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

VOC measurements 2006

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Contents

Summary

This report presents measurements of VOC carried out during 2006 at EMEP monitoring sites. VOC measurements are reported for a total of 15 sites, and 7 of these with carbonyls. All the VOC measurements are made by grab samples of light hydrocarbons in canisters and by 8-hours samples of carbonyls by DNPH adsorption tubes.

This year was characterized by a number of technical problems with the VOC monitoring. Thus the amount of valid measurement data was lower in 2006 than in previous years and this affected the number of carbonyl data in particular.

Fairly uniform mean concentration levels of alkanes were seen in winter, indicating that these compounds become well mixed in the dark season without effective chemical loss mechanisms, although the data from the Slovak station Starina was an exception and showed elevated concentrations of many compounds. Larger regional differences were seen for the alkenes consistent with the fact these compounds undergo chemical oxidation also in winter through the reaction with ozone.

The winter median concentration of the hydrocarbons, used as a proxy for the European emission source strength, was of the same order as seen in the last few years for several components (ethane, propane, pentane). However, some compounds, as acetylene and ethene was higher than in previous years at certain stations (in the Czech Republic and Germany). Toluene and the toluene:benzene ratio was substantially higher at the German EMEP sites compared to previous years, possibly reflecting improved analytical sensitivity of a new GC instrument at the responsible laboratory.

The trend in hydrocarbon concentrations based on the 12 years winter median values for the period 1995-2006 show a mixed picture. For toluene the data do show a strong decline in the concentrations through the whole period whereas for other compounds there are signs of a concentration level levelling off or even increasing during the last few years. Modelling studies are needed to separate the effect of changes in emissions from those of changing meteorology from year to year.

Inspecting the ratio of individual components vs. acetylene reveal a long-term trend in the hydrocarbon speciation. At three sites with sufficient amount of data (Utö, Donon and Košetice) the measurements indicate that ethane and propane increase relative to acetylene, possibly reflecting a larger reduction in traffic related emissions (acetylene) compared to emissions from natural gas. A strong decline in the toluene:acetylene ratio is also found, and the reason for this is not clear.

VOC measurements 2006

1. Introduction

The Geneva Protocol concerning the Control of Emissions of Volatile Organic Compounds or their Transboundary Fluxes was adopted in November 1991. It entered into force on 29 September 1997. Three options for emission reduction targets are specified by the Protocol:

(i) 30% reduction in emissions of VOC by 1999 using a year between 1984 and 1990 as a basis;
(ii) The same reduction as for (i) within a Tropospheric Ozone Management Area (TOMA) and ensuring that by 1999 total national emissions do not exceed 1988 levels;
(iii) Finally, where emissions in 1988 did not exceed certain specified levels, Parties may opt for a stabilization at that level of emission by 1999.

In 1999 the Gothenburg protocol to Abate Acidification, Eutrophication and Ground-level Ozone was adopted by the Executive Body of UN-ECE, and on the 17th May 2005 the Protocol entered into force. The Protocol sets emission ceilings for 2010 for four pollutants: sulphur, NO_x, VOCs and ammonia. These ceilings were negotiated on the basis of scientific assessments of pollution effects and abatement options. Parties whose emissions have a more severe environmental or health impact and whose emissions are relatively cheap to reduce will have to make the biggest cuts. According to the Protocol, Europe's sulphur emissions should be cut by at least 63%, its NO_x emissions by 41%, its VOC emissions by 40% and its ammonia emissions by 17% compared to 1990. The Protocol also sets tight limit values for specific emission sources (e.g. combustion plant, electricity production, dry cleaning, cars and lorries) and requires best available techniques to be used to keep emissions down. VOC emissions from such products as paints or aerosols will also have to be cut.

The EMEP VOC monitoring programme was initiated at the EMEP Workshop on Measurements of Hydrocarbons/VOC in Lindau, 1989 (EMEP/CCC, 1990). A three-fold objective of the measurement programme was defined at the workshop:

- Establishing the current ambient concentrations
- Compliance monitoring ("Do the emission control programme lead to a reduction of atmospheric concentrations?")
- Support to the transboundary oxidant modelling (prognostic and diagnostic)

The Workshop recommended that as a first step it would be sufficient with VOC monitoring at 10-15 rural sampling sites and taking two samples per week at each station centred at 12 noon GMT. Collection in stainless steel canisters and analyses by high resolution gas chromatography was recommended for the detection of light hydrocarbons, whereas impregnated adsorbent tubes sampling combined with high performance liquid chromatography (HPLC) was recommended for the detection of carbonyls. A list of required and desirable compounds was defined and is shown in Table 1.

Certain additional remarks at the Workshop were underlined in the proceedings report (EMEP/CCC, 1990). The need for more information on VOC concentrations close to the emission sources for modelling purposes was raised. Harmonisation with national urban measurement programmes was recommended as well as the assembling of VOC emission inventories. Furthermore, the importance of concurrent measurements of oxides of nitrogen was strongly emphasised.

At the Lindau Workshop it was also recommended that during the starting period the analyses of the VOC samples should be made by the CCC and that other laboratories should be included later on.

Table 1: List of volatile organic compounds that are "required" or "desirable" to measure within the EMEP programme as defined at the EMEP Workshop in Lindau, 1989 (EMEP/CCC, 1990).

	required	**desirable**
Alkanes	ethane	hexane
	propane	branched hexanes
	i-butane	heptane
	n-butane	branched heptanes
	i-pentane	octane
	n-pentane	
Alkenes	ethene	butenes
	propene	pentenes
	isoprene	
Alkynes	acetylene	
Aromatics	benzene	styrene
	toluene	propylbenzenes
	o-xylene	ethyltoluenes
	m,p-xylene	
	ethylbenzene	
	trimethylbenzenes	
Aldehydes	formaldehyde	propionaldehyde
	acetaldehyde	
Ketones	acetone	methylethylketone
		methylvinylketone

The measurements of VOC within EMEP started with the collection of grab samples of light hydrocarbons in the middle of 1992, whereas measurements of carbonyls started in 1993. In the beginning five stations were included in the monitoring programme, Rucava (LV10), Košetice (CZ03), Waldhof (DE02), Tänikon (CH32) and Donon (FR08). Since then the number and selection of VOC measurement sites have changed several times.

The first laboratory intercomparison of light hydrocarbons in EMEP was organised already in 1993 (Romero, 1995). The variation or relative deviation among the laboratories was in a range ±25% from the median. The exercise showed that the majority of the participating laboratories had the required analytical technique to correctly analyse a wide range of NMHC within an accuracy of ±10–15%. Furthermore, the results showed no substantial differences whether the air samples were analysed immediately after collection or after a period up to 2 months (for C_2–C_5 hydrocarbons).

In the EU FP5 project AMOHA (Accurate Measurements of Hydrocarbons in the Atmosphere) a large number of laboratories in Europe participated in parallel sampling and analyses of hydrocarbons in ambient air (Slemr et al., 2002). A major part of the project was to organize four annual intercomparisons starting in 1997 and ending in 2000. The results showed that except for a few laboratories the agreement was within ±25% of the median for the lighter alkanes. For some aromats and unsaturated hydrocarbons as well as the C_6-C_7 alkanes a large spread in the values were seen, indicating measurement difficulties with these compounds. The spread in the results were, however, much less for laboratories using a NPL standard for calibration (Aas et al., 2001). Thus, it may be concluded that a large part of the differences seen among the laboratories reflected the use of different calibration gases. When using the same NPL standard the results from this intercomparison were very satisfactory.

The EMEP VOC measurements are reported annually, and officially made public by the Steering Body of EMEP. Previous results from the EMEP VOC programme have been presented in annual reports (e.g. Solberg, 2007). An EMEP expert meeting on VOC measurements was organised in Berlin, 1994 (EMEP/CCC, 1995), and an evaluation of the measurement programme was made in 1995 (Solberg et al., 1995). Highlights and findings from the EMEP VOC programme have also been presented in a number of scientific papers (Lindskog et al., 1995; Solberg et al., 1996; Hov et al., 1997; Solberg et al., 2001; Borbon et al., 2004; Hakola et al., 2006).

An initiative has been taken to increase the cooperation and exchange of VOC data between GAW (Global Atmospheric Watch) and EMEP. At the EMEP TFMM workshop in Oslo in November 2004, on the implementation of the EMEP monitoring strategy, a closer harmonisation between the VOC monitoring in EMEP and GAW was discussed. Minutes and conclusions from the workshop is given elsewhere (EMEP/CCC, 2005). Harmonisation of data quality objectives (DQOs) and using a common audit questionnaire was recommended, and it is also a wish to arrange common GAW/EMEP training course and to further increase the exchange of VOC monitoring data between EMEP, GAW and WDCGG (World Data Centre of Greenhouse Gases).

A revision and extension of the species recommended to measure was also discussed at the Oslo TFMM workshop. One starting point for such a revision is the VOC speciated emissions provided by UK's National Atmospheric Emissions Inventory (NAEI) as reported by Dore et al. (2004). Table 2, adopted from Dore et al. (2004), shows the photochemical ozone creation potential (POCP) for the top 50 VOCs (with respect to POCP) for the UK. The POCP identifies, on a relative basis, the ozone creation potential for each NMVOC compound through modelling studies. The creation potentials are then normalised by defining ethene as a creation potential of 1. Many of the components in Table 2 are not measured by the present EMEP VOC program due to limitations by the methods presently used, as e.g. alcohols, chlorinated compounds and long-chained alkanes. An extension to include these compounds in the monitoring program will require additional sampling devices as e.g. adsorption tubes.

In 2006 a WMO/GAW workshop on global measurements of VOCs (WMO, 2007) proposed a list of species to be measured based on current and future possibilities and needs of GAW. The proposed species are: Ethane, propane, acetylene, isoprene, formaldehyde, terpenes, acetonitrile, methanol, ethanol, acetone, DMS, benzene, toluene, iso- and n-butane, iso- and n-pentane. Most of these compounds are already part of the EMEP VOC programme with some exceptions. The alcohols (methanol and ethanol) are likely to become more important in the future due to increased use of biofuels in vehicles. Furthermore, terpenes are important as precursors for secondary organic aerosols. These compounds would be of interest to include in the EMEP monitoring as well, but require other sampling methods and instrumentations than presently used for the hydrocarbons and carbonyls.

Table 2: POCP Weighted NMVOC emissions (adopted from UK's NAEI emissions reported by Dore et al., 2004).

	POCP	code	Stationary Combustion	Production Processes	Extraction and Distrib_ Fossil Fuels	Solvent Use	Road Transport	Other Transport	Waste Treatment	TOTAL (Mass Emission)	TOTAL (POCP Weighted)	TOTAL (POCP Weighted %)
butane	35.2	a	4.37	4.52	70.21	19.61	13.30	0.47	0.02	112	40	7.2%
ethanol	39.9	a	1.39	53.56		40.27			0.27	95	38	6.9%
ethylene	100.0	a	3.29	5.65	0.03		14.22	3.55	1.07	28	28	5.0%
toluene	63.7	a	2.03	4.06	0.24	11.44	16.95	3.10	0.16	38	24	4.4%
m-xylene	110.8	a	0.75	2.14	0.09	10.90	5.04	0.70	0.07	20	22	3.9%
propylene	112.3	a	1.65	6.01	0.02	0.00	6.80	1.37	0.06	16	18	3.2%
pentane	39.5	a	2.66	2.00	28.93	0.41	8.64	0.29	0.02	43	17	3.1%
hexane	48.2	a	0.51	4.39	14.93	2.32	7.92	0.20	0.10	30	15	2.7%
1,2,4-trimethylbenzene	127.8	a	0.00	0.52	0.01	5.44	4.69	0.51		11	14	2.6%
2-methylbutane	40.5	a	3.48	1.08	11.11	0.04	17.74	0.77	0.01	34	14	2.5%
formaldehyde	51.9	a	9.05	0.38	0.21	0.03	6.26	1.50	3.40	21	11	2.0%
o-xylene	105.3	a	0.25	0.75	0.04	2.74	5.05	0.80	0.04	10	10	1.8%
heptane	49.4	a	0.77	0.30	15.07	1.26	1.61	0.09		19	9	1.7%
propane	17.6	a	3.22	2.26	36.90	3.81	1.18	0.38	5.11	53	9	1.7%
ethylbenzene	73.0	a	0.24	1.75	0.03	4.17	4.93	0.77	0.12	12	9	1.6%
p-xylene	101.0	a	0.19	0.92	0.02	2.92	3.90	0.54	0.06	9	9	1.6%
ethane	12.3	a	5.84	1.46	49.57	0.00	3.15	0.57	5.44	66	8	1.5%
octane	45.3	a	0.06	0.18	13.27	1.10	0.77	0.09		15	7	1.3%
2-methylpropane	30.7	a	1.01	0.24	13.24	0.89	5.96	0.22	0.01	22	7	1.2%
trichloroethene	32.5	a		0.87		18.97			0.06	20	6	1.2%
1,3,5-trimethylbenzene	138.1	a	0.00	0.19		1.82	1.85	0.24		4	6	1.0%
2-butene	113.9	a	0.60	0.14	0.81		2.67	0.21	0.02	4	5	0.9%
2-methylpropene	62.7	a	0.15	0.68	0.26		5.23	1.03	0.00	7	5	0.8%
2-butanone	37.3	a		0.68		11.38	0.24	0.02	0.01	12	5	0.8%
1,2,3-trimethylbenzene	126.7	a	0.00	0.18		1.84	1.07	0.15		3	4	0.7%
methanol	14.0	a		2.01	0.00	26.09			0.07	28	4	0.7%
2-pentene	111.9	a	0.34	0.01	1.41		1.57	0.04	0.00	3	4	0.7%
decane	38.4	a	0.03	0.84	0.03	7.38	0.92	0.47		10	4	0.7%
1,3-butadiene	85.1	a	0.00	0.29	0.01		2.74	0.61	0.01	4	3	0.6%
butyl acetate	26.9	a		0.19		11.19			0.02	11	3	0.6%
1-butanol	62.0	a		0.23		4.58			0.01	5	3	0.5%
methylethylbenzene	94.1	c		0.23		2.91				3	3	0.5%
benzene	21.8	a	3.88	1.41	0.84	0.00	5.06	1.44	0.89	14	3	0.5%
4-methyl-2-pentanone	49.0	a		0.65		5.07				6	3	0.5%
acetaldehyde	64.1	a	0.00	0.75			2.86	0.67		4	3	0.5%
ethyldimethylbenzene	132.0	c		0.11		1.98				2	3	0.5%
1-butene	107.9	a	0.34	0.62	0.23	0.00	1.21	0.12	0.01	3	3	0.5%
naphthalene	97.7	b	0.48	0.02		1.43		0.01		2	2	0.3%
nonane	41.4	a	0.05	0.52	0.08	4.44	0.21	0.11		5	2	0.4%
2-butoxyethanol	48.3	a		0.10		4.48				5	2	0.4%
dipentene	74.5	b		0.01		2.84				3	2	0.4%
1-propanol	56.1	a		0.06		3.29			0.04	3	2	0.3%
acetone	9.4	a	0.19	1.93		17.04	0.81	0.08	0.00	20	2	0.3%
2-methylpentane	42.0	a	0.03	0.99	2.17	1.09		0.01	0.05	4	2	0.3%
2-propanol	18.8	a	0.01	0.73		8.92			0.02	10	2	0.3%
ethyl acetate	20.9	a		1.31		6.98			0.02	8	2	0.3%
undecane	38.4	a	0.00	0.44		3.85		0.19		4	2	0.3%
1-pentene	97.7	a	0.14	0.06	0.29		0.93	0.04	0.00	1	1	0.3%
3-methylpentane	47.9	a	0.02	0.67	1.21	0.86			0.03	3	1	0.2%
1,2,3,5-tetramethylbenzene	136.0	b		0.06		0.84				1	1	0.2%
Total Top 50 (POCP)			**47**	**109**	**261**	**257**	**155**	**21**	**17**	**868**	**399**	**72.3%**
unspeciated	51.3	c	1.86	32.11	1.20	7.06	1.22	0.36	0.01	44	22	4.1%
other grouped species			0.72	23.31	9.51	6.69	34.54	32.53	1.13	108	68	12.3%
other VOC			1.50	29.87	1.80	106.06	19.80	4.44	1.78	165	62	11.3%
Total VOC			**51**	**194**	**274**	**376**	**211**	**59**	**20**	**1186**	**552**	**100%**

2. Status of the measurement programme in 2006

2.1 The station network

The location of the monitoring sites for VOC presented in this report is shown in Figure 1 and an overview of the measurement programme and the responsible laboratories in 2006 is given in Table 3. Totally 15 measurement sites reported VOC data to CCC in 2006. Carbonyls were sampled at 7 of these sites but due to technical problems the data from Utö and Košetice could not yet be analysed in the laboratory. Furthermore, hydrocarbon data from Campisábalos were provided for the last half year of 2006 only and as the data needed more inspection they are still considered preliminary. Carbonyl data from Campisábalos were delivered for the whole year, but the data values for formaldehyde and acetaldehyde for the period January to July were very low and flagged as invalid. Further inspection should be carried out on these data.

In 2006 there were problems with the VOC analyses at the German lab at UBA and the old GC was replaced by a new one. The new analytical method was somewhat different from the old one. It used a different column and cooling was with liquid CO_2 instead of liquid N_2. Many peaks changed order in the chromatograms making it difficult to identify the peaks as the results was not always reproducible. Due to operational restrictions, it was not possible to run both methods in parallel to make detailed comparisons. In general, the new method seems to be more sensitive for C_7- and higher VOCs.

VOC data were also reported from NL09, Kollumerward, for 3 months of 2006, July – September. These data are included in EMEP’s database ebas, but due to the short period with data they are not included in this report.

Table 4 gives the number of valid (daily) samples of hydrocarbons and carbonyls (after inspection and removal of outliers). According to EMEP's recommendations, the samples should be taken at least twice a week, implying that 104 samples per year correspond to 100% data cover.

A 90% data completeness, i.e. 94 samples pr year, of daily values is given as data quality objective according to the EMEP manual (EMEP/CCC, 1996). The data capture was lower than this for many sites in 2006. Carbonyls are only measured once per week in France giving a data capture of the order of 50%. Only Pallas, Utö, Košetice and La Tardière had a sufficient data capture of hydrocarbons, i.e. 94 samples or more, in addition to the sites with daily/continuous monitoring, Hohenpeissenberg and Rigi. None of the stations measuring carbonyls had a data completeness fulfilling the criteria of 90%.

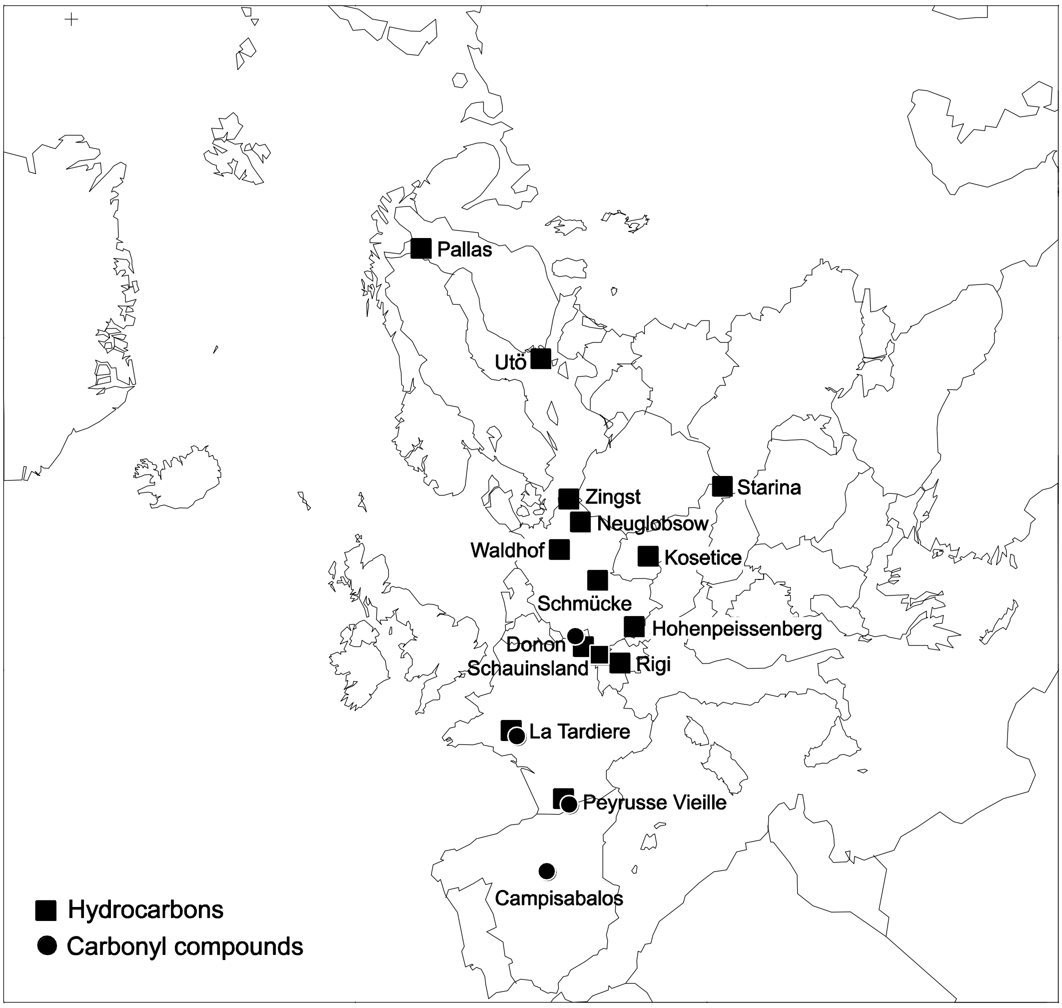

Figure 1: Monitoring sites for VOC in 2006.

Table 3: Status of the VOC monitoring programme in 2006. The columns give the station names, site code, and the sampling frequencies for hydrocarbons (HC) and carbonyl compounds (Carb). The laboratory responsible for the chemical analyses is also given.

Station	Code	HC[1)]	Lab.[2)]	Carb[1)]	Lab.[2)]	Comments
Pallas	FI96	Reg.	FMI	n.m.	-	
Utö	FI09	Reg.	FMI	n.a.	NILU	Samples not yet analysed in the lab due to technical problems
Waldhof	DE02	Reg.	UBA	n.m.	-	
Schauinsland	DE03	Reg.	UBA	n.m.	-	
Neuglobsow	DE07	Reg.	UBA	n.m.	-	
Schmücke	DE08	Reg.	UBA	n.m.	-	
Zingst	DE09	Reg.	UBA	n.m.	-	
Hohenpeissenberg	DE43	Daily	DWD	n.m.	-	GAW station
Košetice	CZ03	Reg.	CHMI	n.a.	NILU	Samples not yet analysed in the lab due to technical problems
Starina	SK06	Reg.	SHMI	n.m.	-	
Rigi	CH05	Cont.	EMPA	n.m.	-	
Donon	FR08	Reg.	EMD	Reg.	EMD	
Peyrusse Vieille	FR13	Reg.	EMD	Reg.	EMD	
La Tardière	FR15	Reg.	EMD	Reg.	EMD	
Campisábalos	ES09	(Reg.)	MMA	Reg.	MMA	Hydrocarbons for the last half year are reported but are considered preliminary

1) Reg. = regularly, Scat. = scattered, n.m. = not measured., n.a. = not yet analysed, cont. = Continuous
2) CHMI = Czech Hydrometeorological Institute
DWD = Deutscher Wetterdienst
EMD = Ecole des Mines de Douai (France)
EMPA = Swiss Federal Lab. for Materials Testing and Research
FMI = Finnish Meteorological Institute
MMA = Ministerio de Medio Ambiente (Spain)
NILU = Norwegian Institute for Air Research
SHMI = Hydrometeorological Institute in Slovakia
UBA = Umweltbundesamt (Germany)

Table 4: The number of valid samples of hydrocarbons (HC) and carbonyls (Carb) in 2006.

Station	Number of samples HC[2)]	Carb[3)]
Pallas	96	-
Utö	97	-
Waldhof	77	-
Schauinsland	77	-
Neuglobsow	78	-
Schmücke	79	-
Zingst	79	-
Hohenpeissenberg[1)]	356	-
Košetice	103	-
Starina	90	-
Rigi[1)]	309	-
Donon	93	51
Peyrusse Vieille	76	49
La Tardière	100	47
Campisábalos	-	42

1) Refers to days with monitoring data
2) Refers to ethane (may differ for other HCs)
3) Refers to formaldehyde (may differ for other carbonyls)

2.2 Analytical procedures and quality control

The procedures for sampling and chemical analyses were similar in 2006 as in previous years, and are not discussed in this report. A detailed description of the procedures used by NILU is given in the EMEP manual (EMEP/CCC, 1996). 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). A presentation of the sampling and analyses performed by the laboratories at EMD (France), EMPA (Switzerland), CHMI (Czech Republic), MMA (Spain), SHMI (Slovakia) and UBA (Germany) has been given in previous annual reports and by Solberg et al. (1996) and is not repeated here. The instrumentation and methods applied by DWD at Hohenpeissenberg have been successfully tested in two international intercomparison experiments (NOMHICE, AMOHA) and have been documented by Plass-Dülmer et al. (2002).

