL  | AUG  | SEP | OCT | NOV | DEC |
| Birkenes        | 40  | 52  | 59  | 40  | 85   | 60   | 42   | 25   | 28  | 22  | 44  | 25  |
|                 | 30  | 50  | 30  | 20  | 95   | 60   | 30   | 20   | 20  | 20  | 50  | 20  |
| Waldhof         | 97  | 143 | 84  | 93  | -    | 84   | 92   | 80   | 85  | 73  | 104 | 104 |
|                 | 90  | 130 | 80  | 80  | -    | 80   | 90   | 80   | 95  | 70  | 100 | 80  |
| Kosetice        | 107 | 105 | 78  | 121 | 107  | 109  | 120  | 157  | 32  | 63  | 113 | 98  |
|                 | 100 | 90  | 80  | 105 | 100  | 110  | 110  | 160  | 20  | 60  | 110 | 90  |
| Donon (NILU)    | -   | -   | -   | 89  | 134  | 20   | 20   | 72   | 20  | 41  | 126 | 57  |
|                 | -   | -   | -   | 20  | 190  | 20   | 20   | 20   | 20  | 20  | 140 | 20  |
| Donon (EMD)     | 59  | 81  | 112 | 128 | 123  | 56   | 56   | 111  | 68  | 58  | 75  | 63  |
|                 | 50  | 70  | 50  | 60  | 75   | 60   | 60   | 90   | 60  | 60  | 70  | 60  |

**PENTANAL**

|              | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|--------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Birkenes     | 22  | 20  | 20  | 20  | 50  | 36  | 57  | 25  | 26  | 20  | 43  | -   |
|              | 20  | 20  | 20  | 20  | 45  | 40  | 50  | 20  | 20  | 20  | 20  | -   |
| Waldhof      | 22  | 31  | 20  | 20  | -   | 26  | 36  | 27  | 20  | 21  | 31  | 31  |
|              | 20  | 20  | 20  | 20  | -   | 20  | 20  | 20  | 20  | 20  | 20  | 20  |
| Kosetice     | 62  | 50  | 20  | 114 | 35  | 49  | 64  | 80  | 20  | 20  | 60  | 44  |
|              | 30  | 55  | 20  | 30  | 35  | 50  | 70  | 90  | 20  | 20  | 20  | 50  |
| Donon (NILU) | 20  | 35  | -   | 20  | 20  | 20  | 20  | 146 | 20  | 20  | 32  | 20  |
|              | 20  | 20  | -   | 20  | 20  | 20  | 20  | 20  | 20  | 20  | 20  | 20  |
| Donon (EMD)  | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   |
|              | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   | -   |

**GLYOXAL**

|              | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|--------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Birkenes     | 15  | 18  | 19  | 39  | 26  | 47  | 86  | 46  | 37  | 19  | 24  | 15  |
|              | 15  | 15  | 15  | 20  | 22  | 40  | 90  | 55  | 40  | 15  | 15  | 15  |
| Waldhof      | 44  | 103 | 106 | 63  | -   | 121 | 219 | 120 | 69  | 39  | 67  | 39  |
|              | 50  | 85  | 90  | 40  | -   | 110 | 70  | 110 | 60  | 30  | 40  | 15  |
| Kosetice     | 92  | 70  | 98  | 66  | 90  | 63  | 163 | 51  | 32  | 33  | 101 | 46  |
|              | 70  | 70  | 80  | 50  | 75  | 70  | 120 | 15  | 15  | 15  | 60  | 15  |
| Donon (NILU) | 23  | 51  | -   | 15  | 15  | 59  | 91  | 80  | 89  | 29  | 15  | 15  |
|              | 15  | 33  | -   | 15  | 15  | 15  | 80  | 15  | 15  | 15  | 15  | 15  |
| Donon (EMD)  | 51  | 61  | 42  | 46  | 64  | 84  | 68  | 186 | 44  | 42  | 40  | 51  |
|              | 60  | 35  | 40  | 40  | 65  | 90  | 60  | 150 | 35  | 30  | 35  | 55  |





## **Appendix B**

### **Time series of VOCs measured in 1998 and reported to EMEP-CCC**