For the EMEP VOC measurements in general, the quality control of the VOC measurements includes QA procedures at all stages from sampling to chemical analyses and integration. The QA procedures are described in the EMEP manual (EMEP/CCC, 1996) and are the laboratories’ responsibility to follow up. In addition, data received from the individual laboratories are inspected before classified as valid or invalid by the EMEP/CCC.

A few notes about the measurements are given in the following. The concentrations of 3-buten-2-one, 2-methylpropenal, 2-butanone and butanal have for many years been difficult to interpret. No systematic and explainable pattern has been found and inter-laboratory comparisons between EMD, UBA and NILU have indicated analytical problems. Laboratory studies at CCC indicate that unsaturated carbonyl compounds are not chemical stable in the prepared sample solution. Furthermore, LC/MS studies indicate possibilities of chromatographic interference in the C_4 carbonyl compound range. Thus, a revision of the monitoring procedures for these carbonyls is needed.

3. VOC concentrations in 2006

3.1 General

Monthly mean and median concentrations of the individual hydrocarbons and carbonyls for 2006 are tabulated in Appendix A. The monthly statistics were not calculated for sample numbers less than 4. Time series of all compounds during 2006 are given in Appendix B. For the continuous monitor data from CH05 Rigi the average of two 2-hourly values around noon were used in the calculations whilst the sample taken around noon at Hohenpeissenberg were used (samples from noon and midnight were reported). Based on previous experience there is not much difference in the anthropogenic HC concentrations at noon and at midnight at Hohenpeissenberg (pers. comm., Christian Plass-Dülmer). For isoprene the difference is substantial as this is a reactive biogenic compound, emitted during daytime, with low concentrations during night.

A comparison of the seasonal mean and percentile concentrations of hydrocarbons in winter (Jan., Feb., Nov., Dec.) and carbonyls in summer (May, June, July, Aug.) measured at the different stations is given in Figure 2 and Figure 3. The stations are arranged from north to south. Considering that the sites span a wide area from southern Europe to the most northern part of the continent, the hydrocarbon winter mean levels are fairly uniform for the alkanes but some systematic differences are seen. Highest concentrations are seen at Starina for many of the hydrocarbons while high peak values are also seen for some compounds at Neuglobsow (DE07). Low concentration levels are seen at the two Finnish sites, Pallas and Utö, and the two German mountain sites, Schauinsland (1205 m asl) and Hohenpeissenberg (985 m asl).

For the alkenes, ethene and propene, the differences among the sites are larger reflecting an efficient chemical loss in the atmosphere also during winter through the reaction with O_3. The ratio between the peak values (90 percentiles) and the mean are generally largest for propene of all the compounds.

The amount of carbonyl data for 2006 is too low to allow any statements about geographical or latitudinal patterns. Furthermore, at the French sites the sampling frequency is once per week, making the seasonal statistics more uncertain. In addition, the Spanish "seasonal" statistics for formaldehyde and acetaldehyde shown in Figure 3 is based on data from August only, as data for the first 7 months were taken out of the data set as mentioned above.

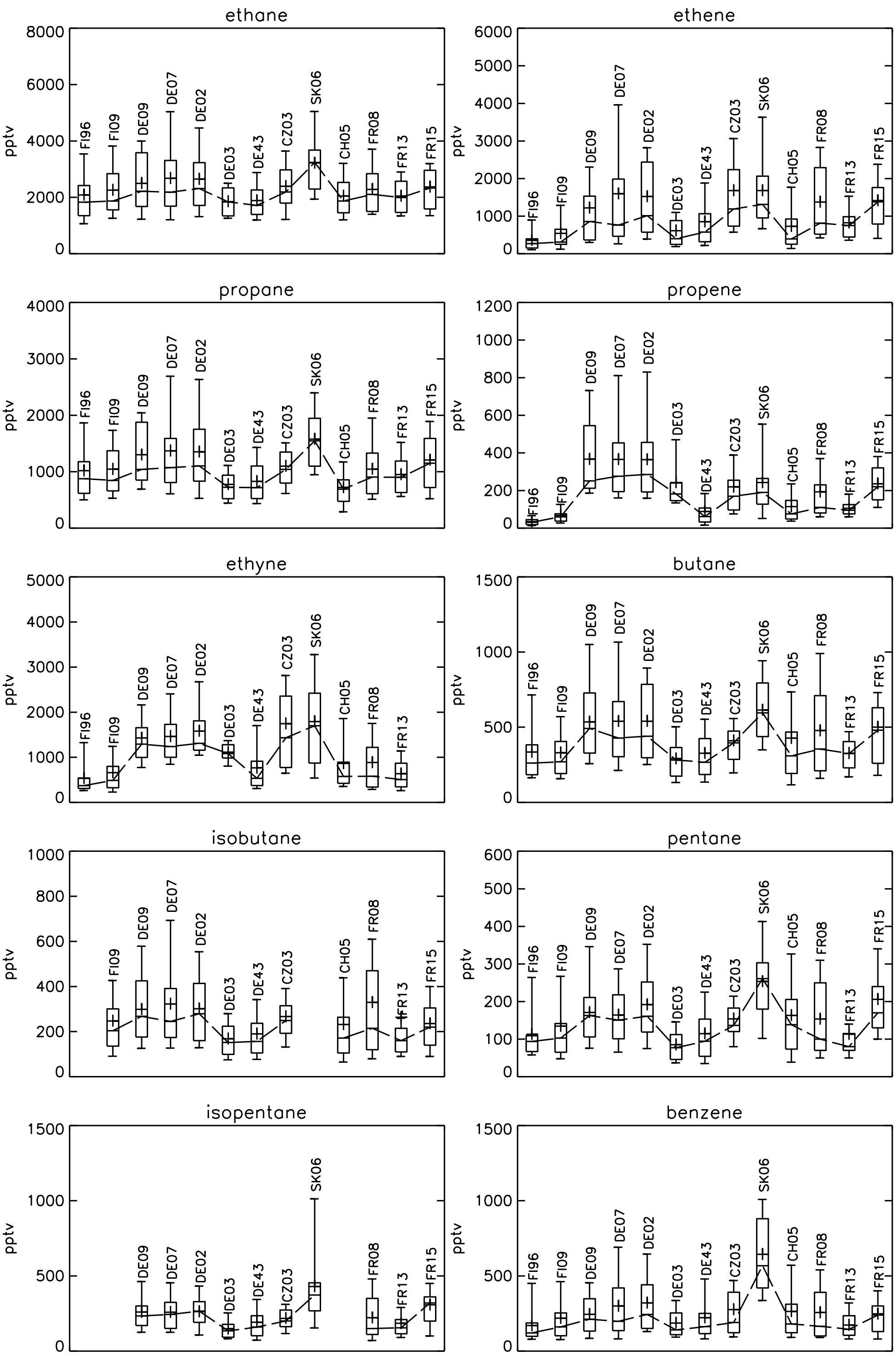

Figure 2: Box- and whisker-diagrams for hydrocarbons during winter 2006 (Jan., Feb., Nov., Dec.). The markers indicate the 10-, 25-, 50-, 75- and 90-percentiles. Mean values are indicated by a cross. The dashed line connects the median values for clarity.

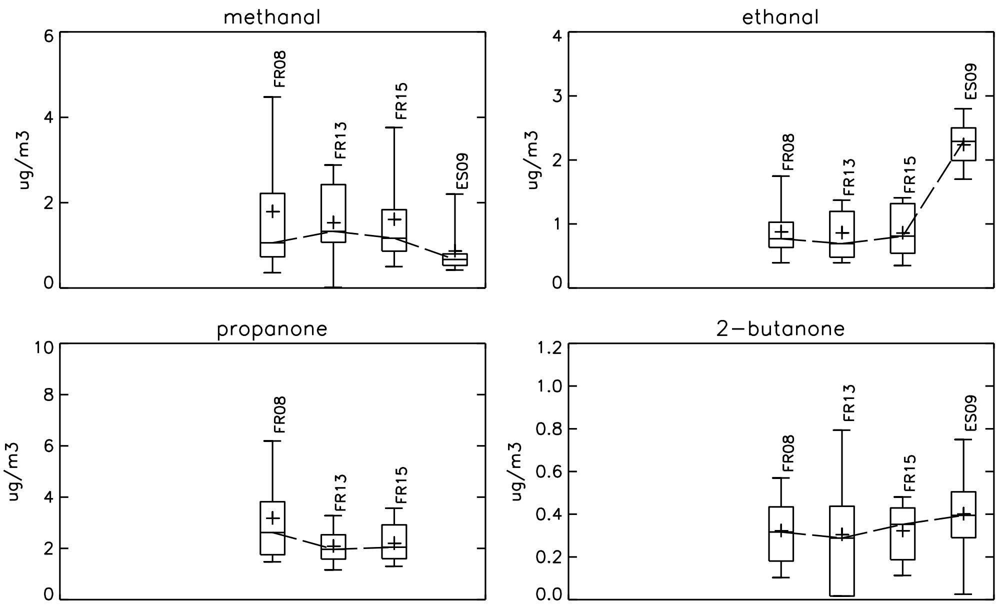

Figure 3: Box- and whisker-diagrams for carbonyls during summer 2006 (May, June, July, August). The markers indicate the 10-, 25-, 50-, 75- and 90-percentiles. Mean values are indicated by a cross. Note that the values for methanal and ethanal at ES09 are based on August only.

3.2 Regional distribution of VOC

Figure 4–Figure 13 show maps with the stations' median concentrations of 10 light hydrocarbons for the winter months January, February, November and December in 2006 taken together. These medians are based on the average of the two 2-hourly values around noon at Rigi and on the day-time values at Hohenpeissenberg.

Although the number of sites obviously is too low to give a picture of the regional background distribution of hydrocarbons in Europe, some characteristics are indicated by these results. Similar figures for three carbonyls for the summer months May-August 2006 are given in Figure 14–Figure 16.

As noted in previous reports, the measurements indicate that hydrocarbons become fairly well mixed in Europe in winter. Components with a long chemical lifetime in winter, such as ethane and propane, show less geographical variations except for the results from Starina, SK06, which show generally higher levels. For benzene the median winter concentrations at Starina are twice as high as measured at the other sites.

Certain characteristics are seen in the 2006 though. For acetylene, propene and i-butane particularly high winter median concentrations are seen at the three German sites in the north (Zingst, Waldhof and Neuglobsow). Also at Košetice the acetylene and i-butane median concentrations are elevated.

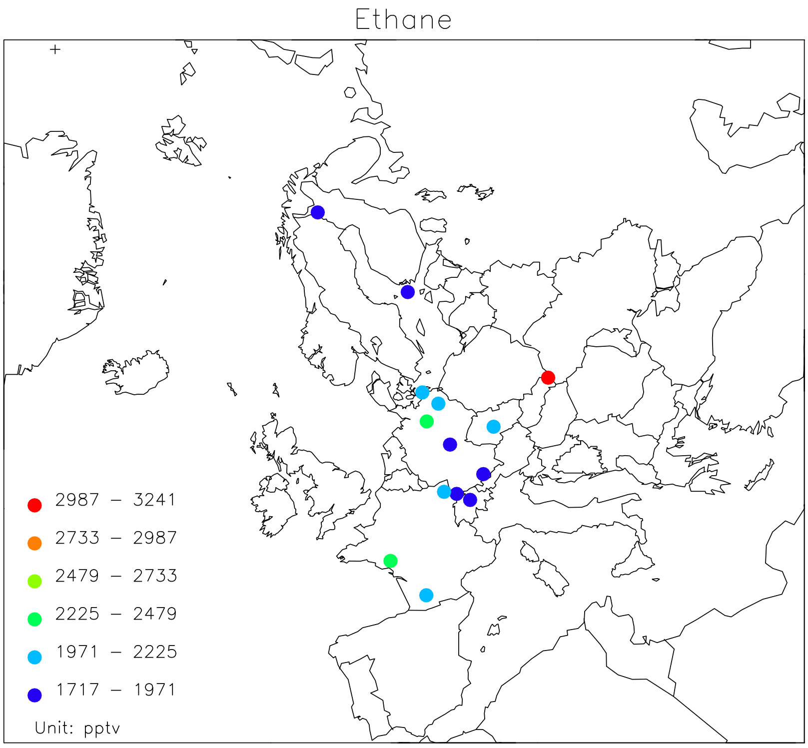

Figure 4: Median concentration of ethane at EMEP sites in the winter months November, December, January and February 2006 taken together.

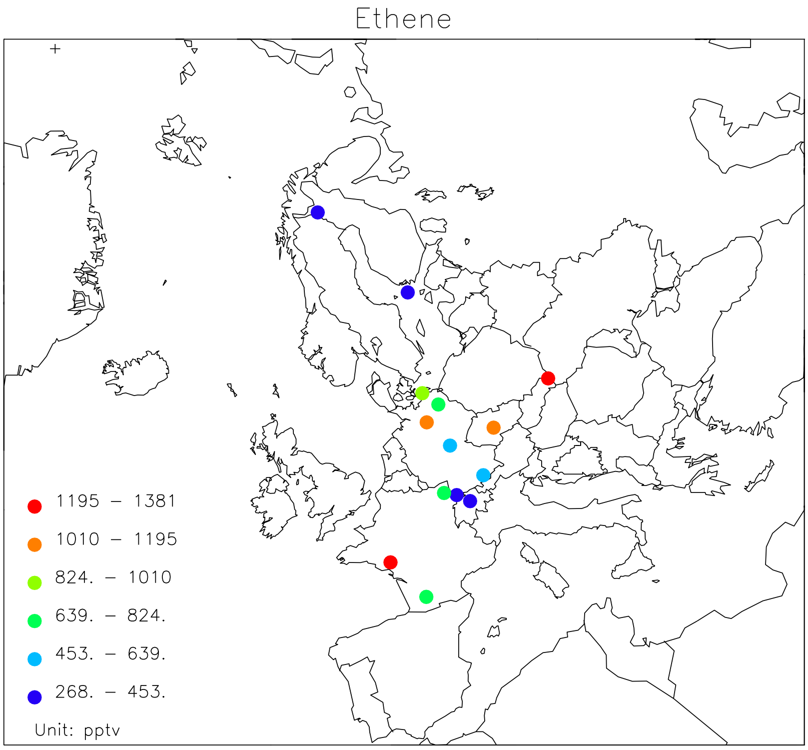

Figure 5: Median concentration of ethene at EMEP sites in the winter months November, December, January and February 2006 taken together.

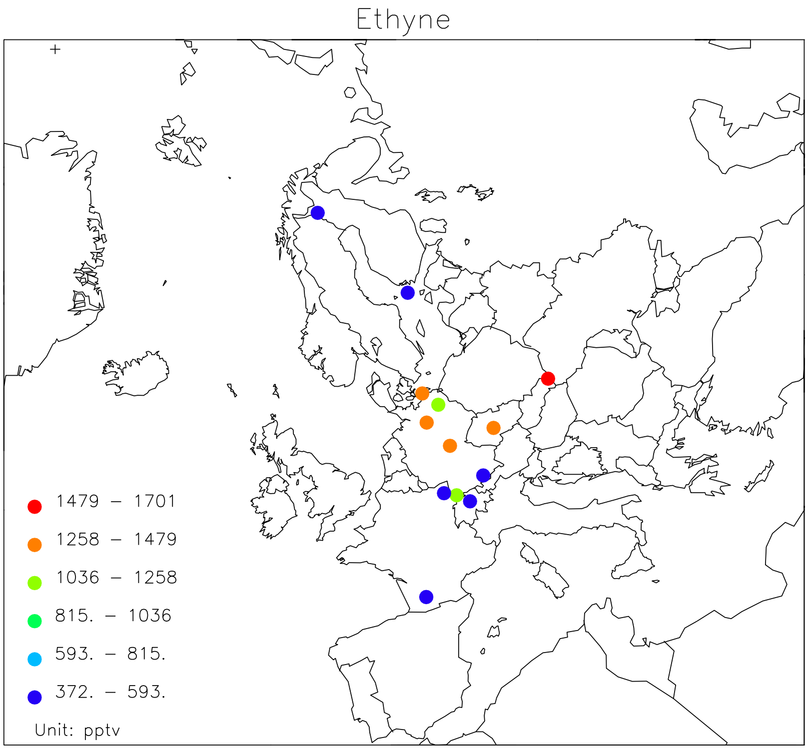

Figure 6: Median concentration of acetylene at EMEP sites in the winter months November, December, January and February 2006 taken together.

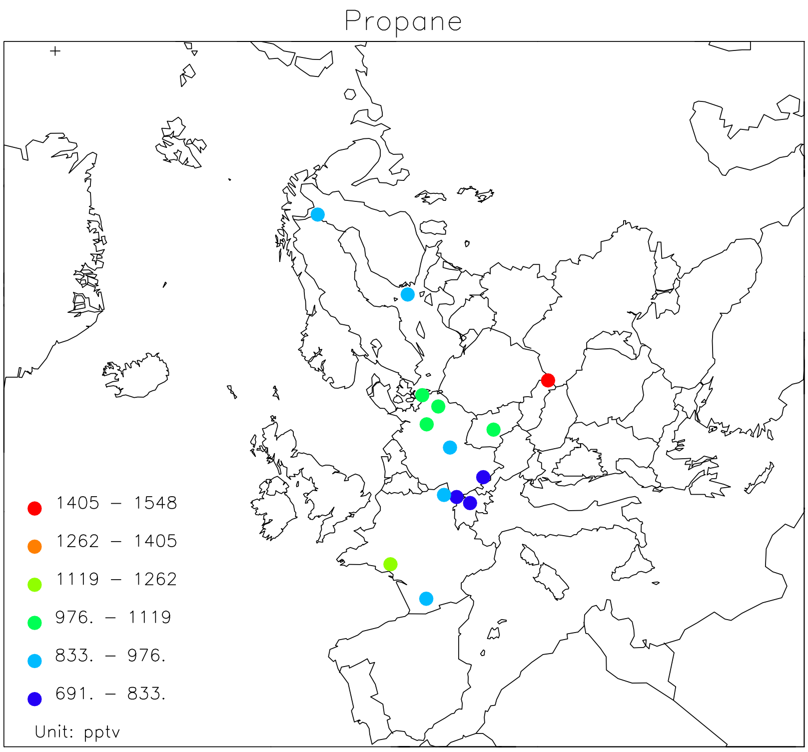

Figure 7: Median concentration of propane at EMEP sites in the winter months November, December, January and February 2006 taken together.

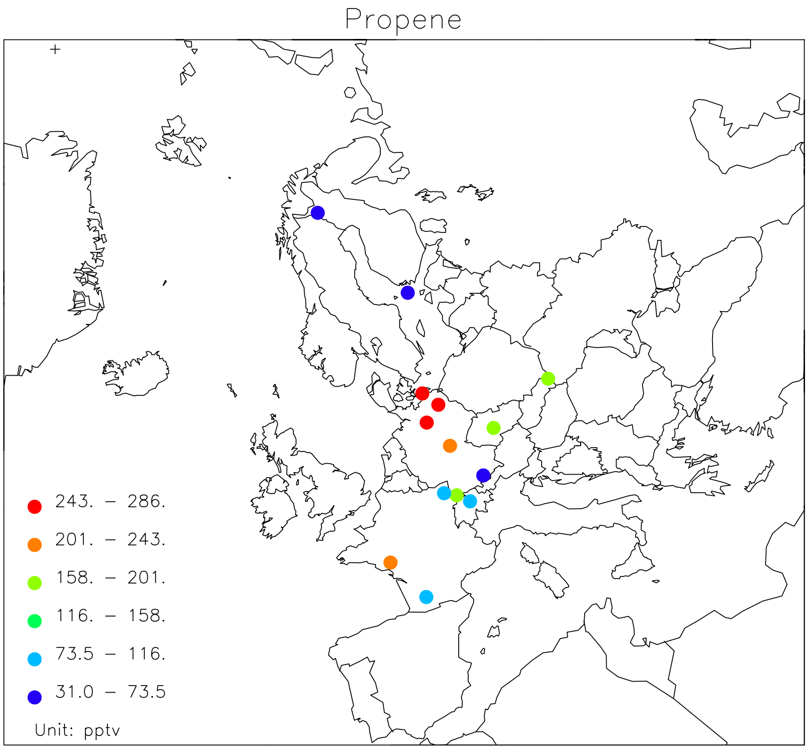

Figure 8: Median concentration of propene at EMEP sites in the winter months November, December, January and February 2006 taken together.

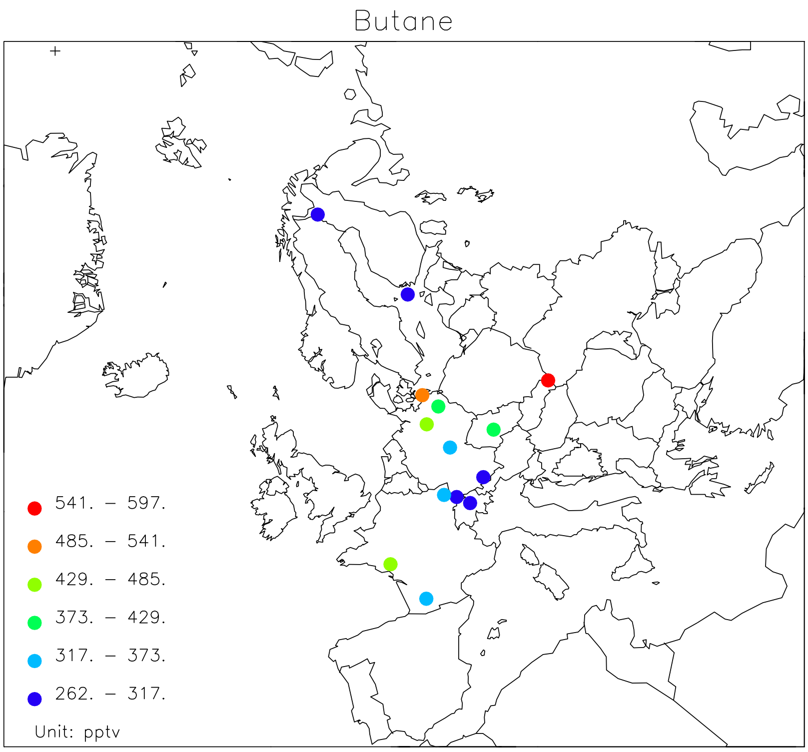

Figure 9: Median concentration of n-butane at EMEP sites in the winter months November, December, January and February 2006 taken together.

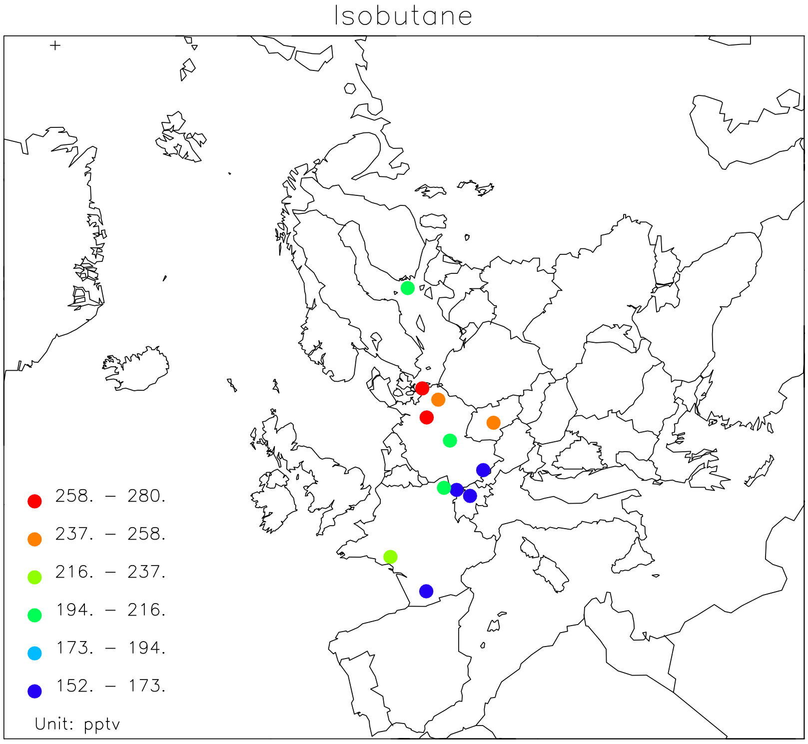

Figure 10: Median concentration of i-butane at EMEP sites in the winter months November, December, January and February 2006 taken together.

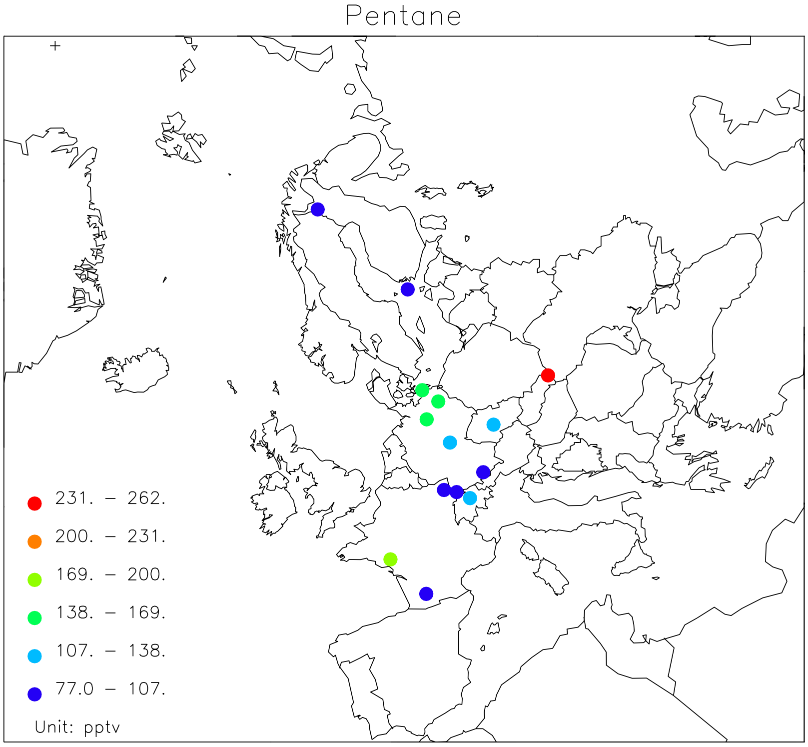

Figure 11: Median concentration of n-pentane at EMEP sites in the winter months November, December, January and February 2006 taken together.

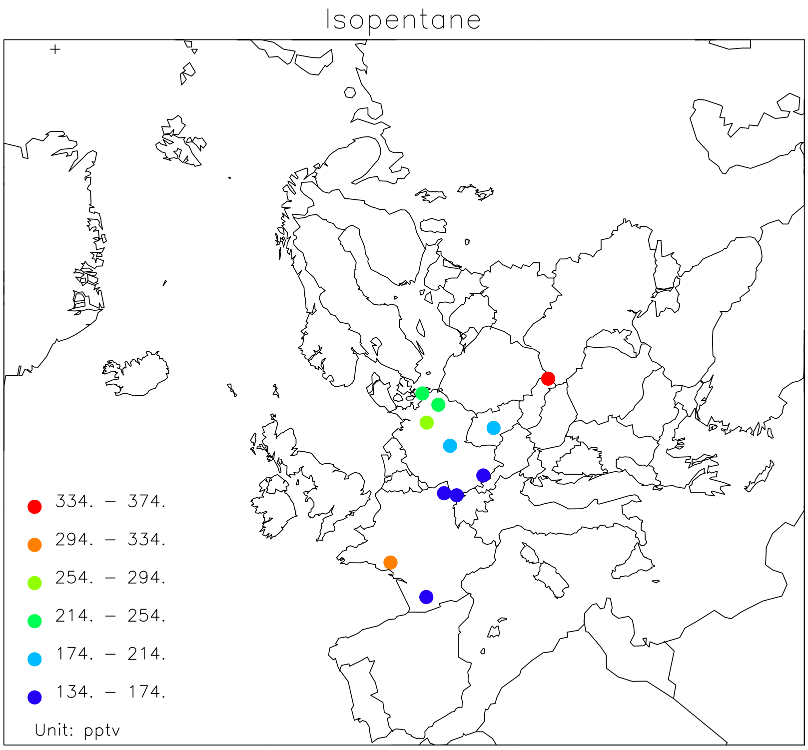

Figure 12: Median concentration of i-pentane at EMEP sites in the winter months November, December, January and February 2006 taken together.

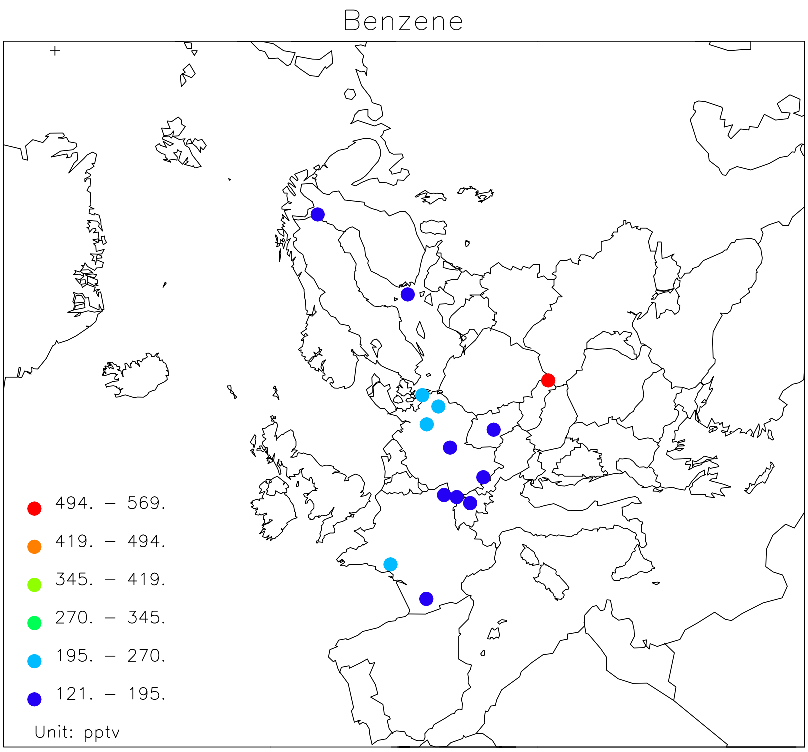

Figure 13: Median concentration of benzene at EMEP sites in the winter months November, December, January and February 2006 taken together.

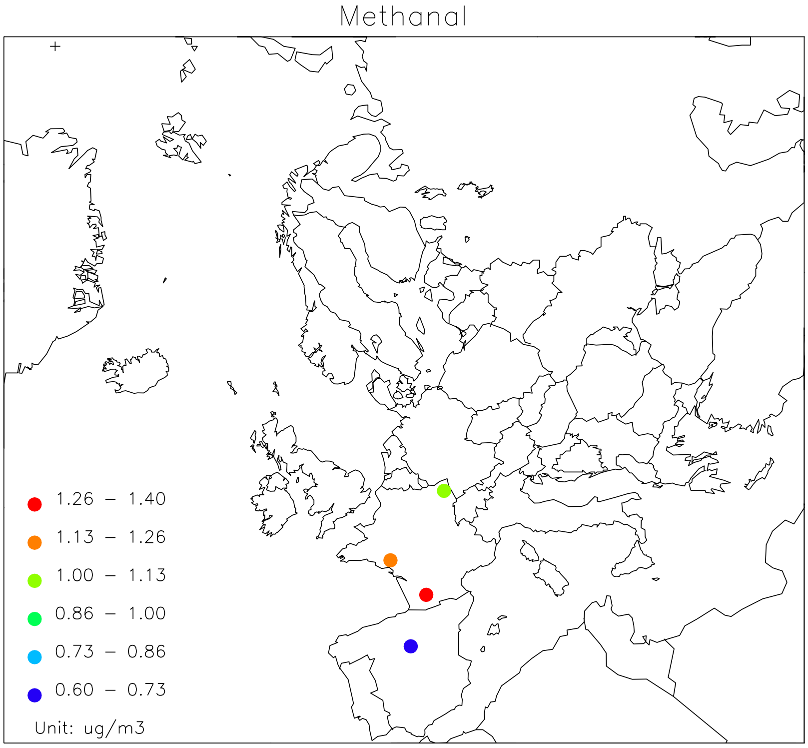

Figure 14: Median concentration of formaldehyde at EMEP sites in the summer months May, June, July and August 2006 taken together. Note that the values for ES09 are based on data for August only.

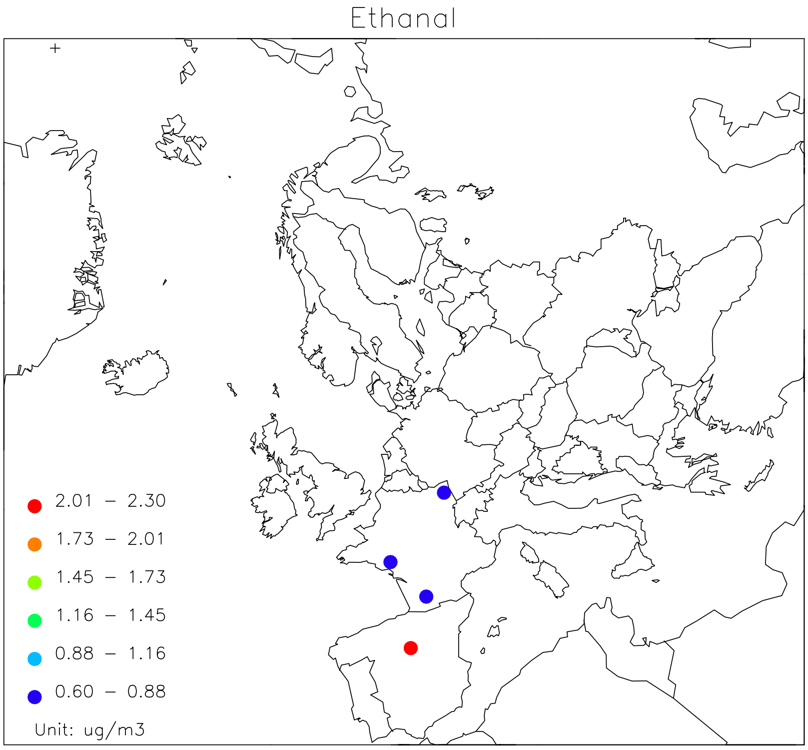

Figure 15: Median concentration of acetaldehyde at EMEP sites in the summer months May, June, July and August 2006 taken together. Note that the values for ES09 are based on data for August only.

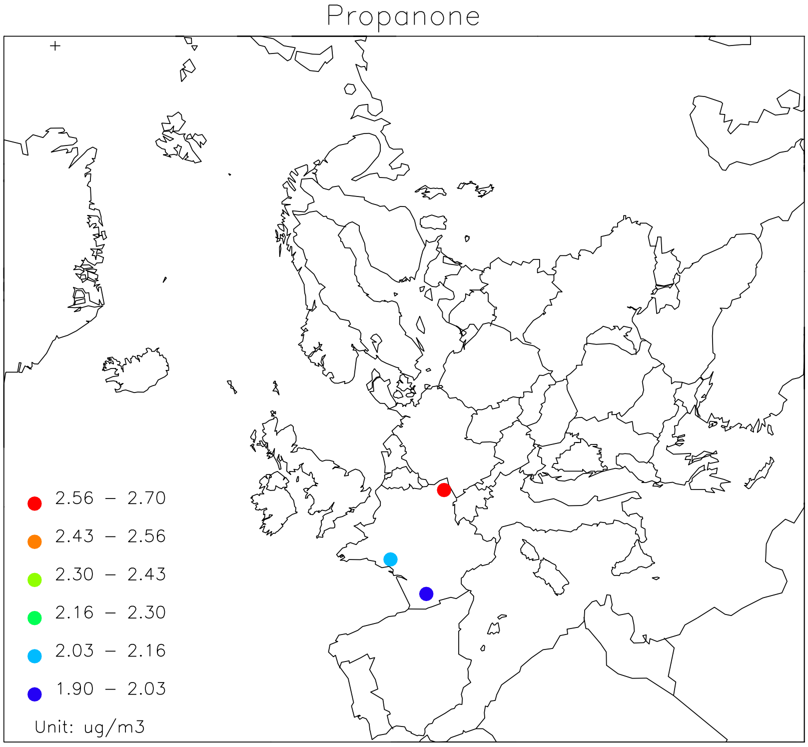

Figure 16: Median concentration of acetone at EMEP sites in the summer months May, June, July and August 2006 taken together.

4. Long-term trends in VOC

The 12 year's trend in the measured VOC from 1995 is indicated in Figure 17 showing the winter medians at Pallas (FI96), Utö (FI09), Waldhof (DE02), Schmücke (DE08), Košetice (CZ03) and Donon (FR08) of selected hydrocarbons.

In addition to the emission source strength, these long-term trends or variations will be largely controlled by inter-annual changes in weather conditions and atmospheric stability. Furthermore, the changes in chemical analysing laboratory may also have a significant impact on the median concentrations and this is marked in the Figures. Note that the parallel sampling and analyses has not necessarily been carried out during the whole season. Thus, large differences between two laboratories for the same year may give a false impression of the laboratory differences.

The 12 year's trend, or variations, in the winter medians varies for the various hydrocarbons as indicated by Figure 17 and no overall picture is seen. For some compounds, like toluene, the results do indicate a long-term reduction in the winter median concentration level, whereas for other compounds, there are signs of a concentration levelling off or even increasing during the last few years. Relative to the other components, the level of acetylene at Košetice and the German sites were higher in 2006 than compared to the last previous years.

The German sites DE02 and DE08 show substantially higher concentrations of toluene in 2006 compared to previous years and the reason for this is unclear. An inspection of the long-term trend in the toluene:benzene ratio showed that after a 2-months gap in the time series in 2006 this ratio became significantly higher than seen in the years before that period. Thus, one should rule out the possibility of systematic changes in the toluene (and benzene) concentrations due to changes in sampling and analyses before making further conclusions.

To separate the sole effect of changes in European VOC emissions on the observed concentrations trends in Figure 17 requires a number of detailed model calculations. Furthermore, due to the large scatter in data values from year to year, a linear trend is of little value to assign.

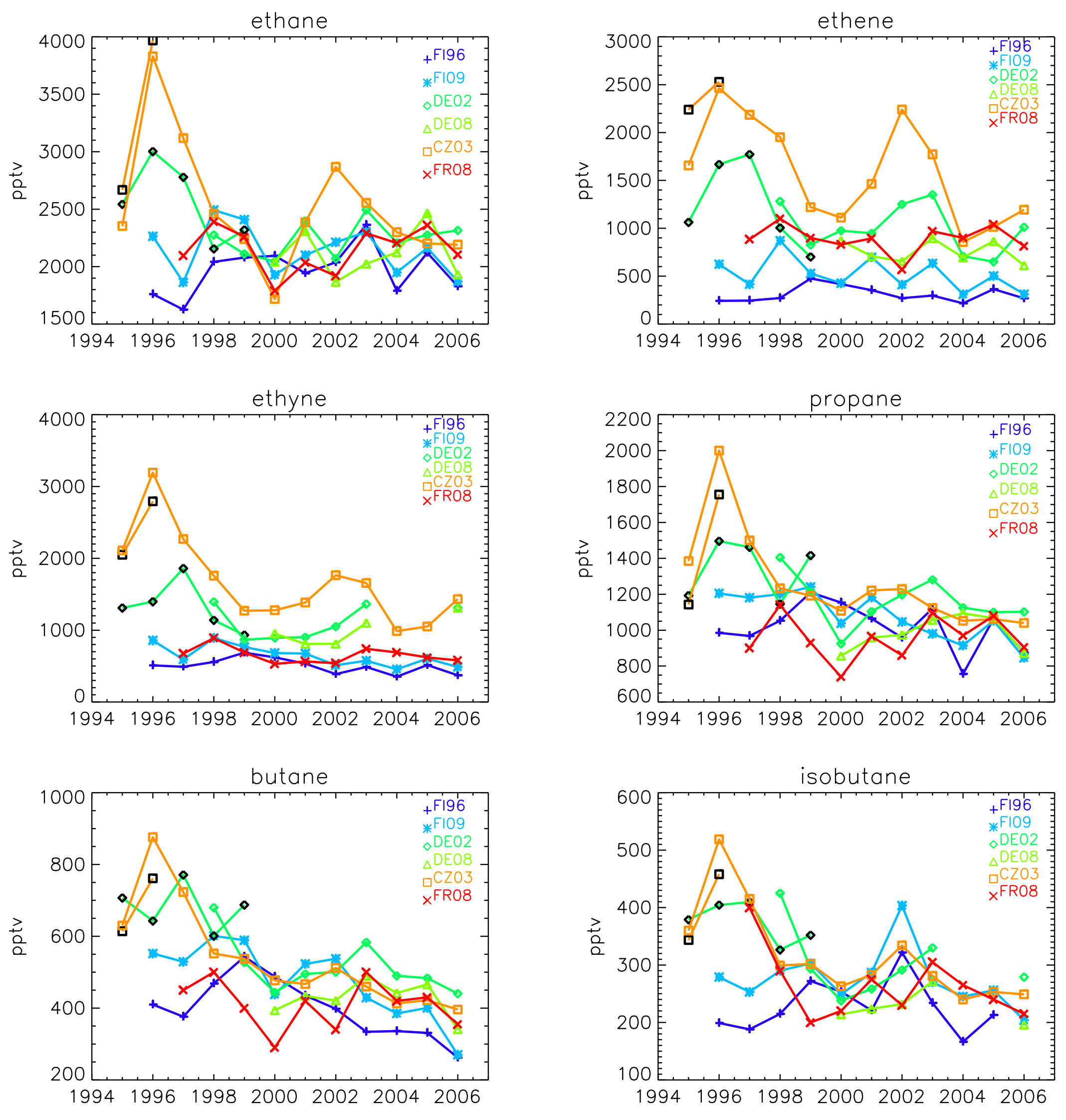

Figure 17: Annual winter (Jan., Feb., Nov., Dec.) median concentrations of hydrocarbons at Košetice (CZ03), Waldhof (DE02), Donon (FR08), Peyrusse Vieille (FR13), Utö (FI09) and Pallas (FI96). Black symbols mark analyses from NILU's lab., coloured symbols mark the national lab.

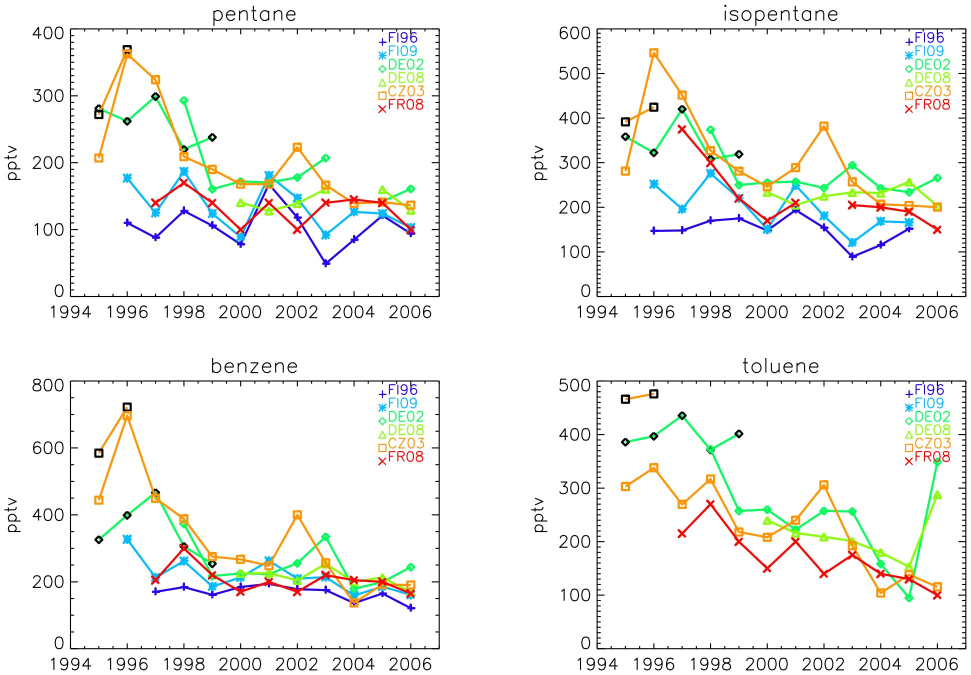

Figure 17, cont.

While the trend in absolute concentrations could be more difficult to interpret due to the large natural variability and the changing influence from large scale meteorology and dispersion, the individual components tend to fluctuate in parallel. Various studies have looked at concentrations relative to acetylene, as this component is regarded to be 100% anthropogenic origin, mainly stemming from combustion processes and thus a tracer of road and ship transport.

The results for three stations Utö (FI09), Donon (FR08) and Košetice (CZ03) are given in Table 5. The Table shows the long term trend of the concentration ratios based on winter-time data (Oct.-March) for the years 1998-2006 together with the linear correlation coefficients (r^2) for the same concentration pair. The trend was calculated from a robust linear regression, less sensitive to outliers and the slope was divided by the median concentration to obtain the "% $year^{-1}$" value shown in Table 5.

The results show a similarity between data from Donon and Košetice while the data from Utö differs somewhat. Ethene is found to increase significantly relative to acetylene at both Donon and Košetice at the same time as a very good correlation is found. The reason for this increase is yet unclear. One reason could be changes in the general emission from road traffic e.g. connected to a larger fleet of diesel powered vehicles, but more investigations are needed to look at this. Then, an considerable increase in ethane and propane relative to acetylene is found at all three sites, possibly indicating that the emissions of road traffic are dropping faster than the emissions of natural gas (source of the lightest alkanes). Furthermore, the largest downward trend vs. acetylene is found for toluene and also benzene at Donon and Košetice.

Table 5. The long-term trend (1998-2006) in the concentration ratio between individual hydrocarbons and acetylene. The square of the linear correlation coefficients (component vs. acetylene) are also given. Only data from winter (October-March) were used.

	Utö		Donon		Košetice	
	trend (% year^{-1})	r^2	trend (% year^{-1})	r^2	trend (% year^{-1})	r^2
Ethane	+5.56	0.58	+1.40	0.64	+4.09	0.61
Ethene	-0.29	0.71	+4.38	0.77	+1.75	0.82
Propane	+1.49	0.62	+1.75	0.69	+2.41	0.63
Propene	+5.35	0.31	+0.31	0.53	-1.18	0.47
n-butane	-2.22	0.46	-0.35	0.46	+0.68	0.61
i-butane	+0.53	0.52	+1.28	0.25	+2.33	0.44
n-pentane	+3.69	0.52	+2.15	0.66	-0.31	0.56
i-pentane	+2.50	0.54	-2.46	0.28	-1.64	0.54
benzene	+2.20	0.62	-2.07	0.94	-3.67	0.74
toluene	n.m.	n.m.	-4.56	0.71	-7.46	0.47

5. Acknowledgement

We would like to thank all people involved in the sampling and handling of hydrocarbon canisters and DNPH tubes. We are very grateful for the VOC measurement data provided by Patrice Coddeville (EMD), Hannele Hakola (FMI), Radek Pokorny (CHMI), Marta Mitosinkova (SHMI), Alberto Gonzalez Ortiz (MMA), Karin Uhse (UBA), Christian Plass-Dülmer (DWD) and Stefan Reimann (EMPA).

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Appendix A

Monthly mean and median concentrations of hydrocarbons and carbonyls in 2006

Monthly mean and median concentrations (first and second line, respectively) of hydrocarbons (pptv)

ETHANE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Pallas	2591	3032	2191	1938	1163	912	629	751	847	942	1211	1756
	2516	2356	2103	1944	1123	830	621	739	834	923	1210	1801
Utö	2966	2947	2433	1988	1366	969	716	845	923	1034	1340	1744
	3046	2437	2313	1960	1243	916	724	825	947	1038	1327	1807
Zingst	3394	3072	2930	-	-	1034	800	876	1477	1296	1307	2123
	2777	3176	2699	-	-	1021	733	816	1220	1240	1231	1805
Neuglobsow	4153	2766	3154	-	-	1095	802	893	1255	2203	1463	1768
	4223	2619	2879	-	-	1113	727	853	1124	2046	1218	1727
Waldhof	3920	-	2490	-	-	1181	798	991	1312	1315	1531	2148
	3873	-	2264	-	-	1159	727	942	967	1245	1553	1845
Schmücke	2490	2354	2430	-	-	1051	713	826	996	1122	1352	2105
	2528	2378	2476	-	-	1000	719	849	794	1076	1412	2046
Schauinsland	2200	2408	2399	-	-	1091	852	769	992	1836	1267	1597
	2248	2336	2415	-	-	1074	892	726	955	1074	1302	1571
Hohenpeissenberg	2167	2487	2360	1764	1427	1001	748	723	899	1063	1317	1617
	1974	2309	2280	1662	1368	900	704	706	865	950	1338	1597
Starina	3012	3564	3060	2015	1559	1085	952	916	1273	1395	3144	3046
	2995	3534	2967	1910	1429	1120	820	856	1093	1464	2931	3102
Košetice	2891	2864	2625	2333	1615	1084	944	813	1307	1583	1687	2166
	3214	2676	2550	2004	1643	1042	791	768	1548	1330	1796	2116
Rigi	2698	2948	2556	2024	1362	1378	983	902	1241	1405	1457	1554
	2533	2520	2285	1915	1361	1382	980	886	1174	1357	1426	1578
La Tardière	2886	2818	2227	1809	1336	1141	727	599	730	1169	1403	2309
	2750	2670	2170	1635	1320	1120	790	645	765	1050	1360	2245
Donon	3033	2728	2173	2019	1319	1393	881	848	967	1229	1481	1900
	2930	2305	2220	1970	1380	1310	820	750	860	1070	1450	1860
Peyrusse Vieille	-	2583	1648	1578	-	1069	708	676	779	1086	1489	2075
	-	2570	1820	1635	-	1025	660	680	770	1080	1465	2025

ETHENE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Pallas	399	611	120	123	55	47	65	194	84	79	262	231
	284	619	103	118	52	39	67	164	88	70	242	199
Utö	644	810	463	311	192	125	106	169	158	199	292	430
	484	563	423	268	98	94	119	143	137	151	252	272
Zingst	2019	1398	834	-	-	202	233	205	230	615	532	798
	1067	1470	635	-	-	194	203	169	221	450	529	358
Neuglobsow	3406	1328	1293	-	-	263	235	264	365	990	537	476
	2381	1120	1014	-	-	247	232	264	316	814	428	441
Waldhof	2756	-	642	-	-	298	234	250	333	555	752	847
	2440	-	560	-	-	269	254	239	315	511	635	571
Schmücke	1393	980	839	-	-	225	135	197	152	387	554	877
	1055	848	770	-	-	193	128	197	167	288	575	721
Schauinsland	799	1072	605	-	-	330	245	211	305	431	392	248
	684	906	707	-	-	323	223	200	293	402	314	236
Hohenpeissenberg	949	1194	575	315	199	192	174	136	270	409	536	744
	650	724	371	279	156	158	161	121	259	300	397	623
Starina	1333	1406	819	401	205	212	153	301	213	415	1948	1897
	953	1349	867	413	142	203	152	317	130	398	1207	1590
Košetice	2500	2147	992	485	406	243	155	254	288	527	862	1217
	2319	1633	639	368	275	181	141	141	284	679	882	1085
Rigi	826	1535	521	268	136	336	262	208	305	520	491	652
	440	858	289	195	112	298	239	187	261	398	349	384
La Tardière	1796	1400	582	443	313	316	327	244	421	586	639	1773
	1710	1360	470	430	330	300	260	250	335	560	670	1745
Donon	2274	1446	659	648	368	493	451	378	477	591	808	936
	2340	730	520	595	365	485	400	370	440	400	540	810
Peyrusse Vieille	-	885	374	273	-	410	295	289	324	523	588	996
	-	800	310	245	-	445	310	270	340	465	600	955

PROPANE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Pallas	1168	1749	891	472	211	127	65	180	295	349	535	851
	1093	1865	796	484	210	104	60	191	287	344	535	875
Utö	1333	1499	1145	636	344	173	133	245	296	351	553	784
	1371	1275	1130	562	284	131	112	269	266	334	536	767
Zingst	1787	1559	1315	-	-	255	249	311	526	654	706	1094
	1590	1876	1279	-	-	257	247	299	615	555	693	920
Neuglobsow	2196	1361	1439	-	-	319	399	352	559	1048	731	890
	2166	1158	1427	-	-	319	306	320	517	1028	690	818
Waldhof	2124	-	1068	-	-	321	267	428	705	665	729	1109
	2262	-	853	-	-	320	249	381	523	604	705	915
Schmücke	1146	1026	1086	-	-	367	346	369	441	514	650	1065
	1103	1042	1015	-	-	346	243	351	394	515	727	942
Schauinsland	943	1021	923	-	-	284	292	239	392	540	496	672
	973	899	993	-	-	225	271	235	369	373	488	636
Hohenpeissenberg	979	1132	945	501	320	251	230	191	349	421	517	702
	917	1037	922	408	265	239	229	170	304	372	517	708
Starina	1551	1754	1410	763	476	325	343	365	513	816	1446	1531
	1523	1779	1333	704	375	313	287	341	440	507	1464	1492
Košetice	1532	1199	1049	687	429	236	253	222	456	590	716	944
	1399	1189	1109	596	377	226	173	207	537	467	751	989
Rigi	842	1104	759	438	280	326	283	232	582	596	572	583
	758	870	666	357	247	308	261	219	527	520	527	617
La Tardière	1604	1334	872	555	269	300	241	136	271	493	614	1229
	1390	1170	890	455	280	310	220	120	290	450	620	1245
Donon	1500	1254	883	705	314	393	300	221	377	450	588	845
	1330	995	970	685	310	350	310	210	330	370	560	775
Peyrusse Vieille	-	1191	702	438	-	301	211	186	279	438	629	1029
	-	1190	630	435	-	305	180	190	300	445	630	1005

PROPENE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Pallas	38	50	19	22	18	24	24	51	24	20	31	24
	30	47	17	21	20	18	23	49	25	18	30	19
Utö	78	75	53	46	38	41	32	45	33	46	49	68
	63	56	45	34	34	33	29	40	26	51	48	57
Zingst	474	467	142	-	-	94	109	176	153	210	236	293
	489	445	144	-	-	91	103	177	131	189	223	225
Neuglobsow	650	307	236	-	-	115	147	171	168	345	245	205
	697	277	217	-	-	110	134	184	161	336	246	188
Waldhof	583	-	147	-	-	113	100	149	161	213	259	264
	472	-	142	-	-	101	99	142	139	214	226	196
Schmücke	274	335	176	-	-	91	84	150	128	175	231	235
	233	206	170	-	-	85	79	153	122	163	209	207
Schauinsland	257	358	138	-	-	131	115	185	178	234	217	155
	228	239	130	-	-	141	113	176	174	225	202	143
Hohenpeissenberg	72	98	42	40	25	24	18	20	29	46	79	100
	31	47	25	30	20	21	14	17	21	33	55	74
Starina	188	156	97	65	47	54	50	79	38	90	301	304
	97	161	99	66	30	41	48	78	24	74	178	237
Košetice	350	223	107	64	30	42	31	58	36	56	121	178
	336	164	75	49	32	34	30	21	38	69	113	176
Rigi	121	264	92	71	76	63	49	45	59	84	96	108
	82	167	69	56	72	59	45	40	47	65	70	78
La Tardière	278	223	86	85	76	91	108	74	129	121	140	299
	280	170	70	80	70	100	100	80	100	110	125	340
Donon	293	194	94	121	78	180	127	100	101	113	137	141
	230	95	90	105	60	110	130	110	100	80	100	120
Peyrusse Vieille	-	84	68	55	-	120	120	86	83	86	105	129
	-	80	60	55	-	120	130	80	70	50	90	105

ETHYNE (ACETYLENE)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Pallas	506	1124	429	380	197	107	65	107	114	152	328	379
	440	1326	439	365	181	94	65	108	101	142	314	337
Utö	798	1103	831	564	339	171	94	142	161	218	282	471
	724	959	820	463	221	149	93	130	104	161	247	401
Zingst	1706	1466	1571	-	-	630	537	726	733	1176	1108	1431
	1236	1655	1317	-	-	653	523	720	680	1151	1025	1388
Neuglobsow	2150	1454	1767	-	-	593	541	697	688	1205	1049	1160
	1891	1468	1370	-	-	588	534	707	673	1027	1008	1166
Waldhof	2157	-	1182	-	-	618	574	721	672	951	1288	1155
	2014	-	982	-	-	601	574	756	677	781	1157	1164
Schmücke	1402	1412	1264	-	-	607	566	727	674	843	1268	1531
	1152	1306	1268	-	-	629	564	710	650	840	1253	1404
Schauinsland	997	1288	1257	-	-	668	609	719	679	808	1071	1119
	878	1280	1277	-	-	626	611	725	683	809	1048	1095
Hohenpeissenberg	918	1150	898	413	289	190	176	139	280	379	435	578
	721	916	705	383	240	167	158	123	253	285	363	535
Starina	2085	2477	1579	784	382	305	166	147	164	355	1342	1350
	1824	2365	1576	824	308	219	178	119	182	319	827	1300
Košetice	2638	2474	1353	704	431	252	206	228	429	671	809	1063
	2383	2189	1200	550	388	240	189	174	447	683	723	926
Rigi	1143	1814	1114	522	408	550	486	304	554	746	645	506
	727	1249	590	490	358	479	480	270	474	604	549	415
La Tardière	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Donon	1508	1030	641	433	264	208	171	140	259	322	411	571
	1520	670	550	425	275	190	190	150	240	210	310	525
Peyrusse Vieille	-	871	384	468	-	140	110	223	170	278	316	723
	-	870	370	345	-	145	120	110	150	245	315	600

BUTANE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Pallas	392	580	304	217	65	44	13	47	86	100	170	275
	340	573	237	166	50	26	10	50	88	96	168	252
Utö	442	461	378	183	101	43	39	72	138	108	173	256
	435	376	424	146	108	32	29	72	123	105	170	273
Zingst	683	670	510	-	-	87	98	114	181	267	316	461
	552	659	479	-	-	74	91	122	211	217	273	347
Neuglobsow	863	543	565	-	-	99	118	126	217	497	297	336
	946	521	595	-	-	102	85	110	208	471	264	320
Waldhof	817	-	402	-	-	109	104	167	248	284	323	444
	792	-	326	-	-	105	108	168	205	270	302	391
Schmücke	447	428	429	-	-	110	85	143	136	170	265	428
	418	436	468	-	-	106	83	121	128	179	249	379
Schauinsland	360	405	322	-	-	115	161	103	166	218	178	235
	315	365	363	-	-	85	127	93	126	126	157	238
Hohenpeissenberg	372	458	324	158	99	92	84	76	144	179	219	266
	349	407	327	136	85	79	75	70	117	134	192	264
Starina	602	656	486	270	192	123	147	177	220	278	580	609
	607	663	478	226	177	118	141	152	209	218	574	573
Košetice	565	434	345	205	108	80	80	85	182	222	273	366
	552	425	373	194	97	75	64	72	200	171	257	389
Rigi	468	630	350	216	138	158	138	97	232	285	248	418
	410	446	290	201	113	154	128	83	190	238	209	256
La Tardière	733	489	298	179	100	130	109	66	125	236	255	496
	660	445	350	180	70	110	100	65	135	230	230	555
Donon	733	583	343	258	119	140	147	90	187	200	251	340
	720	370	330	220	100	130	150	90	150	120	210	305
Peyrusse Vieille	-	396	216	113	-	103	76	64	104	138	226	358
	-	375	180	110	-	100	75	60	110	135	225	325

ISOBUTANE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Pallas	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Utö	307	369	246	119	68	29	27	57	68	72	143	166
	301	289	274	96	52	24	19	47	62	76	99	177
Zingst	396	367	293	-	-	41	50	64	98	163	161	263
	425	353	309	-	-	41	43	68	82	124	149	190
Neuglobsow	509	317	357	-	-	78	72	85	147	431	201	191
	611	300	346	-	-	70	44	67	143	408	155	189
Waldhof	452	-	226	-	-	63	58	104	177	171	191	238
	444	-	161	-	-	55	52	85	160	145	160	216
Schmücke	265	245	249	-	-	55	47	87	82	94	155	238
	271	258	262	-	-	52	42	75	85	100	135	212
Schauinsland	202	219	188	-	-	61	79	51	94	223	107	152
	179	204	204	-	-	44	61	52	72	73	85	131
Hohenpeissenberg	214	259	195	94	63	60	62	47	97	119	136	159
	186	235	194	83	50	53	57	43	77	90	118	146
Starina	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Košetice	383	267	221	139	71	54	56	56	123	150	189	222
	353	268	218	122	60	50	50	48	129	124	175	241
Rigi	267	373	211	122	74	83	79	64	105	177	150	204
	229	263	167	112	62	78	73	60	102	143	123	150
La Tardière	318	268	166	438	38	53	44	25	99	123	126	233
	305	230	170	120	30	50	30	25	70	90	130	260
Donon	527	429	230	176	78	95	100	59	154	154	159	201
	510	220	180	125	45	85	110	60	90	80	110	200
Peyrusse Vieille	-	220	122	158	-	61	35	32	150	80	120	451
	-	215	110	80	-	60	35	30	60	70	115	175

BUTENES

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Pallas	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Utö	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Zingst	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Neuglobsow	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Waldhof	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Schmücke	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Schauinsland	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Hohenpeissenberg	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Starina	63	64	54	42	39	32	32	44	40	40	80	63
	59	65	54	43	38	33	32	44	38	38	79	59
Košetice	119	82	58	45	42	37	27	37	45	36	48	71
	94	72	53	37	32	36	26	24	33	34	49	73
Rigi	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
La Tardière	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Donon	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Peyrusse Vieille	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-

BUT_1_ENE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Pallas	8	11	4	13	5	5	6	11	6	5	5	5
	7	10	3	7	5	3	6	11	7	4	5	5
Utö	11	12	10	10	9	9	7	11	7	7	10	13
	7	10	8	9	8	7	7	10	6	6	10	11
Zingst	48	-	-	-	-	-	-	-	-	-	-	-
	38	-	-	-	-	-	-	-	-	-	-	-
Neuglobsow	63	-	-	-	-	-	-	-	-	-	-	-
	65	-	-	-	-	-	-	-	-	-	-	-
Waldhof	55	-	-	-	-	-	-	-	-	-	-	-
	56	-	-	-	-	-	-	-	-	-	-	-
Schmücke	38	-	-	-	-	-	-	-	-	-	-	-
	40	-	-	-	-	-	-	-	-	-	-	-
Schauinsland	33	-	-	-	-	-	-	-	-	-	-	-
	27	-	-	-	-	-	-	-	-	-	-	-
Hohenpeissenberg	15	19	11	10	8	7	7	7	8	12	18	20
	11	10	9	9	7	6	7	6	8	10	13	16
Starina	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Košetice	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Rigi	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
La Tardière	48	43	21	23	23	26	30	26	56	31	34	56
	50	40	20	20	20	30	30	25	30	30	30	55
Donon	47	33	23	29	21	33	36	31	30	30	32	29
	40	20	20	30	20	35	40	30	30	30	30	30
Peyrusse Vieille	-	17	15	14	-	33	31	23	20	23	19	26
	-	20	10	15	-	30	30	20	20	20	20	25

TRANS_2_BUTENE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Pallas	7	5	5	14	8	5	3	9	6	3	4	5
	5	3	3	4	8	3	3	10	6	3	3	3
Utö	16	3	3	5	7	3	5	3	4	3	4	5
	17	3	3	3	6	3	5	3	3	3	3	3
Zingst	6	-	-	-	-	-	-	-	-	-	-	-
	6	-	-	-	-	-	-	-	-	-	-	-
Neuglobsow	8	-	-	-	-	-	-	-	-	-	-	-
	7	-	-	-	-	-	-	-	-	-	-	-
Waldhof	5	-	-	-	-	-	-	-	-	-	-	-
	6	-	-	-	-	-	-	-	-	-	-	-
Schmücke	8	-	-	-	-	-	-	-	-	-	-	-
	7	-	-	-	-	-	-	-	-	-	-	-
Schauinsland	8	-	-	-	-	-	-	-	-	-	-	-
	7	-	-	-	-	-	-	-	-	-	-	-
Hohenpeissenberg	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Starina	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Košetice	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Rigi	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
La Tardière	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Donon	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Peyrusse Vieille	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-

CIS_2_BUTENE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Pallas	3	5	4	8	3	3	3	3	3	3	3	3
	3	3	3	3	3	3	3	3	3	3	3	3
Utö	6	3	3	3	3	4	3	3	3	3	3	3
	3	3	3	3	3	3	3	3	3	3	3	3
Zingst	6	-	-	-	-	-	-	-	-	-	-	-
	6	-	-	-	-	-	-	-	-	-	-	-
Neuglobsow	8	-	-	-	-	-	-	-	-	-	-	-
	7	-	-	-	-	-	-	-	-	-	-	-
Waldhof	7	-	-	-	-	-	-	-	-	-	-	-
	7	-	-	-	-	-	-	-	-	-	-	-
Schmücke	7	-	-	-	-	-	-	-	-	-	-	-
	5	-	-	-	-	-	-	-	-	-	-	-
Schauinsland	7	-	-	-	-	-	-	-	-	-	-	-
	5	-	-	-	-	-	-	-	-	-	-	-
Hohenpeissenberg	6	7	6	5	4	3	4	3	4	5	6	6
	5	5	6	4	4	3	4	3	4	4	4	6
Starina	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Košetice	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Rigi	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
La Tardière	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Donon	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Peyrusse Vieille	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-

PENTANE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Pallas	114	205	93	59	16	15	8	26	34	38	67	100
	98	188	81	67	18	10	10	25	35	36	68	88
Utö	156	229	159	76	41	22	19	43	62	50	65	93
	133	170	156	58	33	15	10	42	42	34	63	100
Zingst	177	198	158	-	-	33	48	43	69	123	146	168
	163	192	138	-	-	24	30	47	77	90	159	122
Neuglobsow	223	164	173	-	-	41	42	61	106	302	125	122
	240	176	180	-	-	44	30	53	102	280	102	131
Waldhof	246	-	128	-	-	58	53	94	125	146	152	183
	242	-	103	-	-	50	55	74	119	160	137	151
Schmücke	142	128	140	-	-	66	50	66	84	91	106	162
	121	139	153	-	-	54	46	64	87	91	101	160
Schauinsland	85	113	94	-	-	55	85	45	81	192	85	61
	73	99	103	-	-	32	63	38	80	49	48	60
Hohenpeissenberg	116	145	100	62	46	65	60	41	98	103	100	98
	101	123	92	49	33	48	46	34	76	73	67	80
Starina	268	247	172	118	151	70	82	113	113	150	215	287
	278	237	167	106	76	46	71	95	109	142	216	264
Košetice	212	144	119	72	54	50	45	46	92	112	118	138
	183	140	115	61	47	41	41	38	88	97	112	136
Rigi	162	310	157	117	79	131	126	73	217	231	160	114
	125	185	101	89	59	102	99	48	135	148	93	102
La Tardière	251	170	120	171	137	167	228	119	173	223	138	260
	180	150	140	125	140	180	240	110	170	220	130	255
Donon	223	165	94	104	64	75	76	38	83	92	94	130
	160	115	90	70	45	70	80	40	80	80	70	100
Peyrusse Vieille	-	108	108	48	-	56	41	36	49	46	60	173
	-	100	50	50	-	60	40	30	40	45	65	100

ISOPENTANE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Pallas	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Utö	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Zingst	267	291	206	-	-	57	67	109	138	213	244	242
	270	279	179	-	-	40	67	105	149	179	229	185
Neuglobsow	357	244	235	-	-	88	102	147	186	402	194	206
	324	268	239	-	-	83	97	114	186	467	151	194
Waldhof	331	-	172	-	-	86	87	143	181	234	216	238
	318	-	169	-	-	100	87	132	162	230	205	196
Schmücke	203	191	186	-	-	103	87	124	150	191	187	256
	201	209	203	-	-	102	76	130	151	174	167	227
Schauinsland	144	170	141	-	-	77	145	125	186	127	150	130
	124	139	161	-	-	65	118	100	182	104	109	126
Hohenpeissenberg	189	260	170	112	98	115	122	91	188	193	160	160
	162	198	165	97	81	101	108	77	163	160	129	144
Starina	318	311	238	157	191	110	125	305	225	264	544	504
	340	312	241	136	174	74	142	304	216	234	410	374
Košetice	296	209	156	106	71	65	70	80	153	148	161	201
	289	200	147	92	81	62	64	67	136	152	159	191
Rigi	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
La Tardière	423	270	162	165	94	119	138	86	180	254	195	328
	350	225	180	150	90	100	140	90	190	240	165	345
Donon	340	230	149	150	94	98	130	84	154	130	140	173
	290	155	120	100	65	95	130	90	160	90	110	155
Peyrusse Vieille	-	204	218	108	-	76	63	66	116	93	119	231
	-	215	90	95	-	75	60	60	90	105	135	175

HEXANE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Pallas	40	69	25	14	4	4	3	6	10	11	20	30
	34	60	21	15	3	3	3	7	9	11	19	26
Utö	52	78	47	19	12	6	5	17	10	13	22	35
	38	55	42	13	8	7	3	15	9	10	19	32
Zingst	78	103	84	-	-	40	39	38	110	76	113	102
	65	74	69	-	-	30	39	36	48	72	73	72
Neuglobsow	92	95	102	-	-	41	54	78	53	128	74	95
	90	99	106	-	-	42	48	45	56	131	69	73
Waldhof	94	-	75	-	-	58	37	59	117	73	73	95
	91	-	63	-	-	62	41	54	55	74	76	87
Schmücke	53	76	76	-	-	49	40	95	47	90	105	96
	48	85	79	-	-	46	43	54	49	74	83	86
Schauinsland	35	63	61	-	-	49	68	49	56	146	56	89
	31	64	68	-	-	41	56	43	52	43	44	55
Hohenpeissenberg	30	37	25	13	10	11	11	9	18	19	19	23
	27	30	22	11	8	9	9	8	16	15	16	21
Starina	188	117	71	90	63	43	59	76	53	66	109	138
	198	96	72	85	37	23	38	51	43	53	113	118
Košetice	68	46	28	22	16	13	11	14	22	26	28	42
	61	39	22	19	13	11	9	10	22	19	27	45
Rigi	47	68	32	22	21	33	29	22	46	44	35	30
	39	44	25	18	18	31	27	19	40	39	29	30
La Tardière	79	54	25	23	24	38	26	16	35	39	31	61
	70	40	30	20	20	40	30	20	30	30	35	60
Donon	80	63	34	61	36	33	34	33	43	30	40	43
	60	45	30	40	30	30	30	30	30	25	30	40
Peyrusse Vieille	-	40	21	23	-	49	39	29	31	34	24	44
	-	30	20	20	-	40	35	30	20	35	20	40

ISOPRENE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Pallas	7	4	5	4	10	19	54	50	16	4	4	4
	4	4	4	4	4	20	45	48	13	4	4	4
Utö	4	4	12	4	14	12	28	42	8	4	6	7
	4	4	4	4	4	4	19	32	4	4	4	4
Zingst	33	12	5	-	-	107	515	283	147	33	13	6
	18	12	4	-	-	34	539	240	184	26	7	4
Neuglobsow	20	10	8	-	-	130	411	150	163	51	11	11
	21	6	5	-	-	121	364	107	152	40	8	8
Waldhof	11	-	6	-	-	40	115	52	80	39	8	8
	7	-	6	-	-	28	109	50	57	30	8	8
Schmücke	13	7	5	-	-	59	69	28	27	13	6	6
	10	6	5	-	-	40	60	27	27	13	5	5
Schauinsland	123	20	5	-	-	99	200	56	102	32	16	6
	37	15	4	-	-	66	141	56	102	30	15	7
Hohenpeissenberg	4	4	3	8	23	73	124	18	43	18	8	6
	4	3	2	4	12	17	46	10	15	10	4	5
Starina	13	9	10	14	30	222	558	140	145	25	25	18
	9	9	9	9	23	46	403	67	150	19	25	15
Košetice	9	6	5	32	35	83	122	51	53	15	10	10
	4	4	4	11	22	66	119	35	44	11	9	4
Rigi	15	20	13	13	37	107	195	57	86	48	27	14
	15	21	11	12	23	37	126	31	35	35	19	12
La Tardière	10	9	9	8	63	340	718	316	306	69	10	12
	10	5	5	5	50	300	740	345	300	70	8	10
Donon	46	29	24	64	176	1130	2610	599	707	313	76	58
	20	30	10	60	155	750	2570	440	560	210	60	35
Peyrusse Vieille	-	5	38	58	-	1158	2019	741	589	278	42	10
	-	5	10	50	-	965	1900	780	290	295	35	5

BENZENE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Pallas	181	348	144	118	52	27	14	53	37	41	97	114
	137	433	150	120	56	27	14	42	33	39	93	100
Utö	297	335	242	152	93	41	38	65	69	62	97	143
	250	279	212	132	67	36	38	52	57	49	85	136
Zingst	311	377	377	-	-	56	54	66	97	167	122	184
	301	419	289	-	-	57	56	63	95	104	115	133
Neuglobsow	526	377	456	-	-	59	60	68	110	235	121	143
	448	350	309	-	-	56	53	68	103	195	125	139
Waldhof	532	-	249	-	-	64	54	76	103	168	159	190
	491	-	188	-	-	62	53	75	105	116	148	171
Schmücke	360	315	262	-	-	69	52	69	83	107	131	207
	267	326	260	-	-	63	50	68	66	83	131	185
Schauinsland	224	302	261	-	-	68	72	66	85	112	121	114
	206	276	254	-	-	56	64	71	79	83	108	117
Hohenpeissenberg	267	340	273	143	101	73	66	58	94	116	121	169
	212	281	229	132	88	68	61	53	86	92	102	156
Starina	670	660	403	296	130	112	128	140	172	212	607	645
	682	608	414	282	120	89	118	139	127	199	423	624
Košetice	402	374	206	163	88	50	47	51	83	116	128	204
	392	293	176	154	73	46	39	41	90	111	122	168
Rigi	354	548	317	184	112	123	89	72	128	155	149	167
	238	396	246	179	100	118	85	67	115	126	125	141
La Tardière	328	279	176	96	52	56	46	34	54	97	111	261
	300	265	150	80	50	50	40	35	50	90	110	255
Donon	438	295	174	116	59	55	50	50	70	91	118	170
	430	180	150	120	55	50	50	40	70	60	90	160
Peyrusse Vieille	-	231	100	65	-	46	26	30	49	69	98	190
	-	225	100	60	-	50	30	30	40	65	95	165

TOLUENE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Pallas	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Utö	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Zingst	190	348	252	-	-	251	454	291	424	461	347	321
	147	253	252	-	-	175	311	332	428	439	335	293
Neuglobsow	340	294	279	-	-	282	353	396	379	606	348	380
	261	276	269	-	-	292	300	331	342	610	341	400
Waldhof	290	-	227	-	-	455	394	485	422	508	424	412
	285	-	203	-	-	452	209	560	369	446	390	391
Schmücke	157	288	237	-	-	430	294	304	377	274	329	355
	98	292	213	-	-	404	225	325	334	225	290	353
Schauinsland	121	302	207	-	-	166	555	290	624	483	561	286
	101	348	207	-	-	170	643	256	572	516	621	235
Hohenpeissenberg	144	227	132	81	68	64	62	60	119	136	132	132
	104	165	111	71	56	57	54	52	103	112	98	115
Starina	139	54	21	83	42	31	43	28	31	30	23	42
	142	25	22	75	18	15	21	18	17	23	18	33
Košetice	179	150	82	67	30	28	23	42	72	75	87	114
	178	134	62	54	33	26	19	24	49	64	78	96
Rigi	217	395	234	165	192	144	150	122	287	356	227	174
	130	229	150	130	156	134	128	91	263	296	163	133
La Tardière	452	265	130	88	69	93	114	61	191	367	166	335
	450	205	100	90	70	70	100	65	140	340	120	310
Donon	276	183	94	104	51	55	66	60	100	92	103	116
	280	90	70	80	35	55	70	60	80	70	60	90
Peyrusse Vieille	-	146	68	58	-	79	51	42	120	68	96	200
	-	160	50	60	-	70	45	40	90	60	110	145

ETHYLBENZENE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Pallas	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Utö	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Zingst	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Neuglobsow	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Waldhof	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Schmücke	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Schauinsland	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Hohenpeissenberg	23	38	22	14	11	10	10	10	19	22	23	22
	16	25	20	11	9	8	8	8	17	18	19	19
Starina	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Košetice	33	33	15	15	6	9	12	10	11	14	16	18
	29	31	13	9	5	6	7	6	10	12	15	17
Rigi	29	55	27	34	46	42	20	18	38	46	36	28
	21	29	16	31	45	49	17	15	29	38	25	23
La Tardière	62	42	29	31	28	31	41	24	49	91	36	51
	60	40	20	30	30	30	40	20	35	60	30	55
Donon	49	31	19	28	23	15	23	18	23	19	20	23
	50	10	10	25	20	15	20	20	20	20	20	20
Peyrusse Vieille	-	19	10	10	-	29	30	20	30	19	23	34
	-	20	10	8	-	25	30	20	20	20	20	30

m+p-XYLENE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Pallas	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Utö	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Zingst	-	104	34	-	-	65	22	17	35	44	50	56
	-	118	31	-	-	50	21	16	30	35	53	39
Neuglobsow	-	65	52	-	-	41	29	28	31	131	52	52
	-	46	53	-	-	25	20	23	28	112	33	42
Waldhof	-	-	43	-	-	33	17	29	49	60	67	59
	-	-	21	-	-	37	14	23	33	51	74	44
Schmücke	-	73	59	-	-	33	23	26	28	42	48	72
	-	58	60	-	-	31	21	27	24	42	50	74
Schauinsland	-	56	38	-	-	57	35	28	-	30	42	30
	-	51	33	-	-	58	36	16	-	26	30	27
Hohenpeissenberg	49	83	42	29	25	22	20	21	39	49	60	57
	38	55	35	21	18	14	14	18	31	36	40	39
Starina	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Košetice	66	57	31	36	16	18	36	29	17	31	35	42
	52	32	25	27	12	11	8	17	15	26	34	40
Rigi	64	129	72	114	73	79	40	36	78	98	94	74
	42	52	31	105	63	71	32	29	54	74	60	59
La Tardière	174	104	76	104	111	108	134	76	166	300	121	160
	150	105	70	125	120	100	130	80	140	190	110	160
Donon	112	64	34	69	51	53	53	47	51	42	59	61
	80	35	30	60	50	50	50	50	40	40	40	55
Peyrusse Vieille	-	31	26	29	-	91	84	69	77	45	68	84
	-	35	20	20	-	90	75	70	50	45	55	65

o-XYLENE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Pallas	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Utö	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Zingst	-	42	15	-	-	11	7	11	15	21	22	23
	-	44	14	-	-	8	7	10	13	21	23	17
Neuglobsow	-	28	22	-	-	11	9	21	16	43	27	25
	-	22	21	-	-	9	9	17	15	50	17	21
Waldhof	-	-	17	-	-	10	10	14	14	30	31	25
	-	-	14	-	-	9	9	13	13	27	26	19
Schmücke	-	28	22	-	-	12	14	17	14	18	20	29
	-	20	22	-	-	12	13	16	13	17	22	25
Schauinsland	-	27	15	-	-	13	18	15	-	16	18	13
	-	20	13	-	-	11	18	12	-	14	13	12
Hohenpeissenberg	19	31	16	11	10	9	9	9	18	21	22	22
	15	20	13	9	9	8	8	8	16	16	14	19
Starina	404	317	196	234	137	146	171	199	167	211	388	469
	473	302	188	226	141	105	143	193	160	166	304	389
Košetice	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Rigi	27	54	35	39	-	23	21	18	47	45	38	32
	19	26	28	34	-	22	18	14	37	38	24	26
La Tardière	58	29	18	18	17	15	17	10	33	64	28	48
	50	30	10	20	20	10	20	10	25	50	25	45
Donon	39	24	12	21	8	8	5	5	12	11	16	19
	30	8	5	15	8	8	5	5	10	5	5	15
Peyrusse Vieille	-	9	-	24	-	25	8	8	21	6	16	24
	-	10	-	25	-	20	10	5	10	5	10	20

Monthly mean and median concentrations (first and second line, respectively) of carbonyls (μg m^{-3})

METHANAL (FORMALDEHYDE)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
La Tardière	1.796	-	-	1.285	1.084	-	-	1.120	1.840	1.024	1.001	0.676
	1.742	-	-	1.207	1.157	-	-	0.880	1.701	0.905	0.648	0.737
Donon	1.207	0.884	1.139	0.971	0.943	2.119	3.746	0.638	1.649	1.145	0.795	0.542
	0.960	0.932	1.164	1.112	0.892	1.691	4.242	0.718	1.627	1.492	0.741	0.490
Peyrusse Vieille	1.538	1.063	1.304	0.925	1.520	-	-	1.314	-	1.099	0.985	0.793
	1.812	1.106	0.977	0.912	1.491	-	-	1.209	-	1.234	0.977	0.773
Campisábalos	-	-	-	-	-	-	-	0.866	1.247	0.635	0.788	0.152
	-	-	-	-	-	-	-	0.670	1.430	0.590	0.500	0.130

ETHANAL (ACETALDEHYDE)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
La Tardière	1.534	-	-	0.895	0.856	-	-	0.675	0.826	0.836	0.821	0.624
	1.243	-	-	0.841	0.850	-	-	0.664	0.748	0.843	0.622	0.621
Donon	1.311	0.780	0.922	0.664	0.682	0.863	1.471	0.566	0.675	0.806	0.501	0.468
	1.104	0.739	0.988	0.643	0.756	0.830	1.473	0.597	0.592	0.785	0.446	0.429
Peyrusse Vieille	0.833	0.764	0.932	0.697	0.793	-	-	0.536	-	0.660	0.680	0.532
	0.895	0.742	0.711	0.708	0.656	-	-	0.480	-	0.770	0.682	0.524
Campisábalos	-	-	-	-	-	-	-	2.236	1.752	1.874	1.393	0.940
	-	-	-	-	-	-	-	2.290	1.905	1.940	1.580	0.900

PROPANONE (ACETONE)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
La Tardière	2.352	-	-	2.232	2.012	-	-	1.950	1.976	1.913	2.274	1.532
	2.047	-	-	2.151	1.600	-	-	1.898	1.655	1.721	2.303	1.120
Donon	2.045	1.153	1.902	1.944	2.186	3.682	5.424	1.760	2.293	2.202	1.691	0.952
	1.623	1.144	1.888	1.938	2.136	3.080	5.695	1.754	1.746	2.396	1.436	0.839
Peyrusse Vieille	2.678	1.445	1.751	2.146	1.969	-	-	1.998	-	1.829	1.539	1.219
	2.777	1.601	1.518	1.953	1.963	-	-	1.761	-	2.068	1.457	1.245
Campisábalos	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-

PROPANAL

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
La Tardière	0.253	-	-	0.152	0.155	-	-	0.091	0.114	0.121	0.129	0.120
	0.210	-	-	0.144	0.158	-	-	0.094	0.107	0.108	0.096	0.114
Donon	0.212	0.165	0.155	0.100	0.102	0.126	0.192	0.076	0.080	0.114	0.080	0.091
	0.144	0.166	0.165	0.097	0.107	0.121	0.189	0.073	0.070	0.125	0.071	0.096
Peyrusse Vieille	0.182	0.141	0.147	0.120	0.170	-	0.071	0.082	-	0.100	0.122	0.099
	0.212	0.144	0.129	0.120	0.127	-	0.033	0.088	-	0.114	0.116	0.094
Campisábalos	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-

2-PROPENAL (ACROLEIN)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
La Tardière	0.015	-	-	0.015	0.016	-	-	0.016	0.016	0.017	0.015	0.015
	0.015	-	-	0.016	0.016	-	-	0.017	0.016	0.016	0.015	0.015
Donon	0.015	0.015	0.015	0.016	0.016	0.022	0.039	0.016	0.015	0.016	0.015	0.016
	0.015	0.015	0.015	0.016	0.016	0.016	0.042	0.017	0.015	0.016	0.015	0.015
Peyrusse Vieille	0.015	0.015	0.015	0.016	0.016	-	0.028	0.016	-	0.016	0.015	0.016
	0.015	0.015	0.015	0.016	0.016	-	0.032	0.015	-	0.016	0.015	0.016
Campisábalos	0.216	0.045	0.106	0.045	0.053	0.066	0.028	0.088	0.045	0.037	0.024	0.023
	0.230	0.040	0.040	0.045	0.050	0.070	0.020	0.110	0.025	0.025	0.025	0.025

2-BUTANONE (METHYLETHYLKETONE)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
La Tardière	0.710	-	-	0.487	0.366	-	-	-	-	0.342	0.954	0.578
	0.589	-	-	0.474	0.309	-	-	-	-	0.382	0.620	0.314
Donon	0.602	0.397	0.546	0.427	0.415	-	0.387	0.192	-	0.400	0.239	0.201
	0.483	0.387	0.552	0.443	0.428	-	0.389	0.116	-	0.535	0.202	0.195
Peyrusse Vieille	0.462	0.392	0.464	0.406	0.464	-	-	-	-	0.287	0.302	0.292
	0.530	0.414	0.404	0.433	0.388	-	-	-	-	0.314	0.295	0.305
Campisábalos	1.678	0.480	0.514	0.305	0.232	0.265	0.395	0.708	0.505	1.021	1.213	1.005
	0.430	0.490	0.550	0.390	0.300	0.360	0.420	0.750	0.370	1.020	1.240	1.040

2-METHYLPROPENAL (METHACROLEIN)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
La Tardière	0.027	-	-	0.011	0.016	-	-	0.092	0.136	0.033	0.018	0.014
	0.019	-	-	0.012	0.012	-	-	0.098	0.137	0.012	0.012	0.012
Donon	0.021	0.011	0.017	0.024	0.066	0.474	0.884	0.102	0.295	0.091	0.073	0.012
	0.012	0.011	0.011	0.012	0.055	0.593	0.861	0.103	0.319	0.069	0.022	0.012
Peyrusse Vieille	0.024	0.011	0.017	0.012	0.129	-	0.281	0.269	-	0.092	0.032	0.012
	0.027	0.011	0.011	0.012	0.068	-	0.025	0.263	-	0.079	0.019	0.012
Campisábalos	0.302	0.049	-	-	-	-	-	-	-	-	-	-
	0.410	0.025	-	-	-	-	-	-	-	-	-	-

BENZENECARBALDEHYDE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
La Tardière	0.131	-	-	0.150	0.103	-	-	0.070	0.125	0.116	0.083	0.037
	0.160	-	-	0.104	0.095	-	-	0.063	0.128	0.055	0.089	0.038
Donon	0.058	0.037	0.044	0.016	0.028	0.040	0.055	0.020	0.033	0.034	0.015	0.016
	0.016	0.034	0.040	0.016	0.023	0.045	0.054	0.017	0.027	0.038	0.015	0.015
Peyrusse Vieille	0.051	0.020	0.028	0.036	0.040	-	0.039	0.033	-	0.033	0.019	0.016
	0.072	0.015	0.023	0.039	0.040	-	0.033	0.033	-	0.039	0.016	0.016
Campisábalos	0.154	0.033	0.086	0.101	0.184	0.155	0.277	0.834	0.570	0.514	0.296	0.113
	0.180	0.035	0.090	0.120	0.170	0.150	0.250	0.830	0.515	0.370	0.350	0.120

PENTANAL

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
La Tardière	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Donon	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Peyrusse Vieille	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Campisábalos	0.228	0.024	0.032	0.098	0.050	0.044	0.068	0.267	0.301	0.182	0.264	0.112
	0.240	0.025	0.030	0.035	0.040	0.030	0.060	0.270	0.225	0.190	0.270	0.140

ETHANEDIAL (GLYOXAL)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
La Tardière	0.026	-	-	0.018	0.023	-	-	0.017	0.037	0.013	-	-
	0.026	-	-	0.012	0.026	-	-	0.012	0.042	0.012	-	-
Donon	0.011	0.011	0.015	0.012	0.026	0.053	0.044	0.015	0.038	0.028	-	-
	0.011	0.011	0.011	0.012	0.012	0.027	0.045	0.012	0.037	0.031	-	-
Peyrusse Vieille	0.037	0.021	0.044	0.012	0.019	-	0.021	0.030	-	0.012	-	-
	0.041	0.011	0.023	0.012	0.015	-	0.024	0.029	-	0.012	-	-
Campisábalos	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-

HEXANAL

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
La Tardière	0.048	-	-	0.059	0.063	-	-	0.042	0.056	0.043	0.033	0.015
	0.043	-	-	0.064	0.066	-	-	0.046	0.061	0.051	0.024	0.015
Donon	0.036	0.036	0.040	0.043	0.073	0.078	0.099	0.034	0.055	0.041	0.020	0.016
	0.032	0.043	0.042	0.037	0.072	0.079	0.099	0.039	0.057	0.045	0.016	0.015
Peyrusse Vieille	0.215	0.022	0.040	0.070	0.098	-	0.052	0.060	-	0.056	0.034	0.022
	0.267	0.015	0.044	0.072	0.067	-	0.033	0.060	-	0.054	0.032	0.017
Campisábalos	0.170	0.010	0.023	0.018	0.021	0.027	0.034	0.116	0.151	0.114	0.105	0.082
	0.160	0.010	0.020	0.020	0.020	0.030	0.030	0.110	0.130	0.110	0.100	0.090

2-OXOPROPANAL (METHYLGLYOXAL)

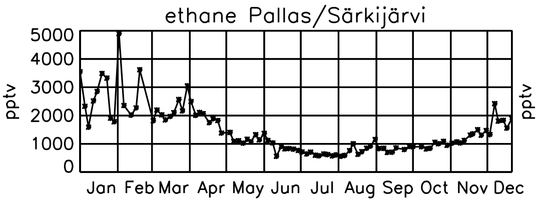
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
La Tardière	0.060	-	-	0.015	0.020	-	-	0.020	0.077	0.029	0.032	0.020
	0.043	-	-	0.016	0.016	-	-	0.017	0.071	0.021	0.016	0.016
Donon	0.027	0.033	0.031	0.030	0.031	0.201	0.323	0.021	0.068	0.029	0.023	0.016
	0.016	0.036	0.028	0.016	0.016	0.102	0.340	0.017	0.056	0.017	0.016	0.015
Peyrusse Vieille	0.053	0.022	0.081	0.016	0.037	-	0.077	0.023	0.113	0.016	0.025	0.020
	0.056	0.015	0.036	0.016	0.035	-	0.033	0.016	0.022	0.016	0.025	0.016
Campisábalos	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-

Appendix B

Time series of VOC measured in 2006

Explanations and synonyms to component names

ethyne:	acetylene
butane:	n-butane
isobutane:	i-butane
pentane:	n-pentane
isopentane:	i-pentane
hexane:	n-hexane
methanal:	formaldehyde
ethanal:	acetaldehyde
propanone:	acetone
N2propenal:	2-propenal (acrolein)
N2butanone:	2-butanone (methyl ethyl ketone)
N3buten2one:	3-buten-2-one (methyl vinyl ketone)
N2methylpropenal:	2-methyl propenal (methacrolein)
benzenecarbaldehyde:	benzaldehyde
ethanedial:	glyoxal
N2oxoproanal:	2-oxopropanal (methyl glyoxal)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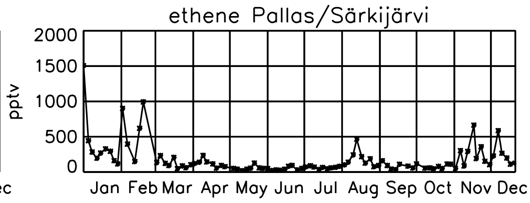
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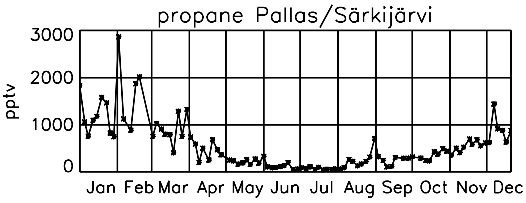
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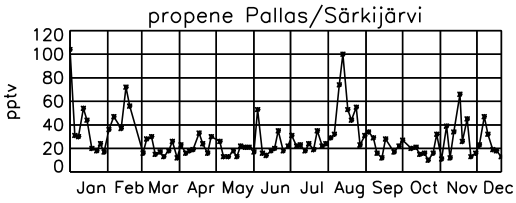
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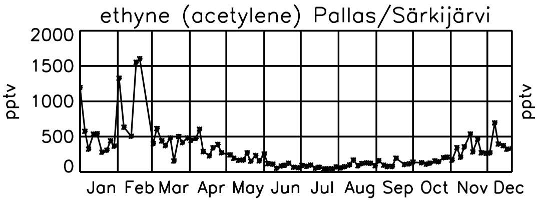
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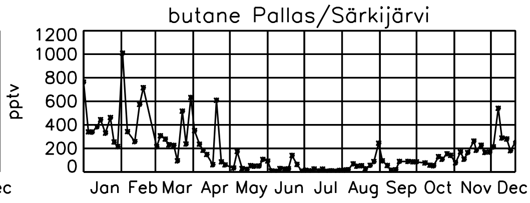
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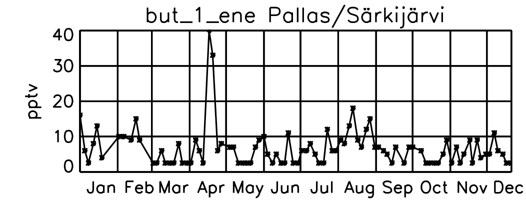
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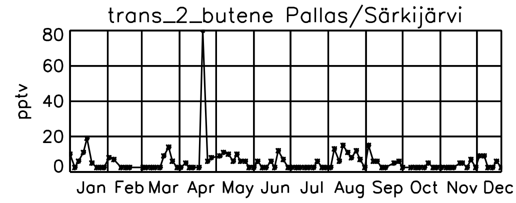
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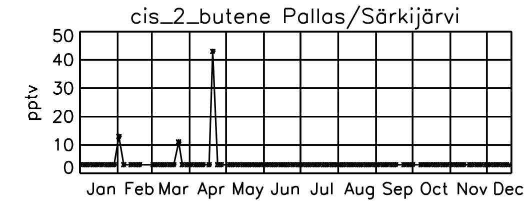
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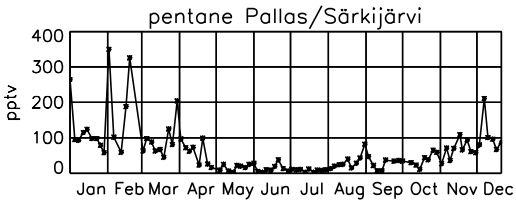
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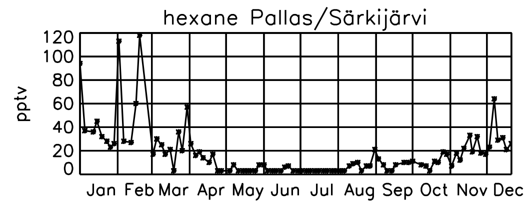
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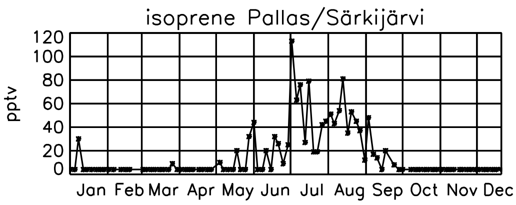
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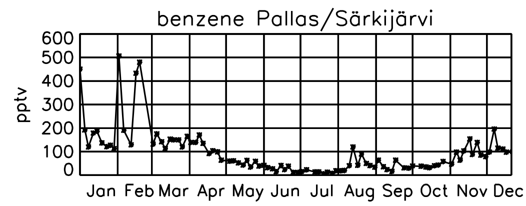
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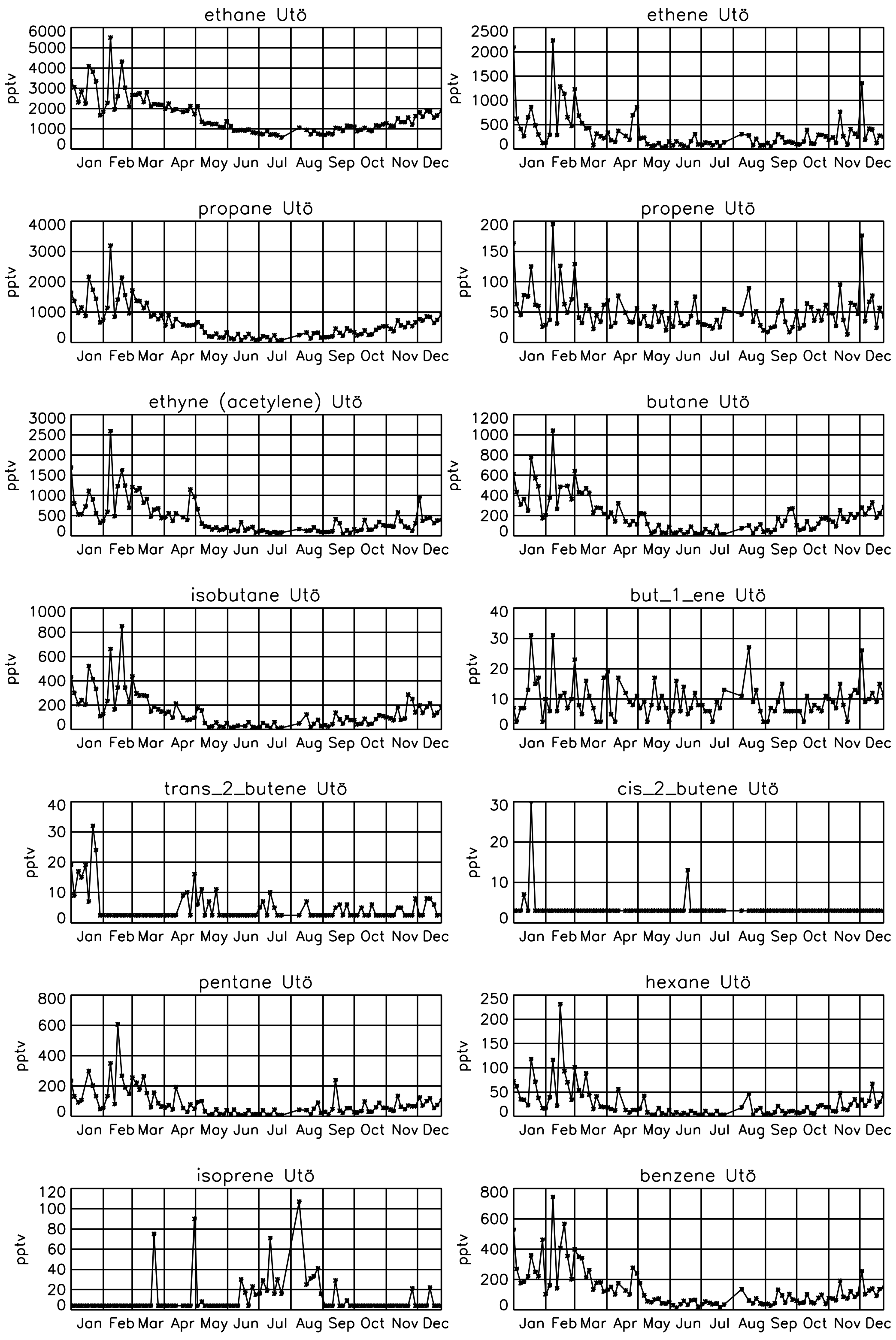
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ethene Utö
propane Utö
propene Utö
ethyne (acetylene) Utö
butane Utö
isobutane Utö
but_1_ene Utö
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cis_2_butene Utö
pentane Utö
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benzene Utö
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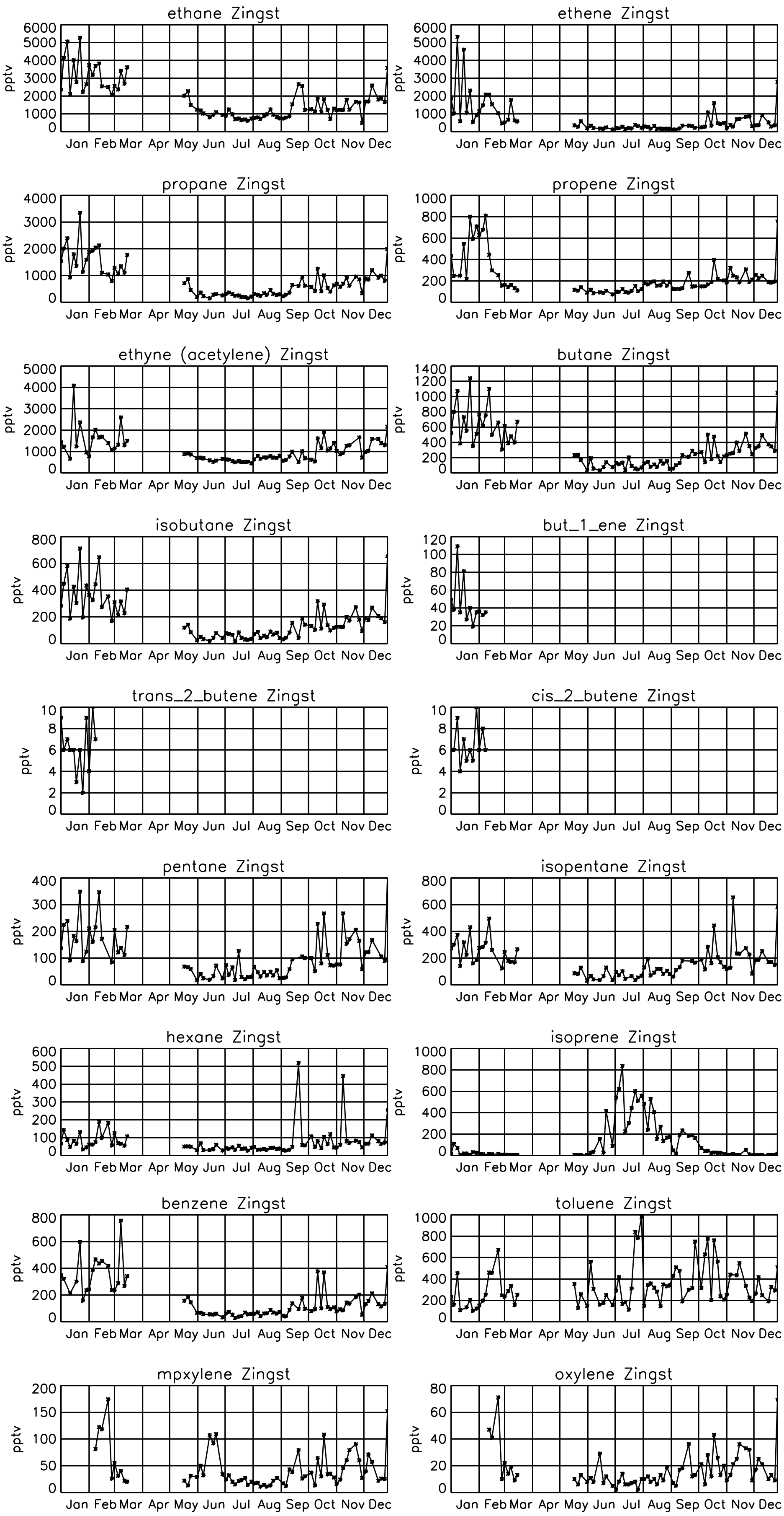
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propane Zingst
pptv
0 1000 2000 3000 4000
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propene Zingst
pptv
0 200 400 600 800 1000
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
ethyne (acetylene) Zingst
pptv
0 1000 2000 3000 4000 5000
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
butane Zingst
pptv
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Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
isobutane Zingst
pptv
0 200 400 600 800
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
but_1_ene Zingst
pptv
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Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
trans_2_butene Zingst
pptv
0 2 4 6 8 10
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
cis_2_butene Zingst
pptv
0 2 4 6 8 10
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
pentane Zingst
pptv
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Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
isopentane Zingst
pptv
0 200 400 600 800
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hexane Zingst
pptv
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Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
isoprene Zingst
pptv
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Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
benzene Zingst
pptv
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toluene Zingst
pptv
0 200 400 600 800 1000
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
mpxylene Zingst
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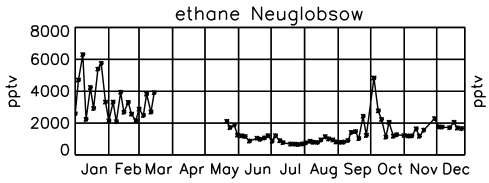
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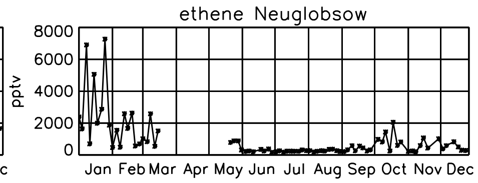
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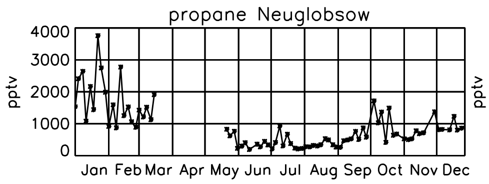
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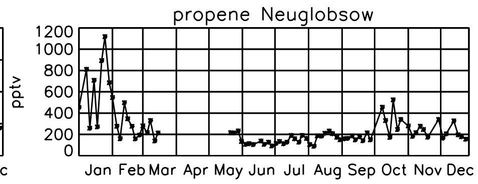
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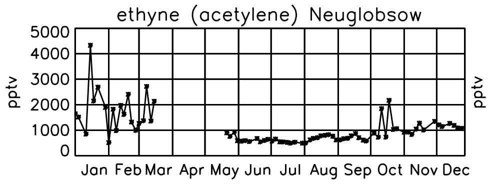
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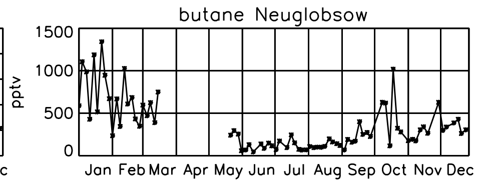
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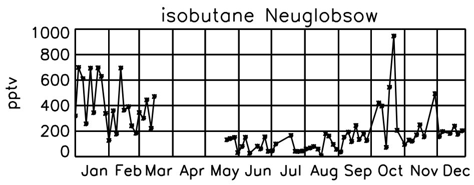
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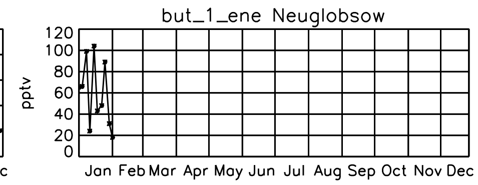
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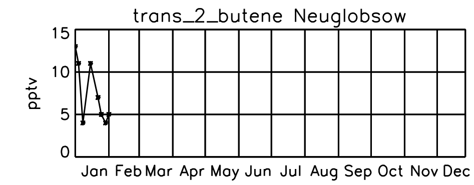
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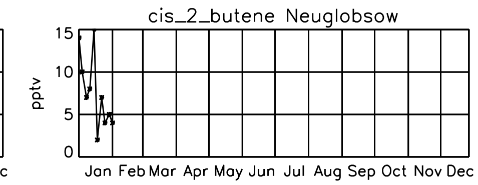
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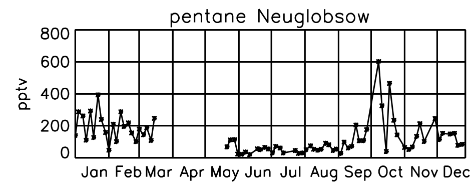
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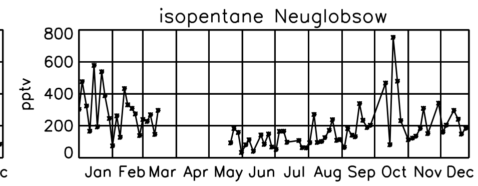
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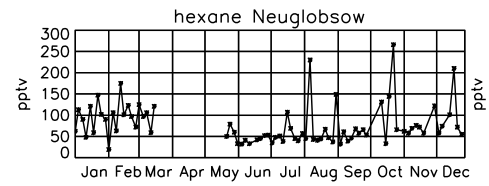
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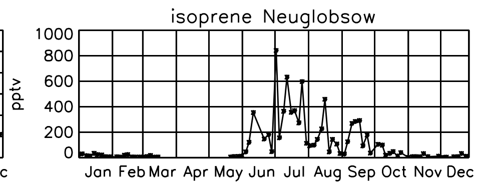
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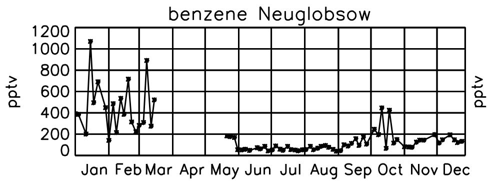
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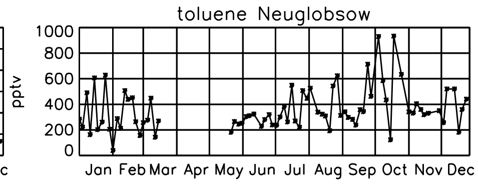
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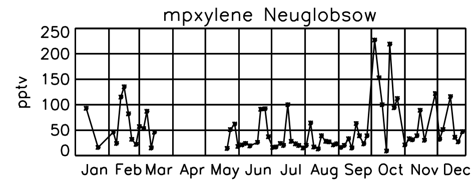
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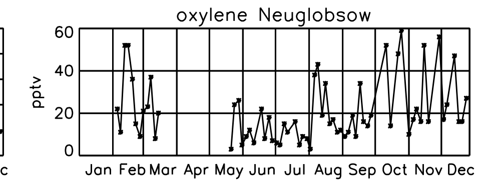
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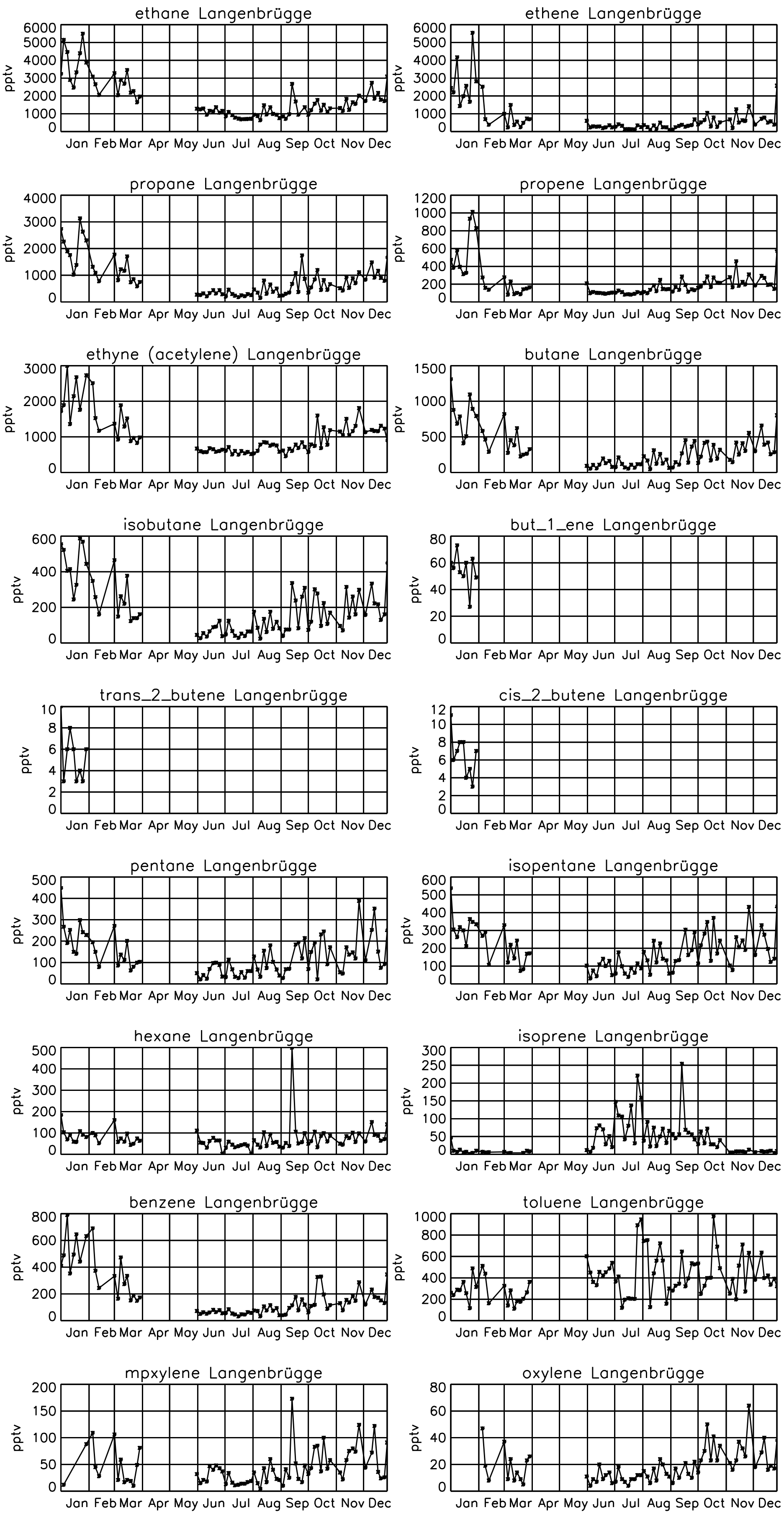
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propane Langenbrügge
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butane Langenbrügge
isobutane Langenbrügge
but_1_ene Langenbrügge
trans_2_butene Langenbrügge
cis_2_butene Langenbrügge
pentane Langenbrügge
isopentane Langenbrügge
hexane Langenbrügge
isoprene Langenbrügge
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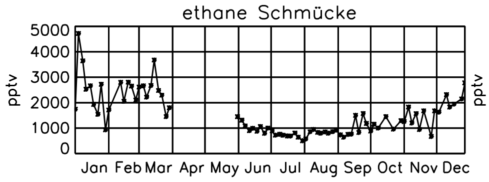
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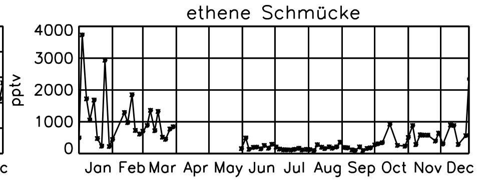
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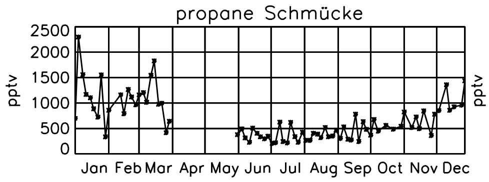
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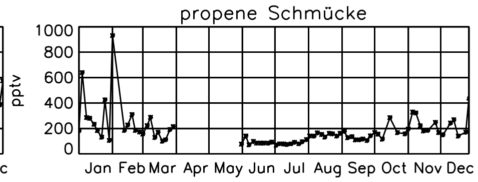
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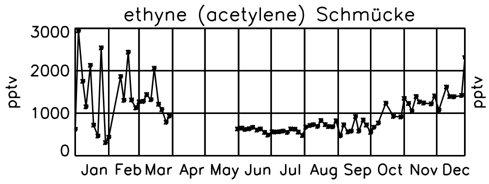
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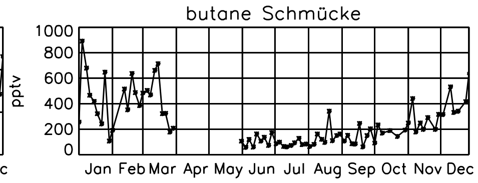
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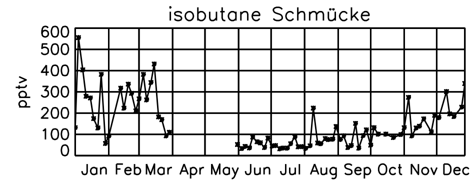
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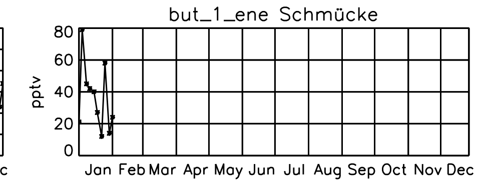
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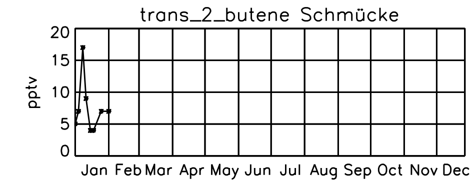
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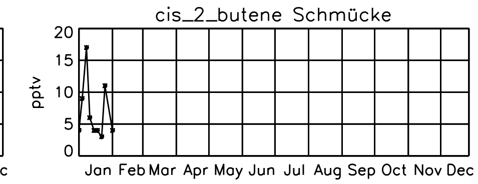
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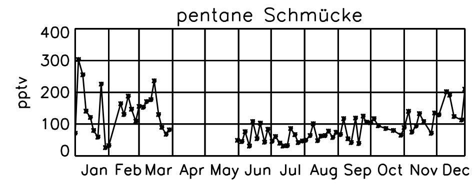
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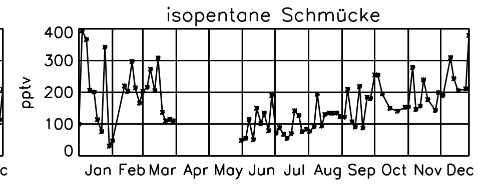
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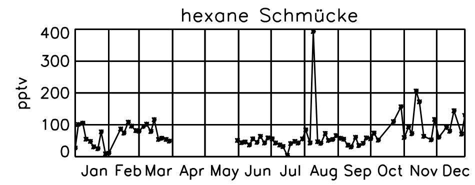
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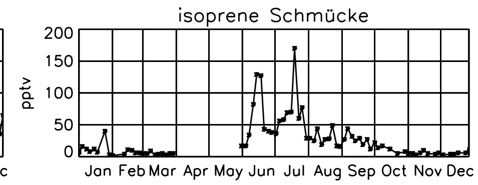
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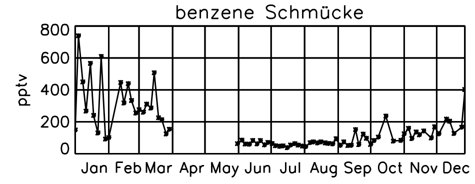
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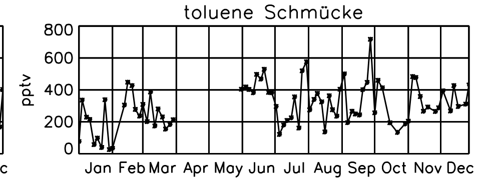
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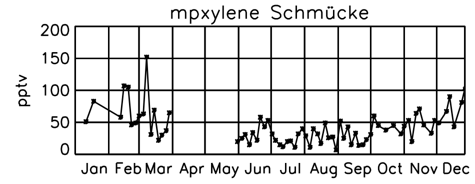
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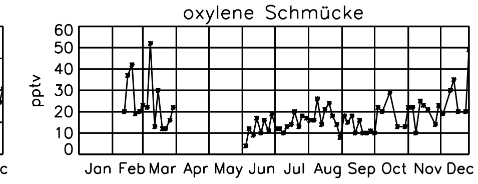
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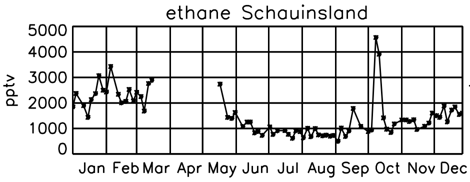
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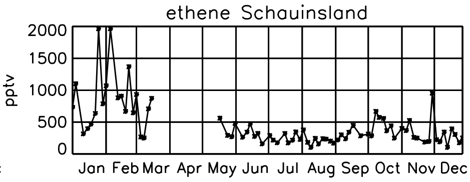
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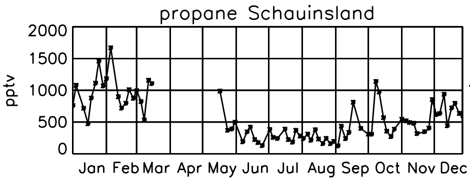
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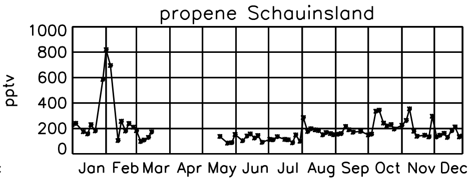
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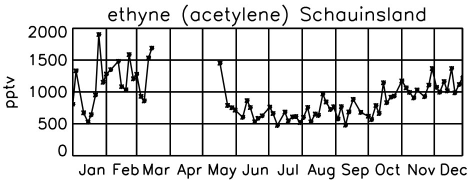
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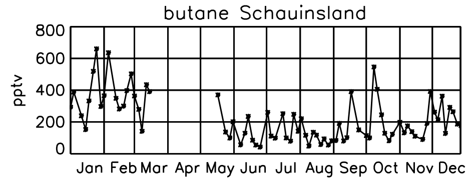
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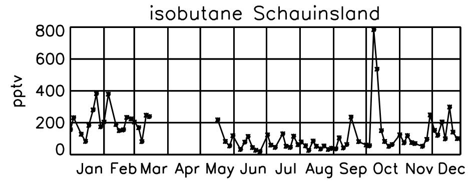
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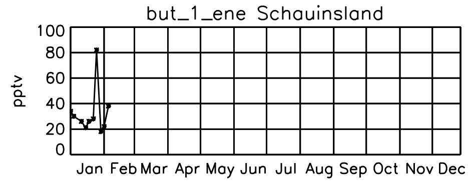
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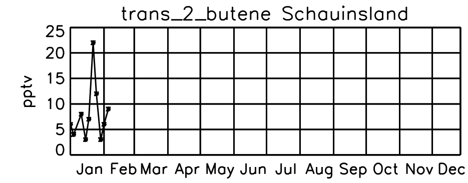
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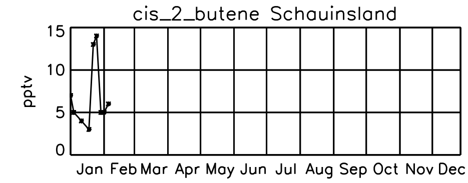
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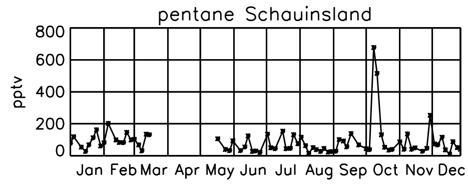
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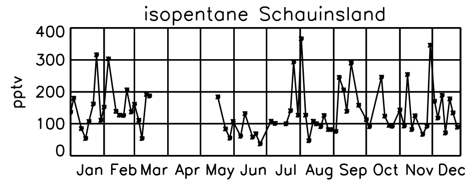
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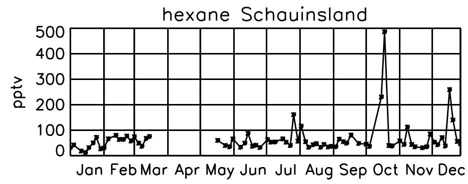
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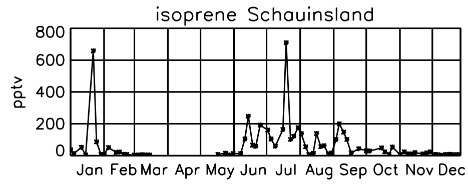
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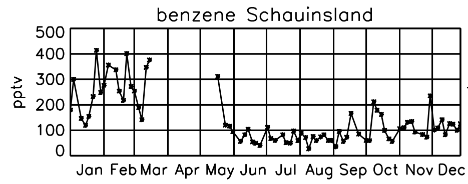
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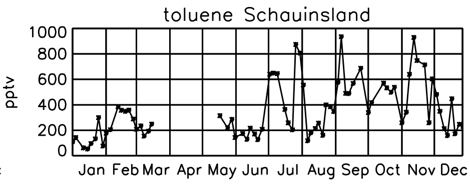
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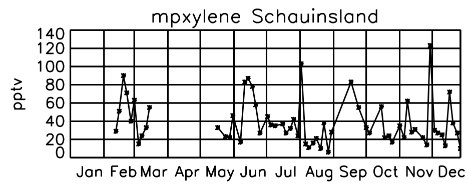
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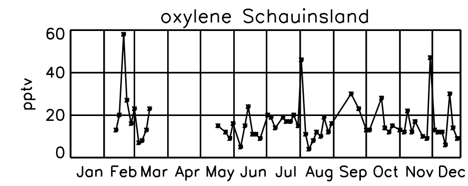
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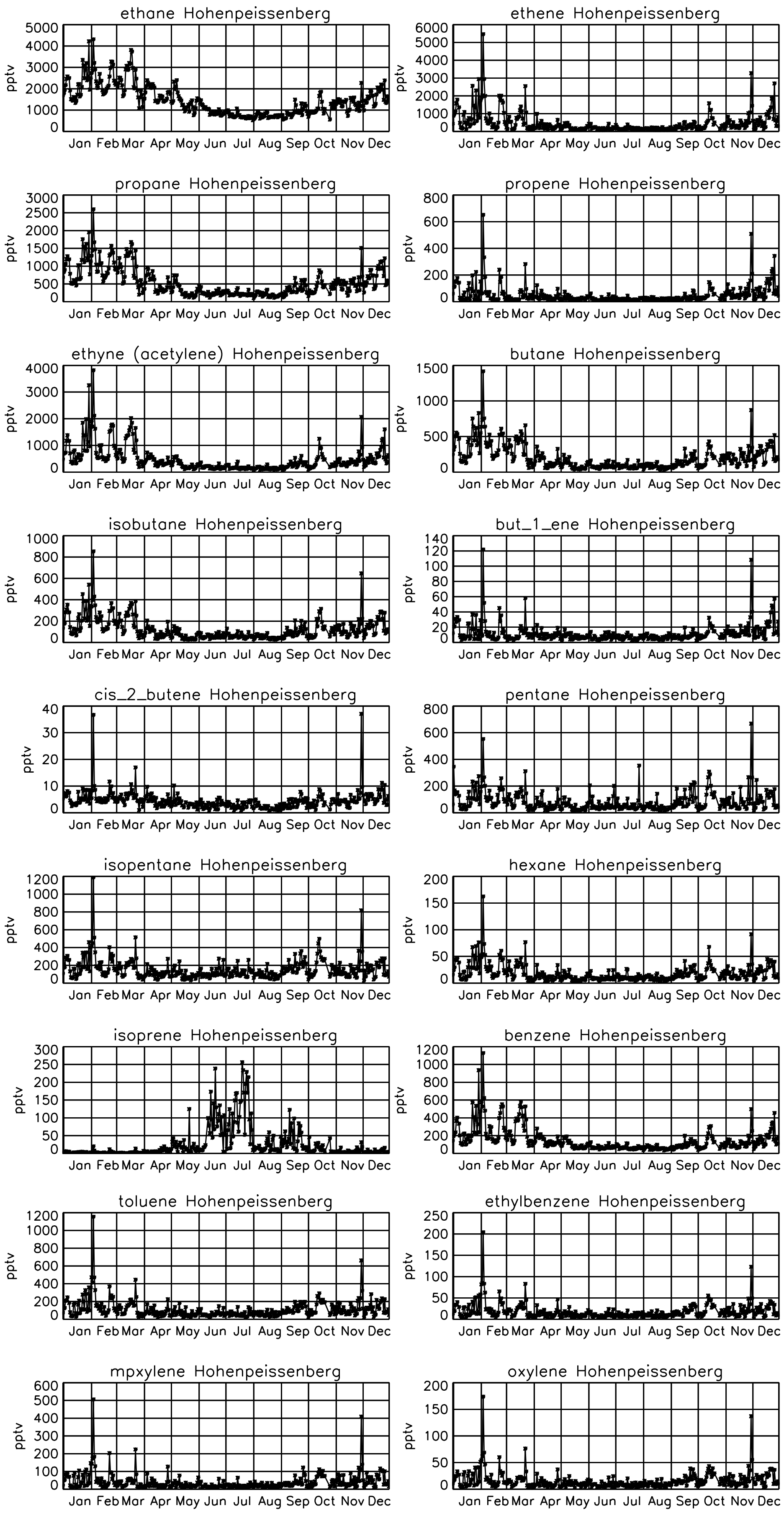
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cis_2_butene Hohenpeissenberg
pentane Hohenpeissenberg
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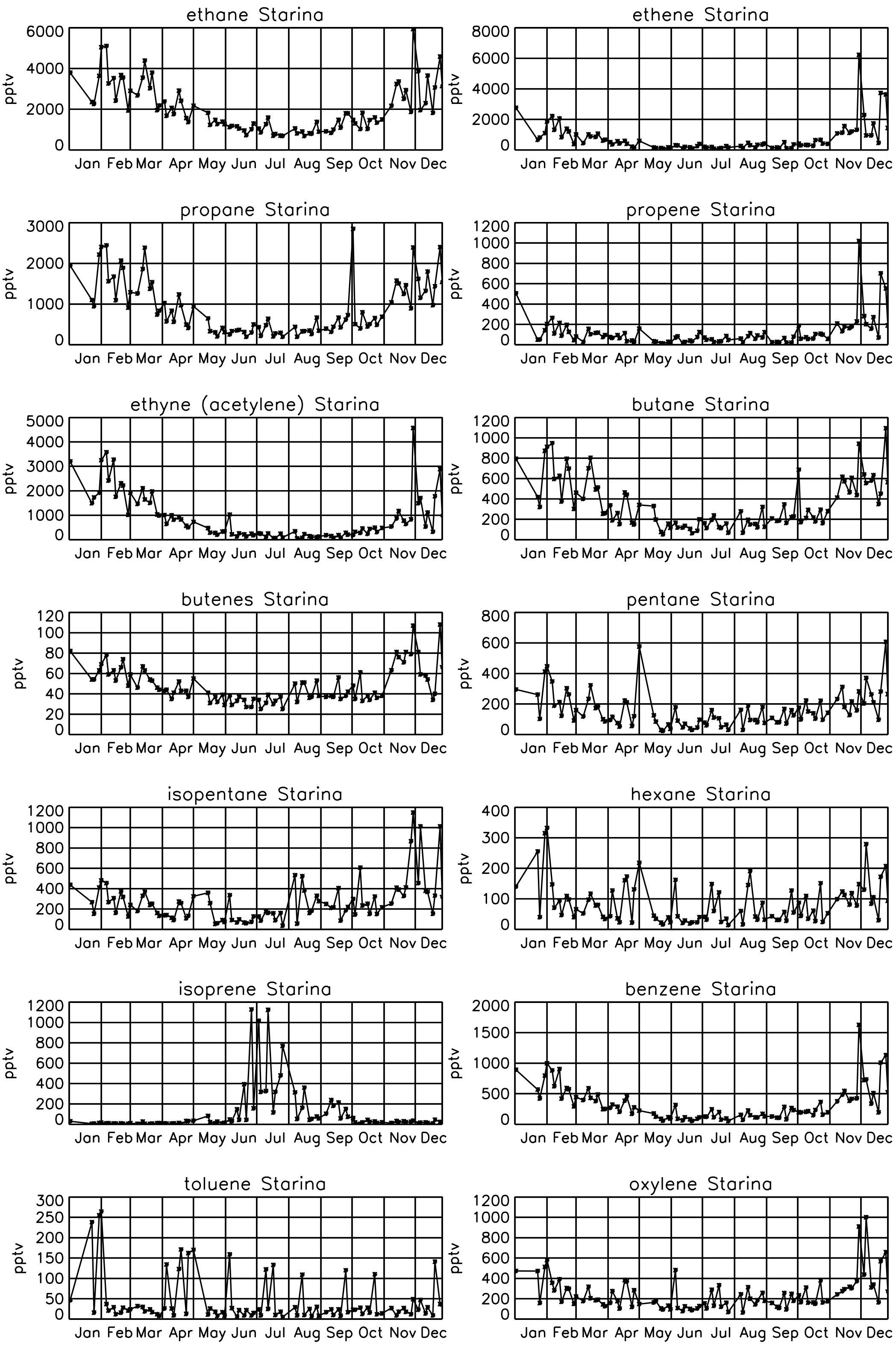
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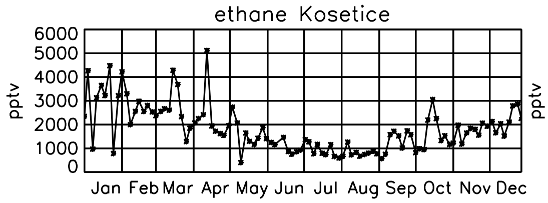
ethane Kosetice



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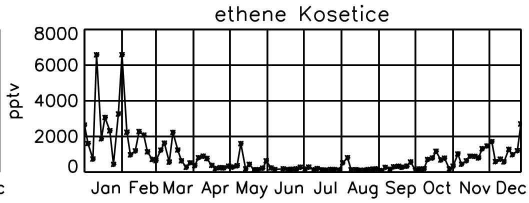

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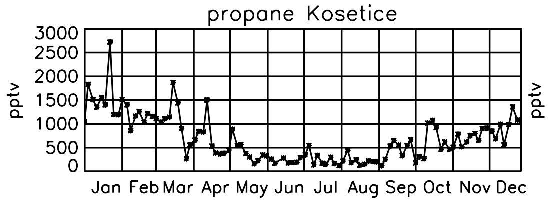

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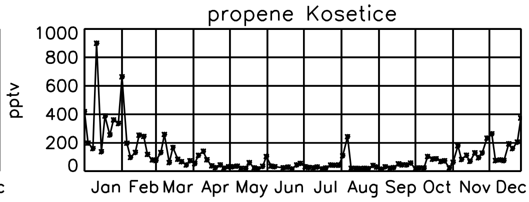

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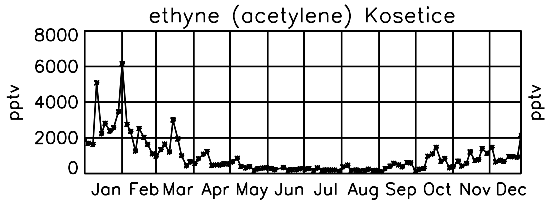

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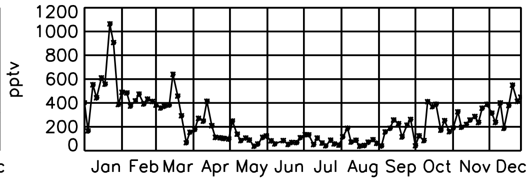

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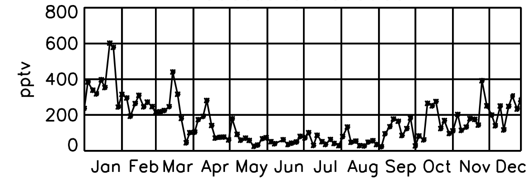

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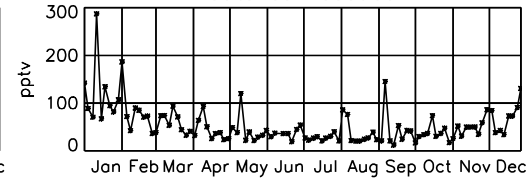

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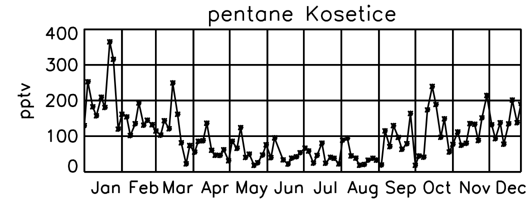

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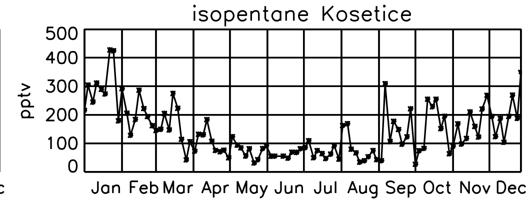

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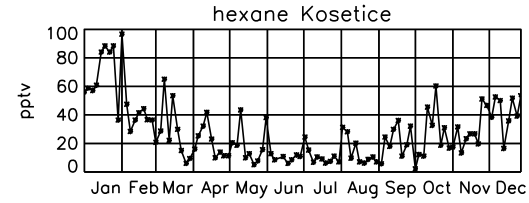

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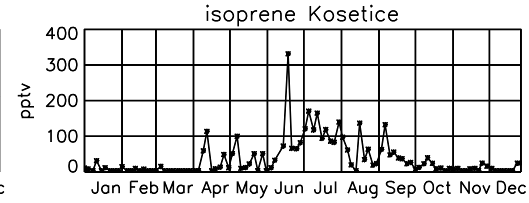

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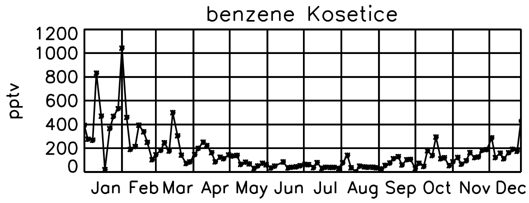

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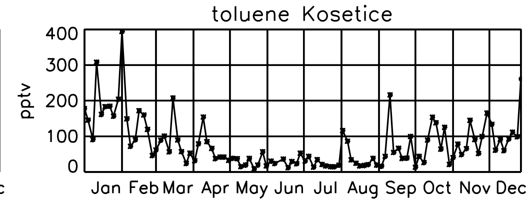

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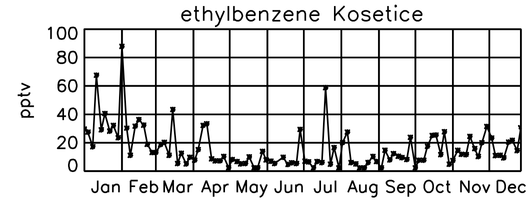

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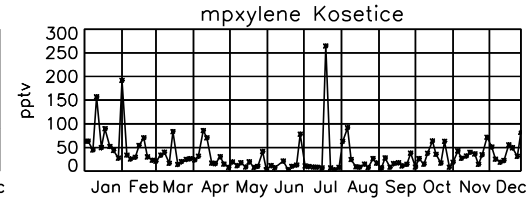

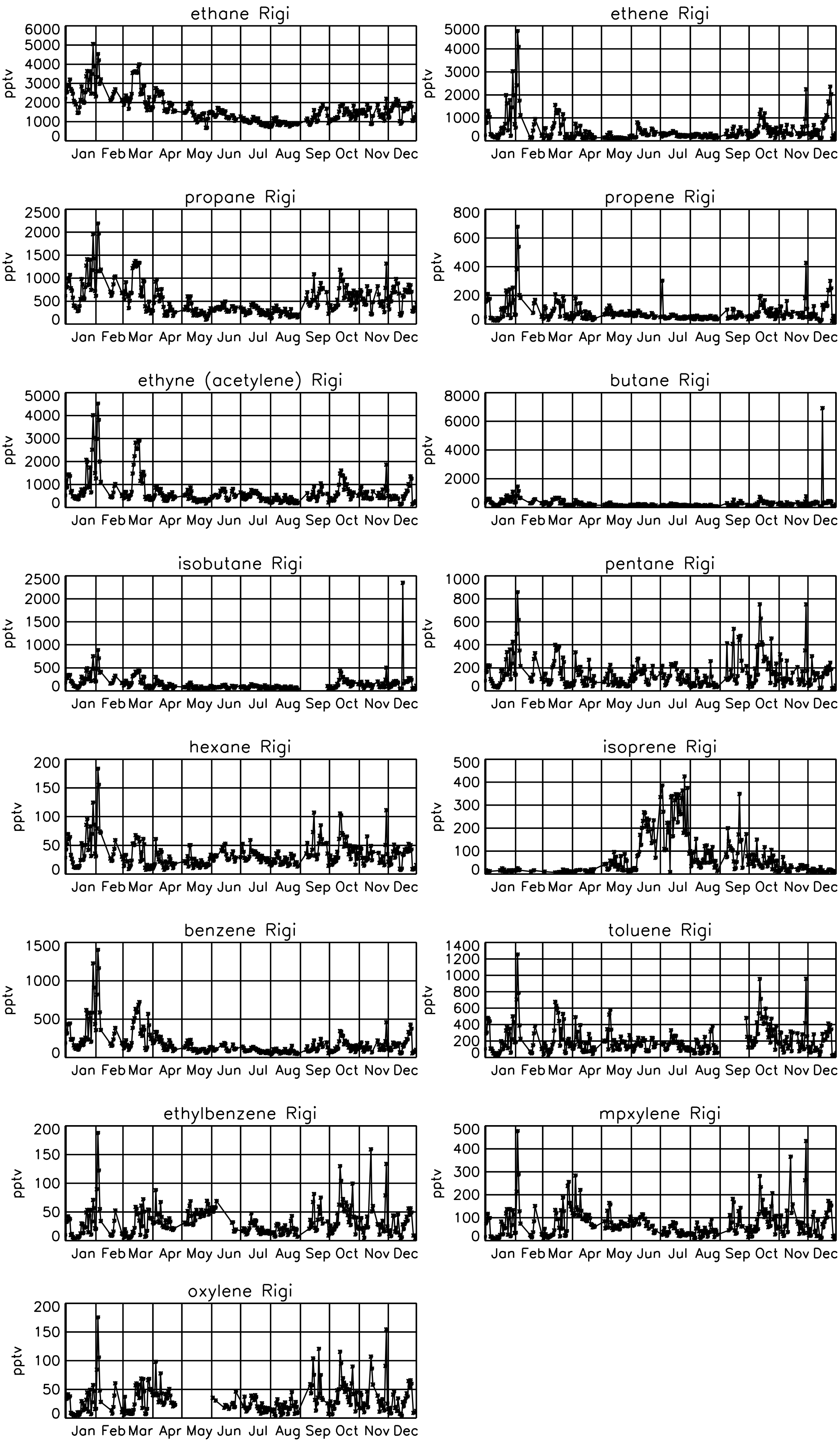

ethane Rigi
ethene Rigi
propane Rigi
propene Rigi
ethyne (acetylene) Rigi
butane Rigi
isobutane Rigi
pentane Rigi
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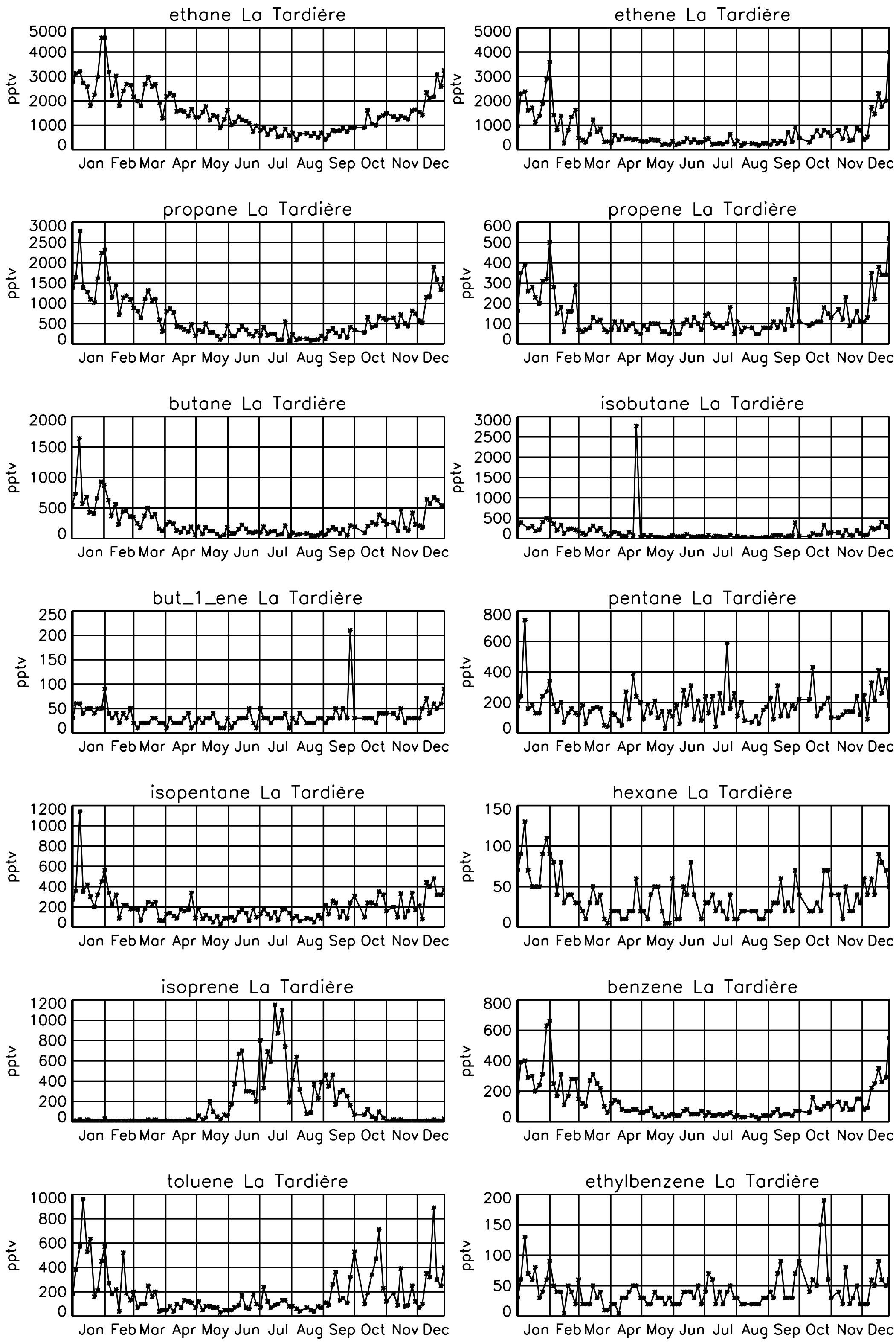
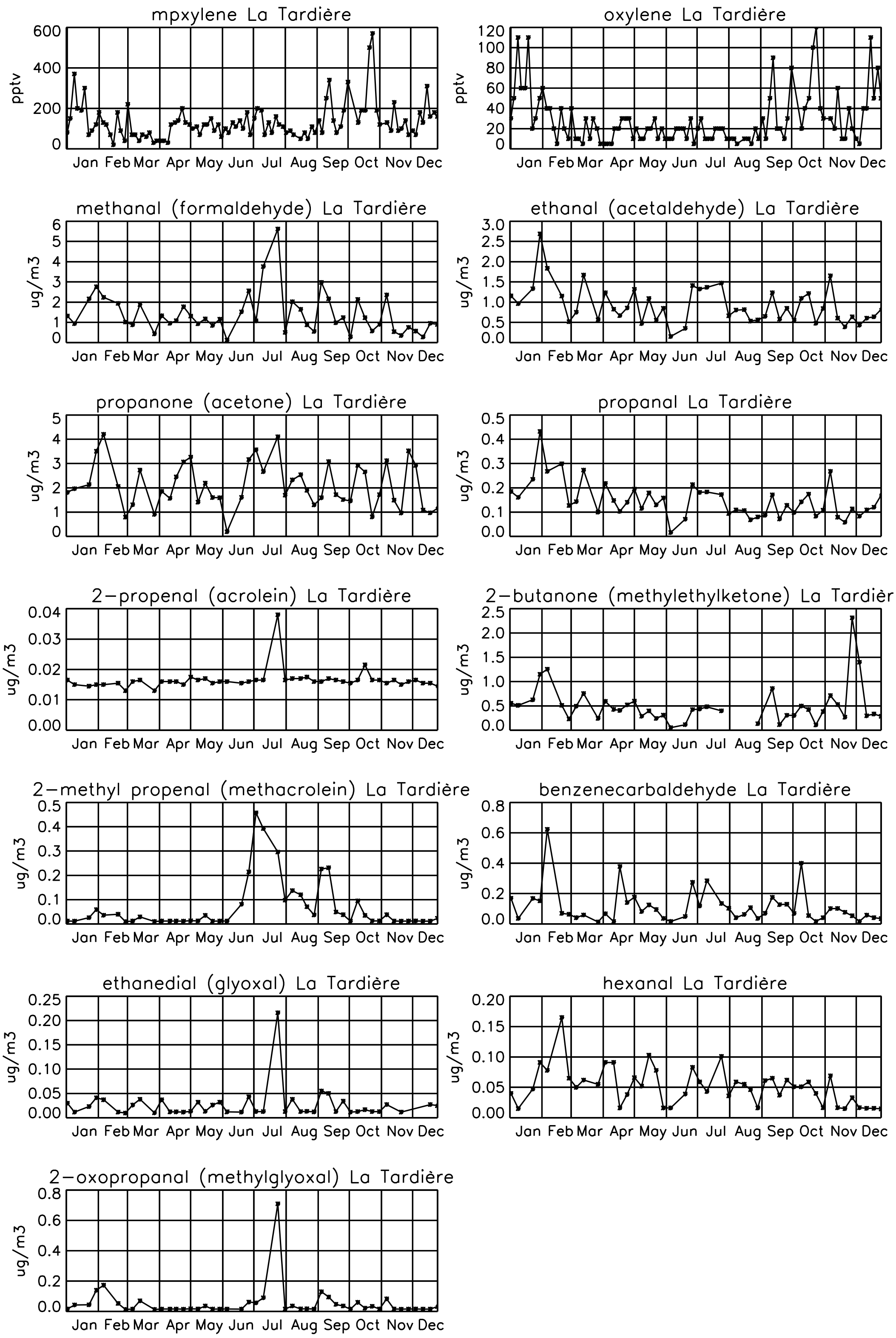
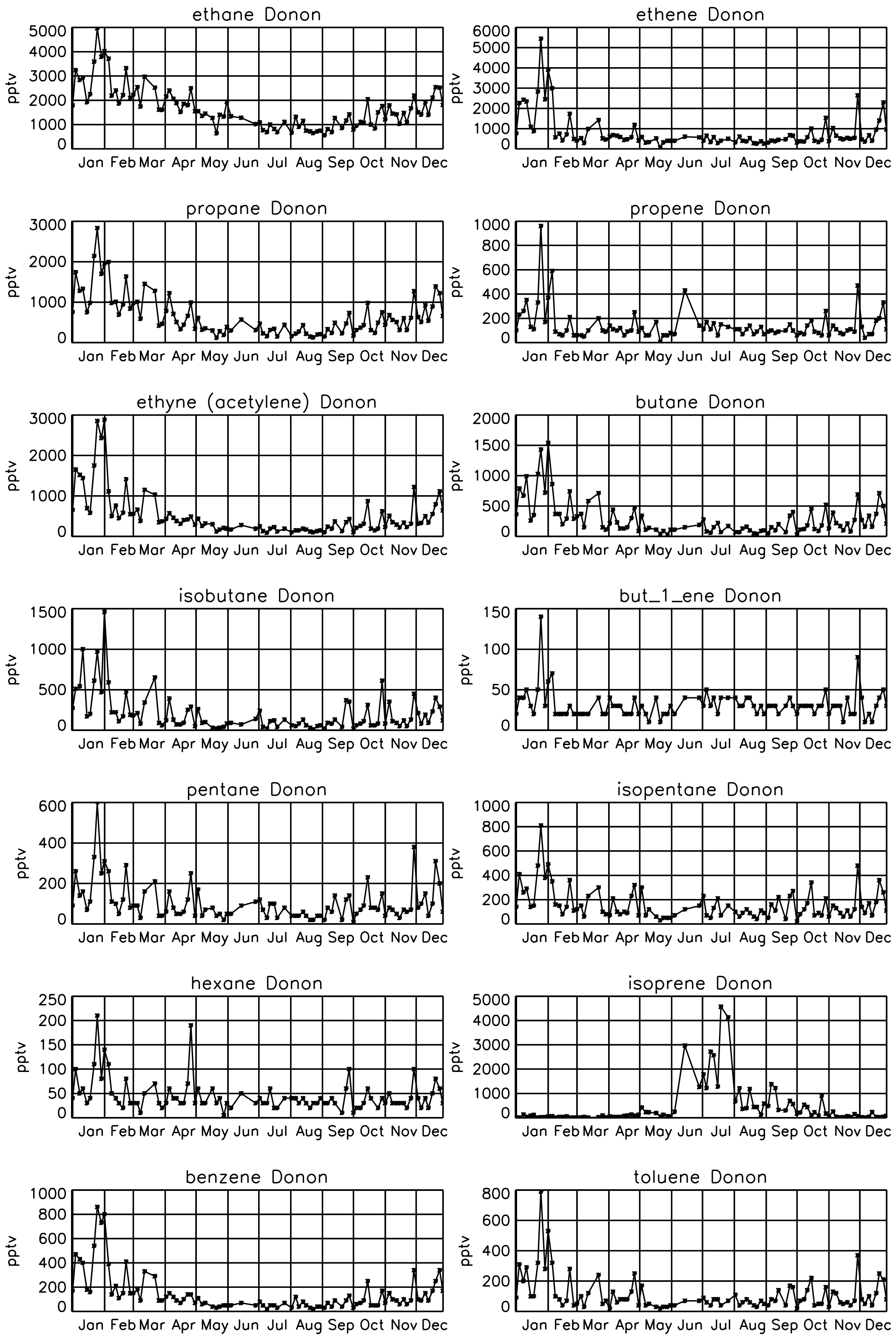
pptv
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec


ethane La Tardière
ethene La Tardière
propane La Tardière
propene La Tardière
butane La Tardière
isobutane La Tardière
but_1_ene La Tardière
pentane La Tardière
isopentane La Tardière
hexane La Tardière
isoprene La Tardière
benzene La Tardière
toluene La Tardière
ethylbenzene La Tardière
pptv
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec


mpxylene La Tardière
oxylene La Tardière
methanal (formaldehyde) La Tardière
ethanal (acetaldehyde) La Tardière
propanone (acetone) La Tardière
propanal La Tardière
2−propenal (acrolein) La Tardière
2−butanone (methylethylketone) La Tardièr
2−methyl propenal (methacrolein) La Tardière
benzenecarbaldehyde La Tardière
ethanedial (glyoxal) La Tardière
hexanal La Tardière
2−oxopropanal (methylglyoxal) La Tardière
pptv
ug/m3
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec


ethane Donon
ethene Donon
propane Donon
propene Donon
ethyne (acetylene) Donon
butane Donon
isobutane Donon
but_1_ene Donon
pentane Donon
isopentane Donon
hexane Donon
isoprene Donon
benzene Donon
toluene Donon
pptv
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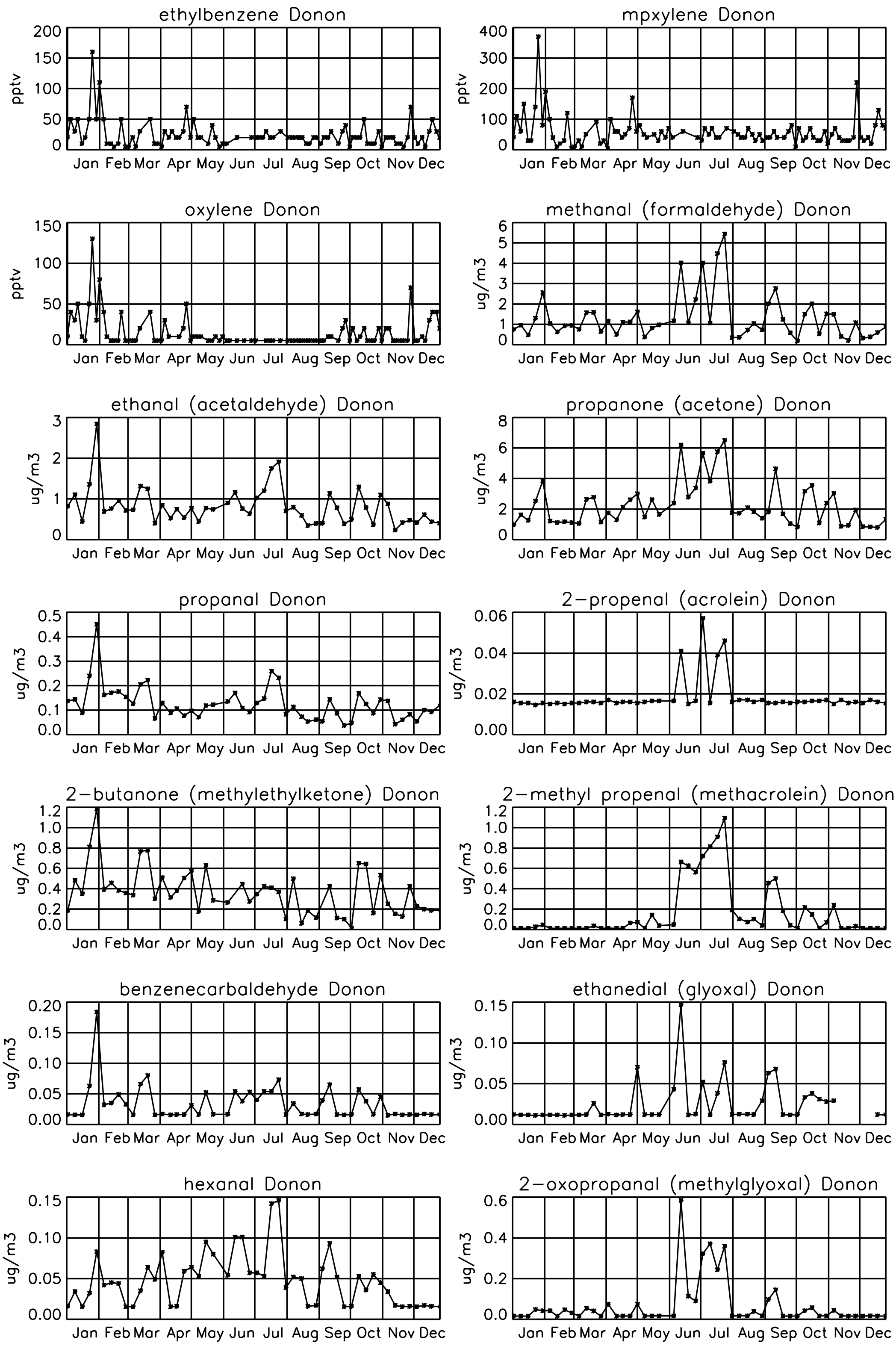
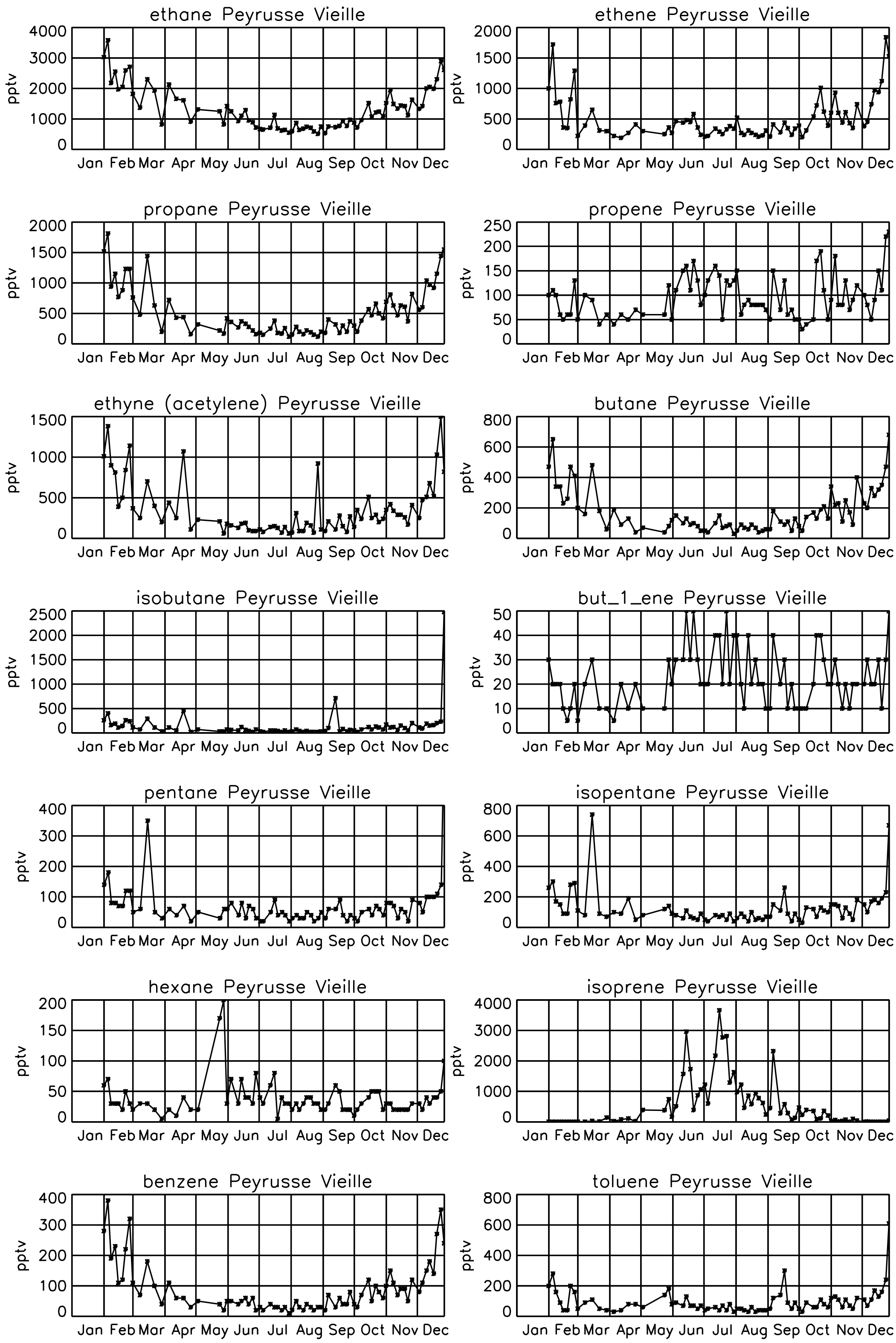

ethylbenzene Donon
pptv
mpxylene Donon
pptv
oxylene Donon
pptv
methanal (formaldehyde) Donon
ug/m3
ethanal (acetaldehyde) Donon
ug/m3
propanone (acetone) Donon
ug/m3
propanal Donon
ug/m3
2−propenal (acrolein) Donon
ug/m3
2−butanone (methylethylketone) Donon
ug/m3
2−methyl propenal (methacrolein) Donon
ug/m3
benzenecarbaldehyde Donon
ug/m3
ethanedial (glyoxal) Donon
ug/m3
hexanal Donon
ug/m3
2−oxopropanal (methylglyoxal) Donon
ug/m3
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec


ethane Peyrusse Vieille
ethene Peyrusse Vieille
propane Peyrusse Vieille
propene Peyrusse Vieille
ethyne (acetylene) Peyrusse Vieille
butane Peyrusse Vieille
isobutane Peyrusse Vieille
but_1_ene Peyrusse Vieille
pentane Peyrusse Vieille
isopentane Peyrusse Vieille
hexane Peyrusse Vieille
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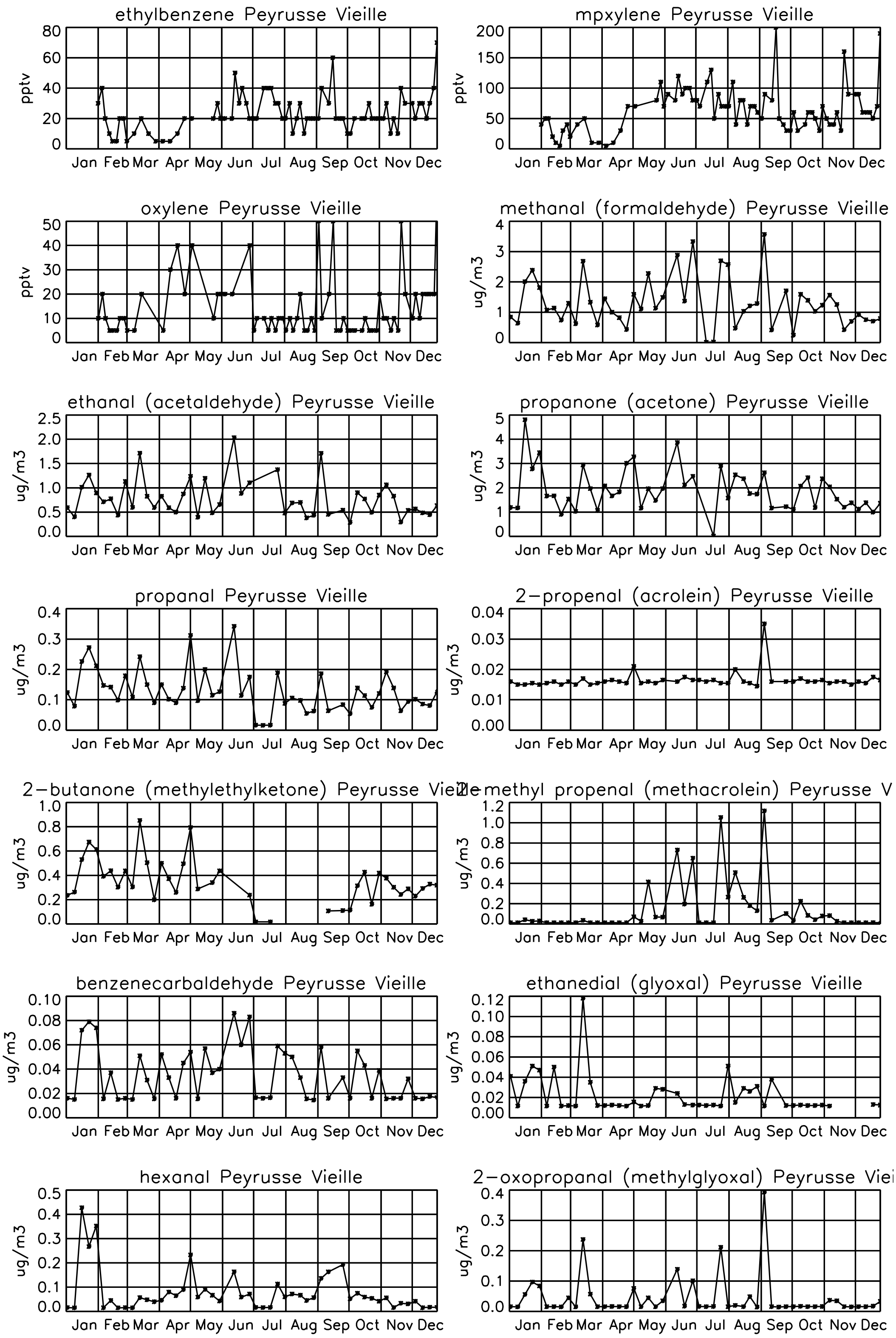
ethylbenzene Peyrusse Vieille
pptv
mpxylene Peyrusse Vieille
pptv
oxylene Peyrusse Vieille
pptv
methanal (formaldehyde) Peyrusse Vieille
ug/m3
ethanal (acetaldehyde) Peyrusse Vieille
ug/m3
propanone (acetone) Peyrusse Vieille
ug/m3
propanal Peyrusse Vieille
ug/m3
2−propenal (acrolein) Peyrusse Vieille
ug/m3
2−butanone (methylethylketone) Peyrusse Vieille
ug/m3
2−methyl propenal (methacrolein) Peyrusse V
ug/m3
benzenecarbaldehyde Peyrusse Vieille
ug/m3
ethanedial (glyoxal) Peyrusse Vieille
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ug/m3
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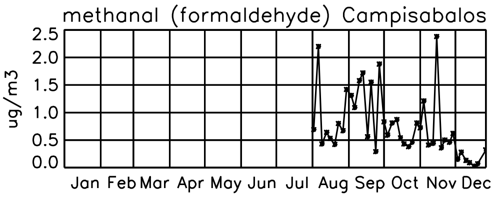
ug/m3
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec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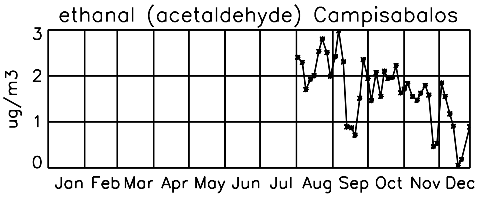
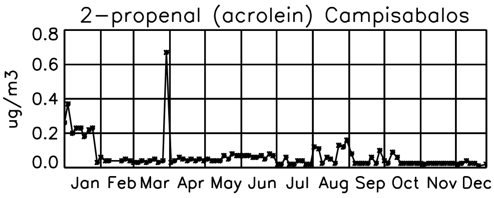
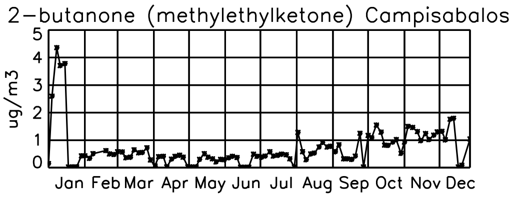
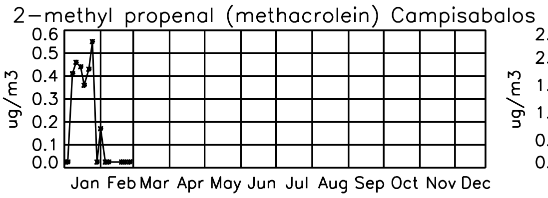
ug/m3
2.5 2.0 1.5 1.0 0.5 0.0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec


ethanal (acetaldehyde) Campisabalos
ug/m3
3 2 1 0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec


2−propenal (acrolein) Campisabalos
ug/m3
0.8 0.6 0.4 0.2 0.0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec


2−butanone (methylethylketone) Campisabalos
ug/m3
5 4 3 2 1 0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec


2−methyl propenal (methacrolein) Campisabalos
ug/m3
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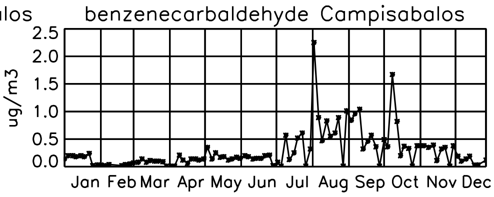
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec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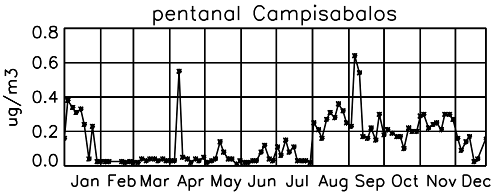
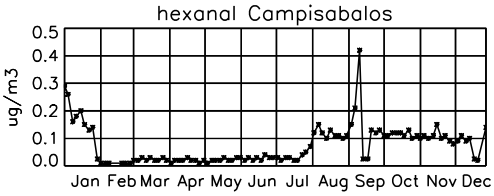
ug/m3
2.5 2.0 1.5 1.0 0.5 0.0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec


pentanal Campisabalos
ug/m3
0.8 0.6 0.4 0.2 0.0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec


hexanal Campisabalos
ug/m3
0.5 0.4 0.3 0.2 0.1 0.0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec