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

VOC measurements 2008

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Summary

This report presents measurements of VOC carried out during 2008 at EMEP monitoring sites. VOC measurements are reported for a total of 14 sites, and 3 of these with carbonyls. Except for two sites with continuous monitoring of hydrocarbons (Rigi and Hohenpeissenberg) 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.

Compared to 2007, the monitoring network was reduced by one station in 2008 as VOC monitoring at the long-term running station Donon in southeast France was ended.

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. The winter median concentration of the hydrocarbons, used as a proxy for the European emission source strength, was fairly low in 2008 for many of the components measured.

Some compounds, like acetylene (ethyne), butane and benzene, show a long-term development indicating a general reduction in the concentration level, whereas for other compounds there is too large year-to-year variations to see clear trends. Robust trend calculations of the VOCs are difficult due to the poor sampling frequency (normally 2 samples per week) and the strong influence of meteorology. Modelling studies are needed to separate the effect of changes in emissions from those of changing meteorology from year to year.

VOC measurements 2008

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 17^{th} 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.

In the new EMEP Monitoring Strategy for 2010-2019 (ECE/EB.AIR/GE.1/2009/15), it is not specified which hydrocarbons and carbonyls should be measured, but it is clearly stated that it is necessary to harmonise with the WMO GAW programme.

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 2008

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 2008 is given in Table 3. Totally 14 measurement sites reported VOC data to CCC in 2008. Carbonyls were only sampled at 3 sites and only in France and Spain. Previously the lab at NILU/EMEP-CCC analysed carbonyls sampled at Utö in Finland and Košetice in Czech Republic. Furthermore, the hydrocarbon data reported from Campisábalos, Spain, needs further inspection in order to be considered valid. VOC monitoring at Donon, a long-running station in southeast France, was ended and no data are reported for 2008 from this site.

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 some sites in 2008 and particularly low at Starina with only 56 samples. Carbonyls are only measured once per week in France giving a data capture of the order of 50%. Hohenpeissenberg and Rigi have continuous sampling and thus a much higher data capture than the other sites. Only Campisábalos in Spain had a data completeness fulfilling the criteria of 90% for carbonyls.

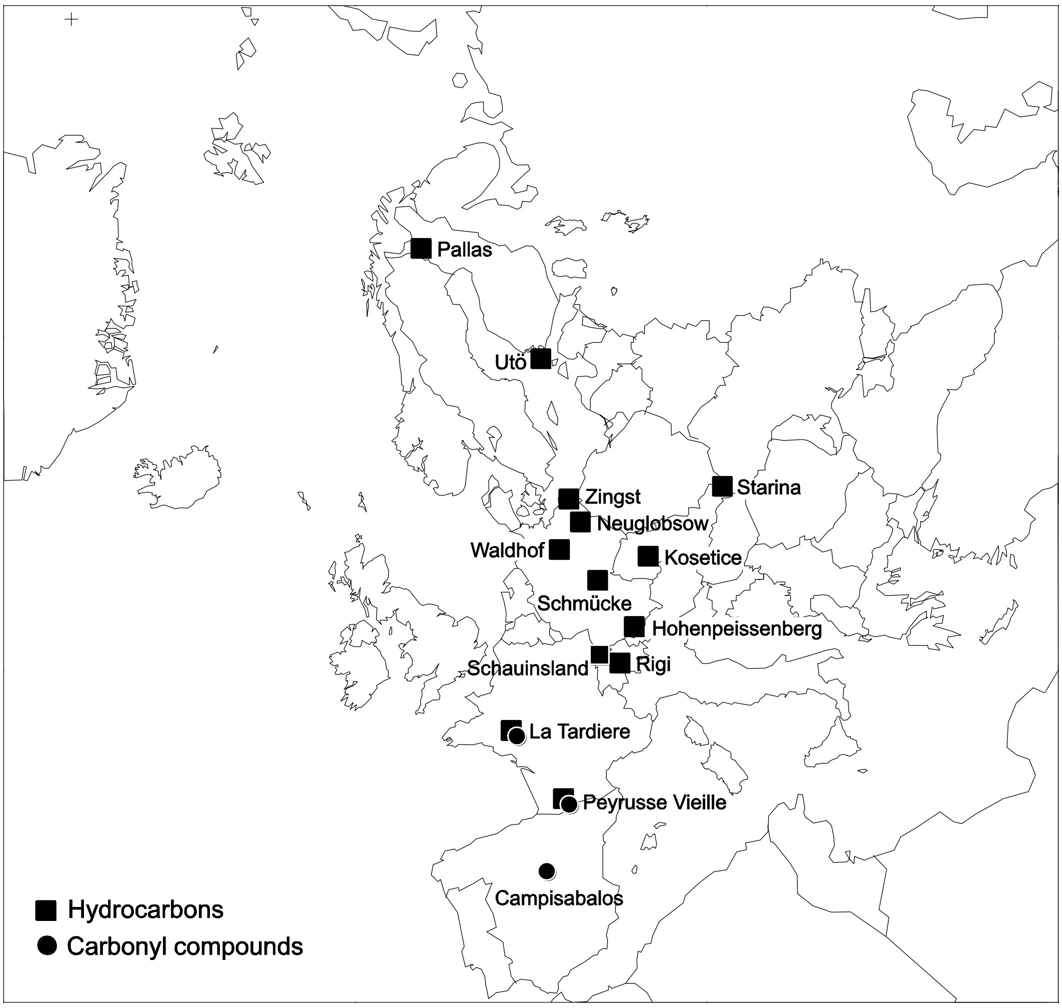

Figure 1: Monitoring sites for VOC in 2008.

Table 3: Status of the VOC monitoring programme in 2008. 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	HC1)	Lab.2)	Carb1)	Lab.2)
Pallas	FI96	Reg.	FMI	n.m.	-
Utö	FI09	Reg.	FMI	n.m.	-
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.	-
Košetice	CZ03	Reg.	CHMI	n.m.	-
Starina	SK06	Reg.	SHMI	n.m.	-
Rigi	CH05	Cont.	EMPA	n.m.	-
Peyrusse Vieille	FR13	Reg.	EMD	Reg.	EMD
La Tardière	FR15	Reg.	EMD	Reg.	EMD
Campisábalos	ES09	(Reg.)3)	MMA	Reg.	MMA

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)
3) Hydrocarbons reported but considered preliminary

Table 4: The number of valid samples of hydrocarbons (HC) and carbonyls (Carb) in 2008.

Station	Number of samples HC2)	Number of samples Carb3)
Pallas	77	-
Utö	85	-
Waldhof	95	-
Schauinsland	83	-
Neuglobsow	93	-
Schmücke	95	-
Zingst	97	-
Hohenpeissenberg1)	274	-
Košetice	99	-
Starina	56	-
Rigi1)	356	-
Peyrusse Vieille	97	50
La Tardière	98	51
Campisábalos	0	104

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 2008 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. A new GC and new analytical methods were introduced by UBA for the German sites in 2006 leading to certain systematic changes. In general, the new method was more sensitive to C7 and higher VOCs. 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.

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 2008

3.1 General

Monthly mean and median concentrations of the individual hydrocarbons and carbonyls for 2008 are tabulated in Appendix A. The monthly statistics were not calculated for sample numbers less than 4. Time series of all compounds during 2008 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.

High peak concentrations of ethene, propene and acetylene (ethyne) are seen at Košetice (CZ03) indicating a stronger influence of road traffic emissions at that site. Isobutane and benzene concentrations are considerably higher at Starina (SK09) than at the other sites.

The carbonyl monitoring has been substantially reduced the latest years and carried out only at three sites in France/Spain in 2008. Furthermore, at the French sites the sampling frequency is once per week, making the seasonal statistics more uncertain. We note that formaldehyde levels were significantly lower at Campisábalos than at the other two sites and vice versa for acetaldehyde.

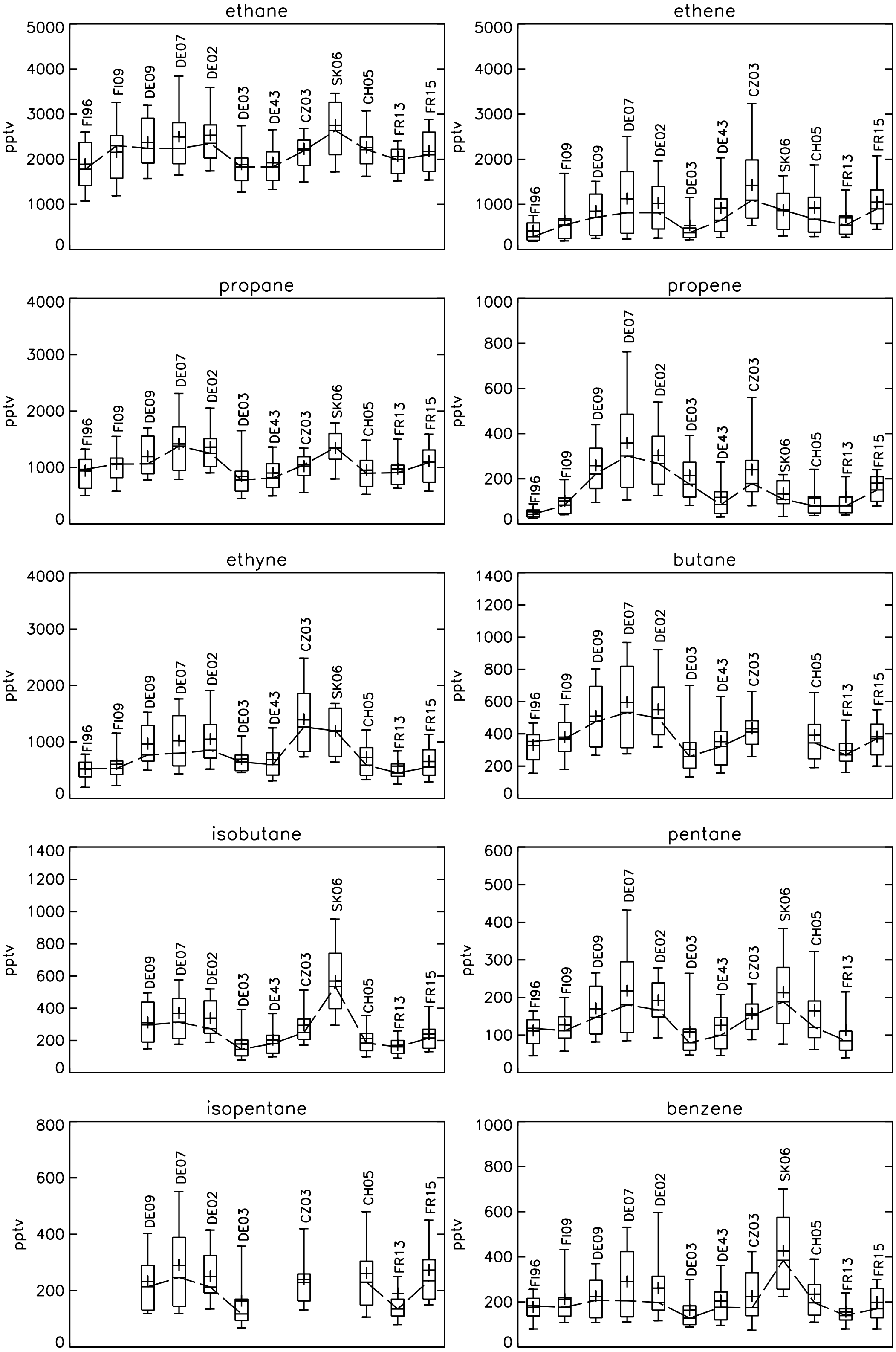

Figure 2: Box- and whisker-diagrams for hydrocarbons during winter 2008 (Jan., Feb., Nov., Dec.). The markers indicate the 10-, 25-, 50-, 75- and 90-percentiles. Mean values are indicated by a cross. The dashed line connects the median values for clarity.

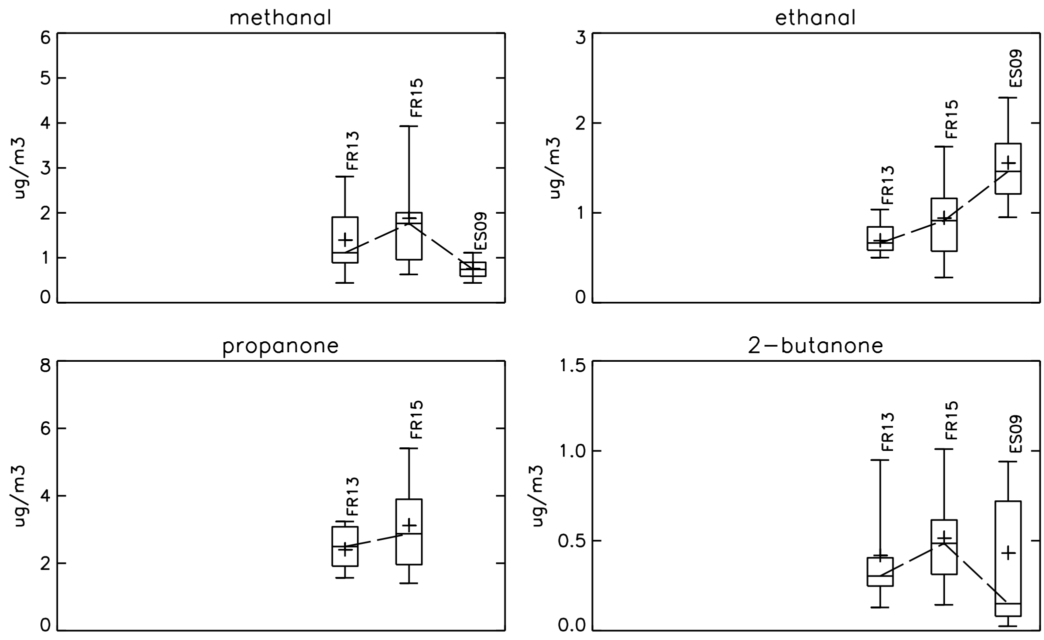

Figure 3: Box- and whisker-diagrams for carbonyls during summer 2008 (May, June, July, August). The markers indicate the 10-, 25-, 50-, 75- and 90-percentiles. Mean values are indicated by a cross.

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 2008 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 2008 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.

Few systematic patterns could be seen from the 2008 hydrocarbon data, though. For some of the species highest concentrations are seen in the East, at CZ03 and SK06, for other species the highest median values are found in Northern Germany.

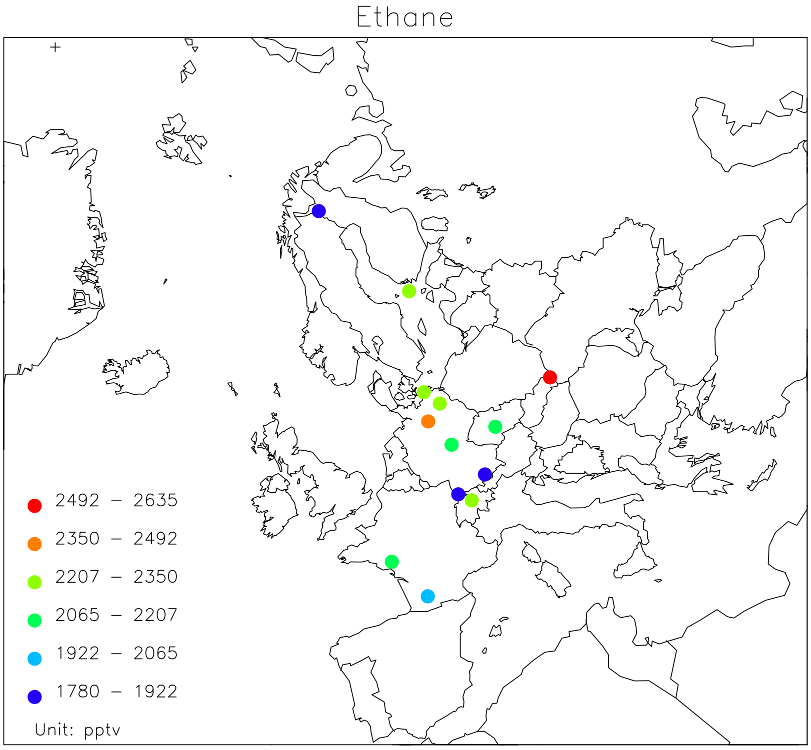

Figure 4: Median concentration of ethane at EMEP sites in the winter months November, December, January and February 2008 taken together.

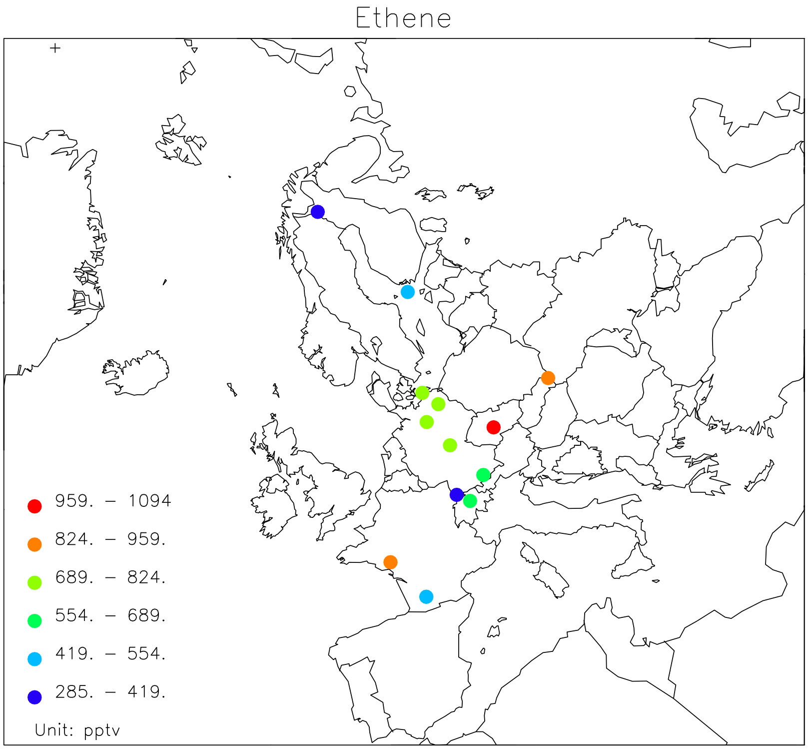

Figure 5: Median concentration of ethene at EMEP sites in the winter months November, December, January and February 2008 taken together.

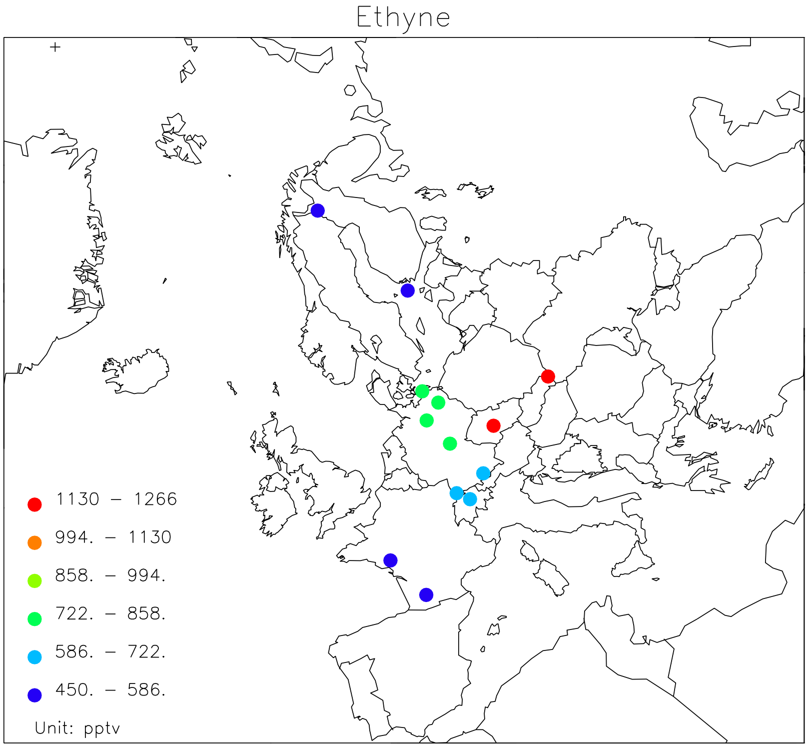

Figure 6: *Median concentration of acetylene at EMEP sites in the winter months November, December, January and February 2008 taken together.*

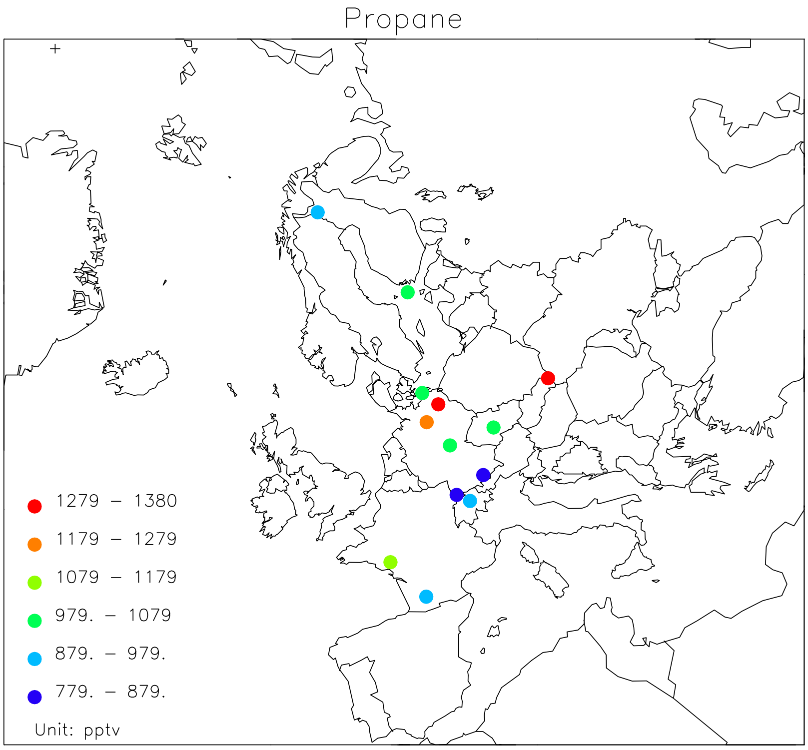

Figure 7: *Median concentration of propane at EMEP sites in the winter months November, December, January and February 2008 taken together.*

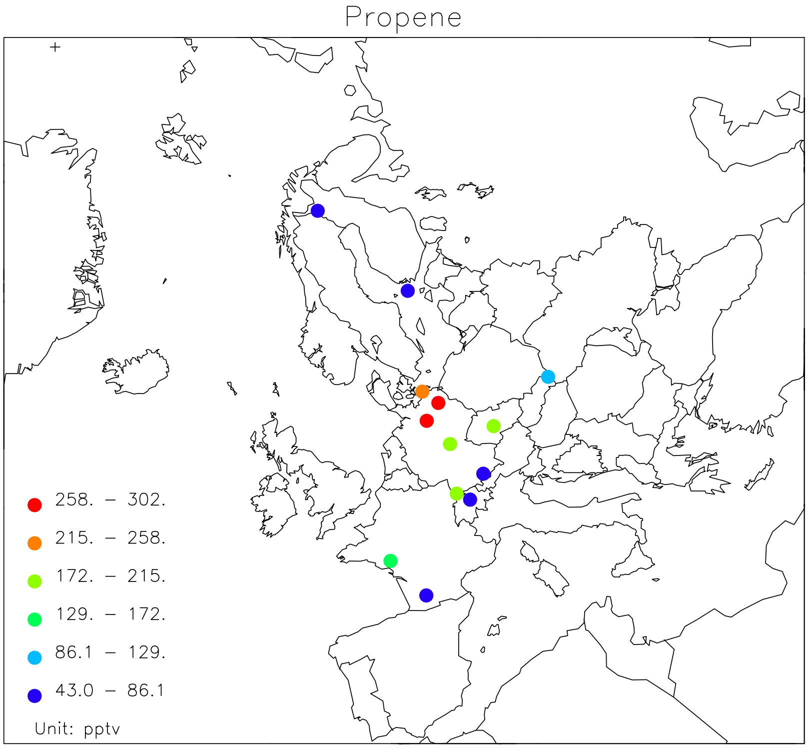

Figure 8: Median concentration of propene at EMEP sites in the winter months November, December, January and February 2008 taken together.

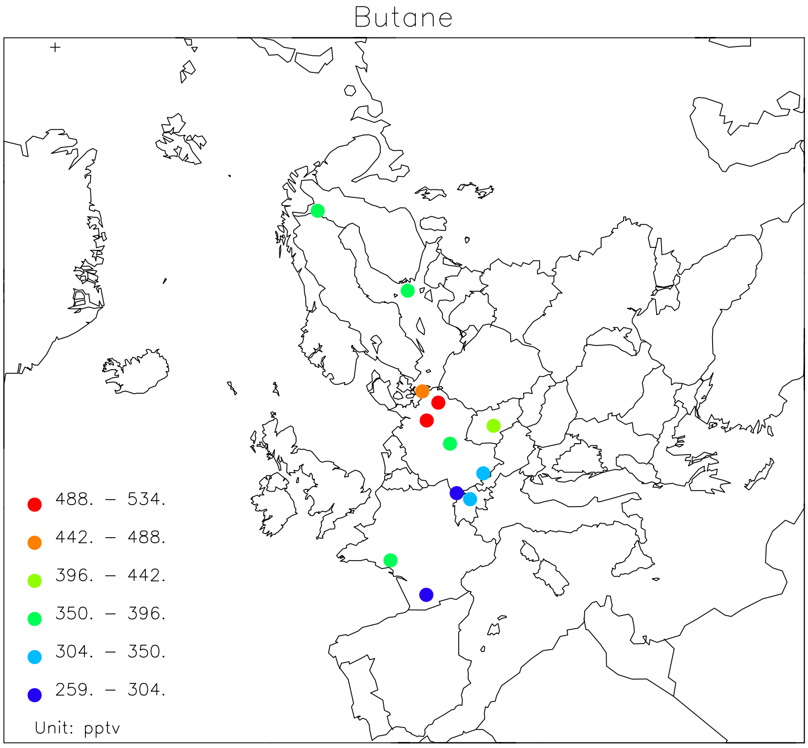

Figure 9: Median concentration of n-butane at EMEP sites in the winter months November, December, January and February 2008 taken together.

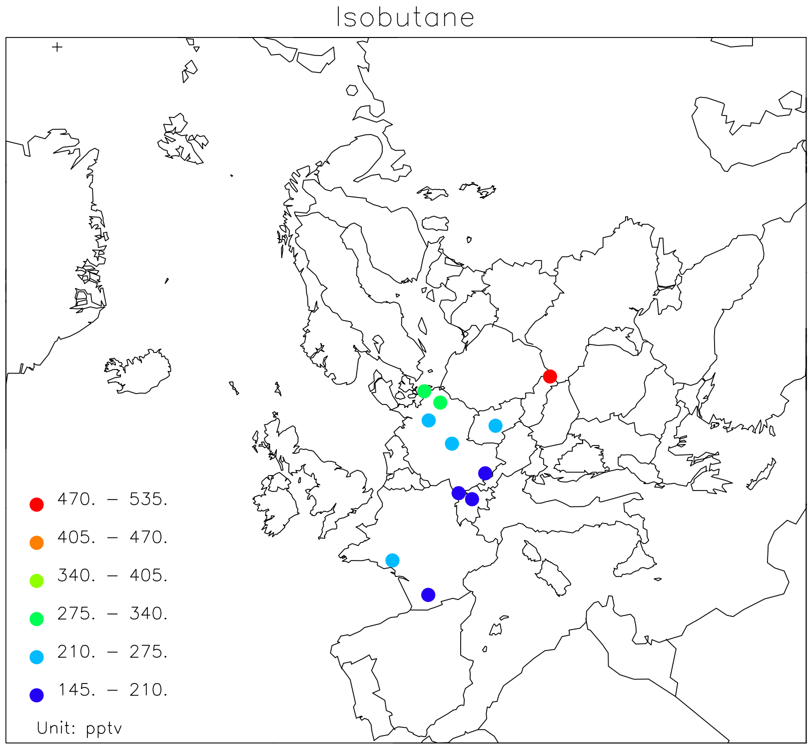

Figure 10: Median concentration of i-butane at EMEP sites in the winter months November, December, January and February 2008 taken together.

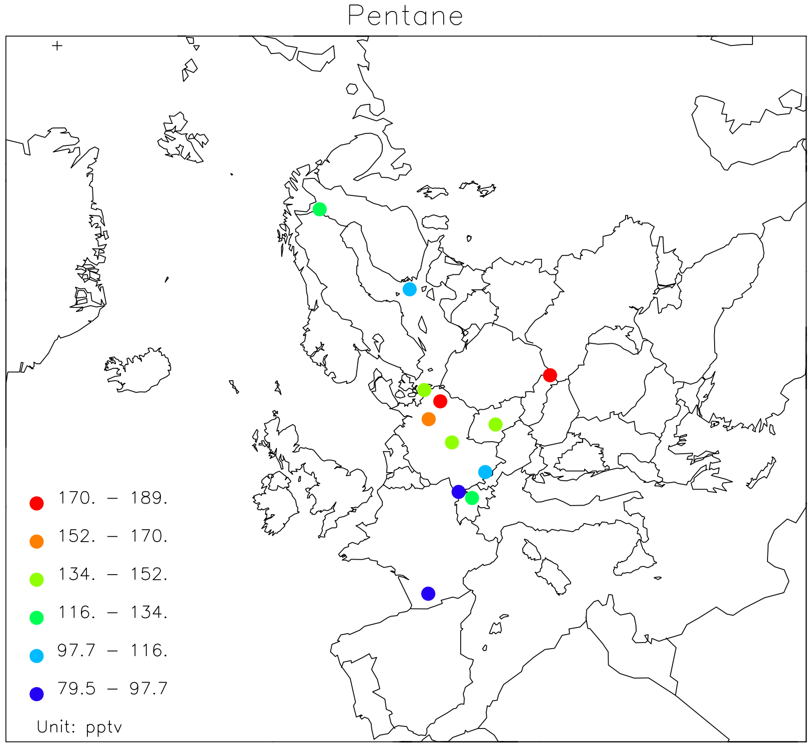

Figure 11: Median concentration of n-pentane at EMEP sites in the winter months November, December, January and February 2008 taken together.

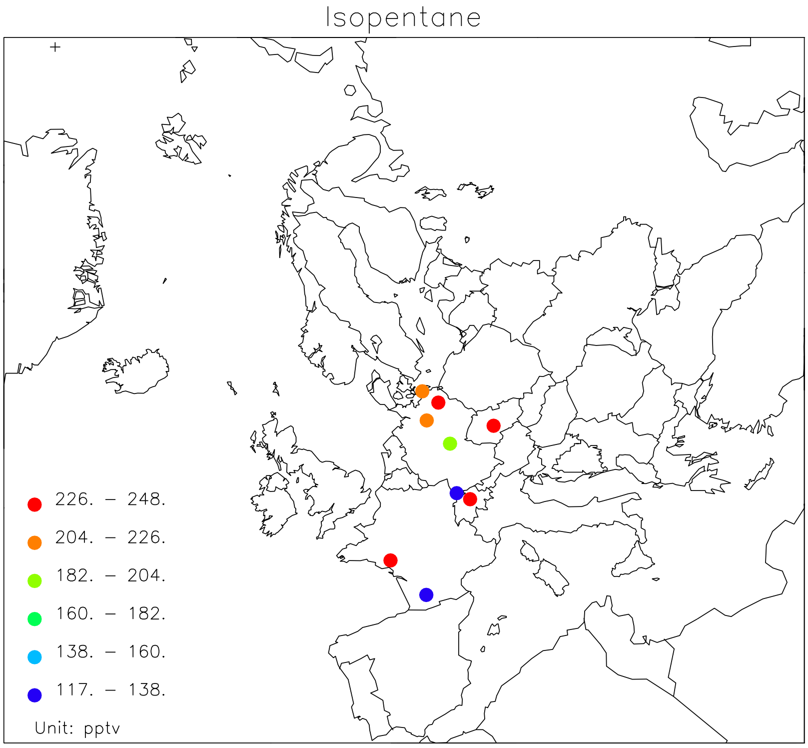

Figure 12: Median concentration of i-pentane at EMEP sites in the winter months November, December, January and February 2008 taken together.

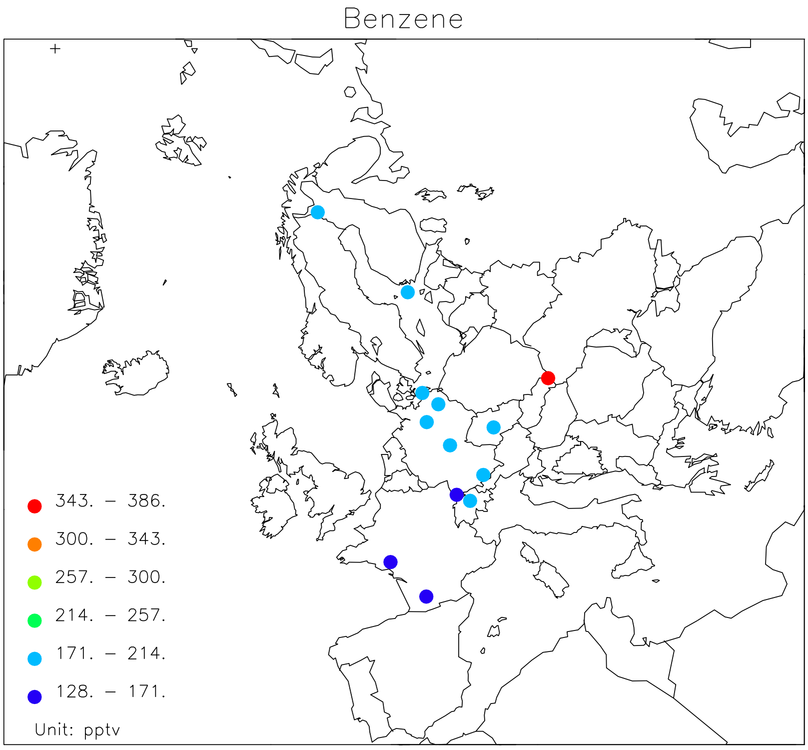

Figure 13: Median concentration of benzene at EMEP sites in the winter months November, December, January and February 2008 taken together.

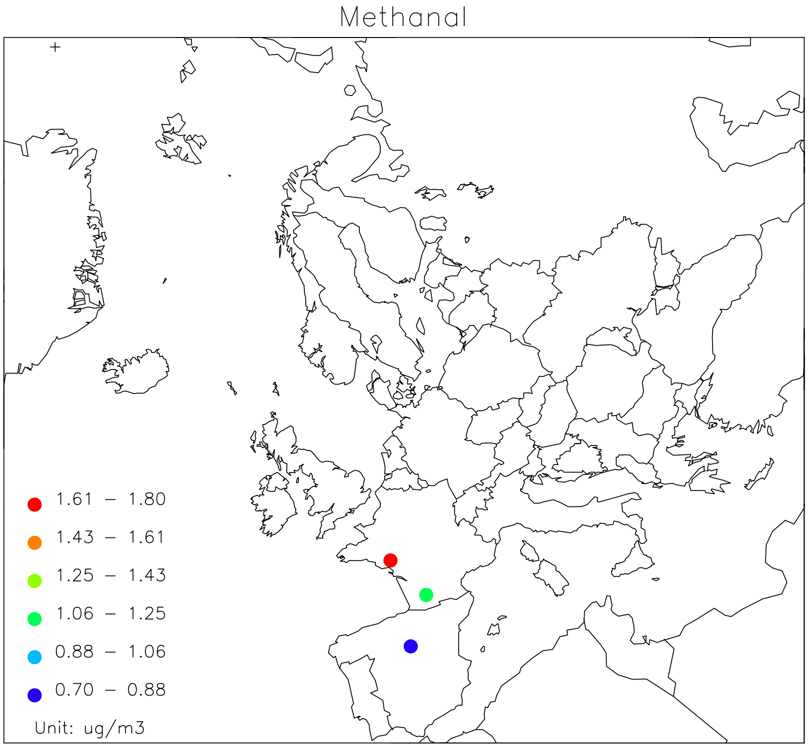

Figure 14: Median concentration of formaldehyde at EMEP sites in the summer months May, June, July and August 2008 taken together.

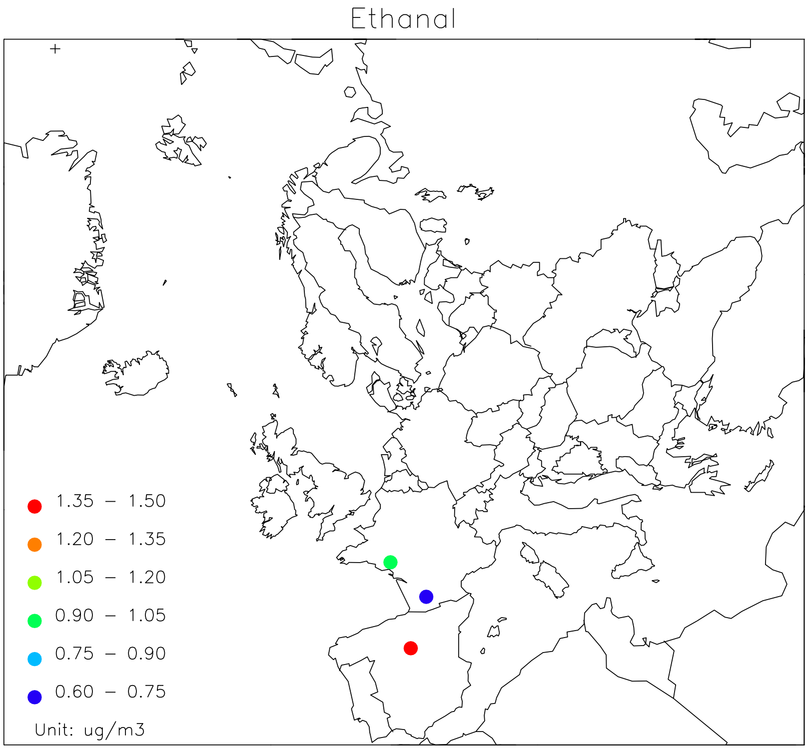

Figure 15: Median concentration of acetaldehyde at EMEP sites in the summer months May, June, July and August 2008 taken together. Note that the values for ES09 are based on data for August only.

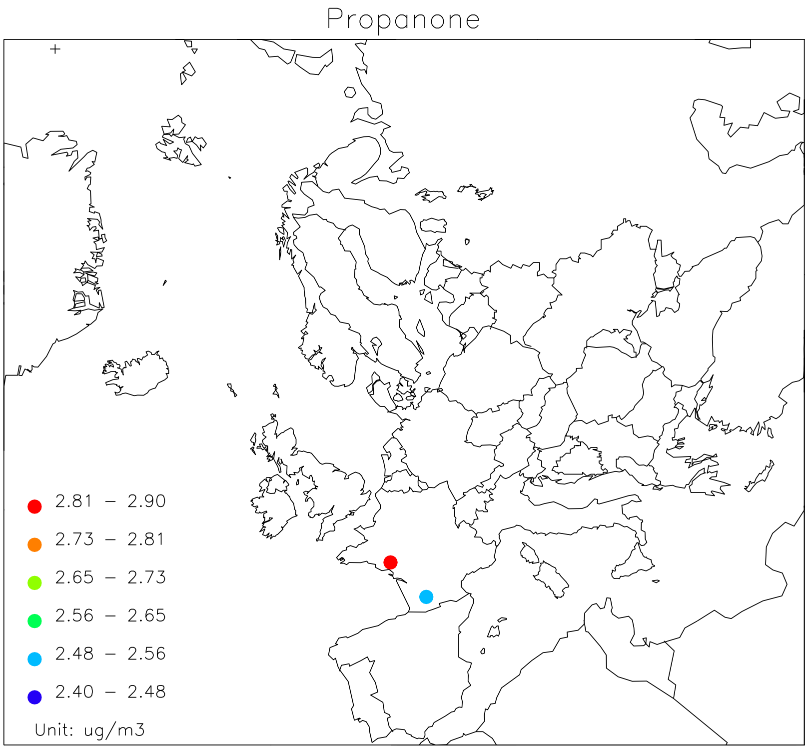

Figure 16: Median concentration of acetone at EMEP sites in the summer months May, June, July and August 2008 taken together.

4. Long-term trends in VOC

The 14 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 Peyrusse Vieille (FR13) 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.

The 14 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 acetylene (ethyne), butane and benzene, the results do indicate a long-term reduction in the winter median concentration level for many of the sites, whereas for other compounds, the year-to-year variations are too large to draw any further conclusions.

In general the median concentration levels for 2008 shown in Figure 17 indicates concentrations similar to or slightly lower than in 2007 which also showed generally low NMHC concentrations. The winter median levels of ethane were somewhat higher in 2008 compared to 2007 for several of the sites.

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.

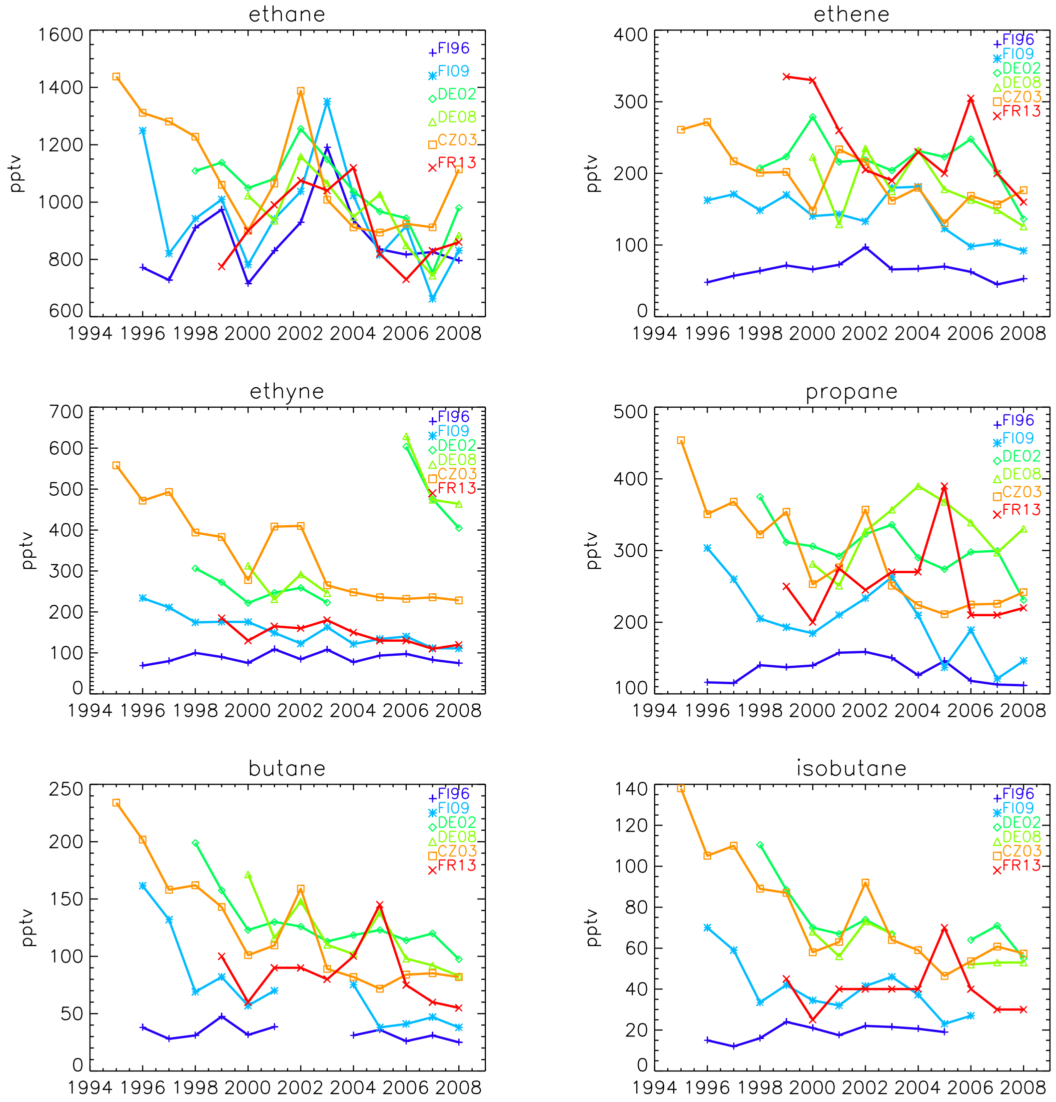

Figure 17: Annual winter (Jan., Feb., Nov., Dec.) median concentrations of hydrocarbons at Košetice (CZ03), Waldhof (DE02), Peyrusse Vieille (FR13), Utö (FI09) and Pallas (FI96).

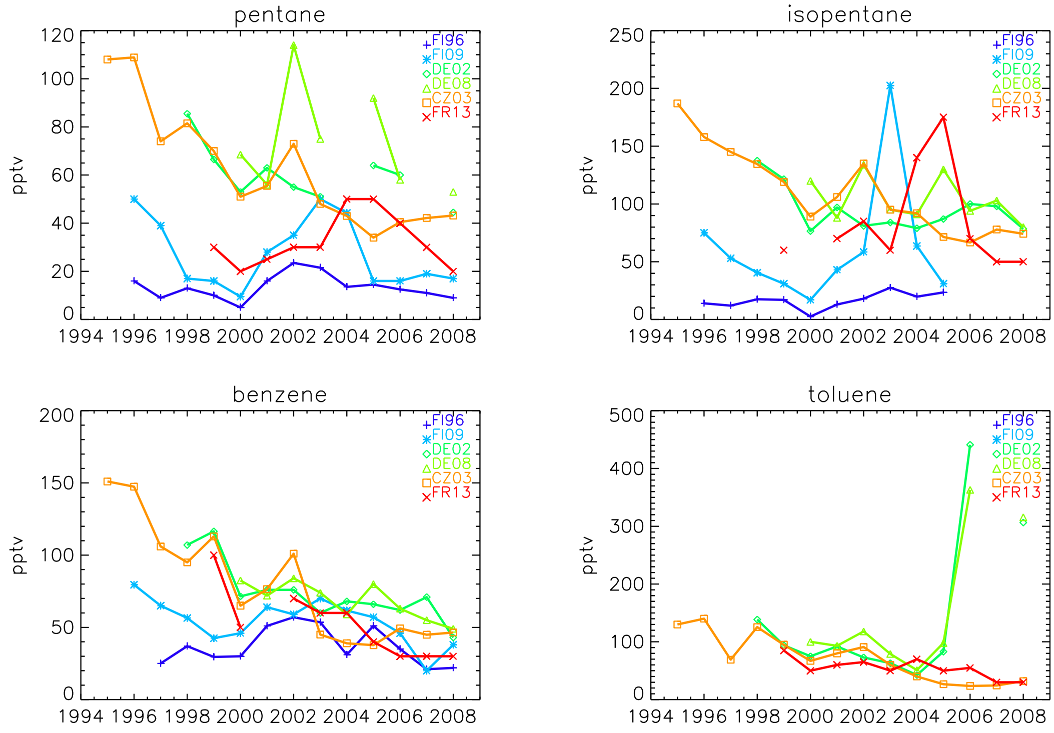

Figure 17, cont.

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 2008

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	1975	2508	2940	-	1538	899	614	629	669	767	1190	1618
	2279	2457	2936	-	1596	888	629	634	679	785	1072	1681
Utö	2579	2616	3097	2434	1345	946	679	653	813	1167	1185	1704
	2355	2520	2912	2478	1311	980	694	672	638	1113	1193	1613
Zingst	2622	2179	2140	1830	1547	1095	774	820	897	1785	1988	2648
	2340	2127	2114	1853	1495	1117	812	846	762	1778	1894	2678
Neuglobsow	2337	2636	2149	1637	1498	1097	838	778	977	1670	2078	2893
	2350	2109	2156	1631	1426	1099	835	717	826	1569	1881	3105
Waldhof	2615	2444	2303	1835	1560	1081	818	756	974	1666	2434	2575
	2433	2371	2245	1905	1570	1063	815	735	887	1717	2193	2561
Schmücke	2207	2009	2190	1903	1426	1038	791	690	1111	1589	1910	2254
	2294	2088	2113	1850	1459	1075	793	664	838	1551	1776	2102
Schauinsland	1548	2258	1931	1763	-	1088	813	653	981	1365	1744	1936
	1773	2051	1910	1835	-	995	778	634	983	1331	1571	1822
Hohenpeissenberg	1833	2012	2109	1992	1349	1092	783	639	941	1094	1561	2205
	1855	1938	2172	2089	1328	1054	771	637	878	1079	1558	2041
Starina	3013	2421	2099	1756	1303	1075	681	-	1243	-	-	-
	2664	2091	2019	1838	1287	1161	657	-	1447	-	-	-
Košetice	2659	2391	2086	2134	1496	1211	875	733	1281	1148	1792	2240
	2227	2189	2301	2130	1461	1222	813	726	1155	1045	1712	2306
Rigi	2183	2335	2326	2212	1580	1243	872	756	1101	1256	1925	2549
	2201	2291	2355	2212	1579	1192	874	761	1048	1208	1909	2373
La Tardière	2024	2316	2239	2084	1457	1019	752	613	1019	1117	1753	2563
	1900	2345	2175	2110	1470	985	770	580	900	1080	1630	2580
Peyrusse Vieille	2163	2104	1963	2450	1273	941	709	789	960	1069	1651	2374
	2055	2190	2040	1925	1240	900	770	650	1010	990	1650	2010

ETHENE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Pallas	472	288	326	-	51	61	52	121	89	142	404	506
	340	263	318	-	37	53	57	77	82	134	195	590
Utö	655	742	530	299	104	112	101	149	298	224	321	793
	607	244	262	223	84	92	84	158	127	178	294	677
Zingst	916	592	280	238	237	191	150	262	166	479	655	1193
	731	295	257	186	232	187	150	264	142	374	422	1001
Neuglobsow	1131	939	231	195	155	157	135	210	191	592	918	1508
	1111	432	204	151	115	128	116	207	172	461	582	1552
Waldhof	746	863	386	240	212	121	168	213	260	524	1206	1297
	719	877	315	233	158	122	128	171	181	536	953	988
Schmücke	803	630	367	398	203	118	120	186	347	718	768	976
	805	644	355	269	230	119	107	124	254	666	650	744
Schauinsland	215	807	327	199	-	227	169	215	225	390	470	574
	243	422	238	191	-	201	155	177	219	357	326	379
Hohenpeissenberg	508	931	400	365	240	183	147	131	348	465	692	1226
	401	653	285	323	194	181	117	96	268	297	564	982
Starina	1011	689	404	214	184	145	147	-	264	-	-	-
	944	442	264	184	147	128	139	-	306	-	-	-
Košetice	1078	1275	617	429	241	194	211	163	476	528	1279	1853
	628	816	624	322	214	179	183	136	420	313	1159	1650
Rigi	657	926	394	354	270	226	152	191	377	459	749	1268
	504	631	316	288	231	194	136	163	335	318	576	907
La Tardière	972	781	455	468	345	298	223	176	331	354	763	1624
	910	665	415	355	375	270	230	170	300	310	715	1420
Peyrusse Vieille	819	398	235	254	186	183	166	249	194	277	474	1173
	715	355	230	180	180	160	140	270	180	220	425	610

PROPANE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Pallas	916	1204	1314	-	266	110	79	94	165	250	607	887
	1126	1191	1333	-	279	103	72	71	168	274	521	945
Utö	1224	1240	1360	921	259	154	98	162	316	436	651	935
	1107	1129	1237	906	221	131	82	163	161	414	580	918
Zingst	1303	1141	908	601	390	241	206	352	361	865	981	1345
	1295	957	875	610	339	253	211	363	282	882	857	1365
Neuglobsow	1314	1464	897	603	376	239	243	279	435	759	1120	1748
	1404	1194	912	519	362	238	176	259	316	731	987	1764
Waldhof	1279	1274	1066	645	455	243	282	273	452	839	1496	1417
	1224	1289	966	693	492	241	197	227	381	748	1381	1294
Schmücke	1121	908	970	737	412	389	308	377	592	960	981	1314
	1245	979	944	765	411	377	314	329	414	834	900	1156
Schauinsland	623	1083	769	564	-	300	205	200	388	489	742	883
	759	816	763	551	-	251	187	158	381	402	632	784
Hohenpeissenberg	797	850	808	624	315	283	208	183	398	444	730	1096
	814	756	824	662	302	263	187	155	366	401	661	929
Starina	1465	1172	1026	681	488	439	297	-	728	-	-	-
	1366	1175	1013	743	447	481	299	-	894	-	-	-
Košetice	1169	1002	891	649	347	276	214	191	571	402	956	999
	975	980	926	635	341	256	168	185	487	323	977	1072
Rigi	846	909	742	546	326	273	171	203	389	412	798	1215
	877	865	724	534	305	238	157	172	350	346	716	1139
La Tardière	1247	974	901	708	388	278	176	126	406	489	774	1380
	1100	1055	805	735	400	215	120	100	340	400	680	1470
Peyrusse Vieille	1051	861	715	633	272	207	166	217	362	356	744	1281
	960	905	745	530	250	170	140	220	380	350	720	1200

PROPENE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Pallas	25	37	35	-	22	29	31	46	36	43	87	70
	25	36	34	-	18	23	31	32	34	45	62	75
Utö	96	104	63	49	33	38	35	48	71	75	91	118
	86	57	54	52	31	33	28	46	60	69	95	93
Zingst	230	150	117	112	139	146	137	153	132	219	251	392
	223	96	116	105	136	140	136	150	127	201	195	368
Neuglobsow	262	263	95	115	139	160	138	160	129	242	323	561
	271	118	95	109	128	139	137	161	127	225	226	521
Waldhof	210	207	148	105	144	126	131	152	146	218	319	464
	190	167	133	99	141	127	121	153	124	222	275	417
Schmücke	175	151	104	141	147	120	124	127	138	264	237	356
	187	154	99	141	135	112	110	118	135	262	226	318
Schauinsland	85	184	153	118	-	163	145	180	131	222	189	338
	81	137	134	109	-	150	143	162	124	210	168	332
Hohenpeissenberg	59	100	49	43	20	26	19	15	35	65	88	178
	49	66	40	34	12	16	16	13	25	40	64	126
Starina	162	99	80	40	47	46	46	-	51	-	-	-
	125	90	72	36	36	49	43	-	48	-	-	-
Košetice	135	165	82	54	31	28	39	30	62	89	248	350
	88	111	73	37	31	24	29	20	69	42	210	271
Rigi	85	107	59	54	38	38	21	26	46	57	83	175
	64	74	51	45	39	35	19	22	39	33	60	93
La Tardière	178	120	101	83	113	81	54	53	70	82	135	279
	170	110	80	75	125	65	50	50	70	70	145	210
Peyrusse Vieille	110	55	49	60	48	49	44	80	36	53	79	249
	100	50	50	40	50	40	40	50	40	60	65	110

ETHYNE (ACETYLENE)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Pallas	593	631	724	-	202	77	49	85	96	119	317	486
	544	562	684	-	201	74	49	60	84	124	215	563
Utö	639	753	826	592	242	105	70	102	237	219	282	625
	556	543	660	486	233	112	59	108	99	176	227	577
Zingst	1034	837	756	692	598	433	366	446	414	737	808	1158
	890	733	707	677	621	420	386	452	411	700	630	971
Neuglobsow	1090	922	712	577	503	367	345	413	479	763	827	1255
	1004	696	704	583	541	401	349	403	414	718	535	1335
Waldhof	920	1066	780	709	520	413	407	381	445	804	1056	1173
	882	1119	786	721	471	390	389	387	397	835	773	853
Schmücke	993	918	816	629	600	472	411	467	609	896	867	967
	1000	897	777	668	590	468	430	452	556	766	720	867
Schauinsland	629	851	671	609	-	470	410	417	530	661	612	704
	697	768	698	632	-	497	402	406	557	620	565	552
Hohenpeissenberg	515	754	522	464	283	196	139	124	284	338	539	815
	472	585	501	449	266	170	117	118	246	240	438	655
Starina	1318	1040	433	477	301	244	205	-	484	-	-	-
	1248	743	299	498	292	210	205	-	626	-	-	-
Košetice	1102	1300	881	693	411	283	166	201	474	486	1381	1640
	783	906	874	630	383	291	188	212	481	338	1463	1413
Rigi	553	833	496	439	293	192	138	168	319	355	590	864
	478	651	460	428	273	178	120	149	319	289	481	672
La Tardière	643	678	465	425	250	125	101	86	232	214	444	822
	630	590	445	410	235	105	90	80	200	190	405	790
Peyrusse Vieille	699	499	366	294	198	131	89	110	223	220	350	764
	525	465	395	290	190	100	60	90	190	170	370	430

BUTANE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Pallas	282	405	446	-	51	52	23	24	49	81	228	348
	351	407	448	-	46	40	22	20	43	87	195	378
Utö	453	423	443	345	56	42	38	50	139	106	216	356
	435	376	374	300	39	35	23	47	57	100	208	352
Zingst	629	459	290	167	129	87	76	166	123	400	389	554
	485	371	267	156	88	98	77	181	91	420	304	504
Neuglobsow	575	633	264	155	100	78	80	96	170	327	433	736
	531	511	268	132	97	74	67	92	113	318	378	816
Waldhof	554	549	354	202	146	86	122	125	156	343	539	561
	476	589	335	175	102	85	73	118	122	301	508	479
Schmücke	408	343	389	226	134	85	83	98	205	323	392	474
	455	350	265	228	141	80	83	67	181	299	378	405
Schauinsland	198	400	254	141	-	119	92	100	147	188	276	324
	260	269	196	125	-	100	77	81	147	120	232	250
Hohenpeissenberg	289	342	255	180	102	112	76	76	144	183	287	442
	303	313	252	182	91	99	72	64	128	149	253	362
Starina	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Košetice	434	351	278	173	105	95	84	69	207	144	447	478
	334	356	281	150	105	82	65	65	142	113	462	466
Rigi	287	381	264	192	138	128	95	156	203	232	370	516
	289	344	259	183	125	112	87	136	207	191	334	430
La Tardière	377	310	259	206	135	86	99	71	149	154	314	511
	410	330	235	200	145	70	70	60	110	120	285	510
Peyrusse Vieille	316	269	178	136	58	71	54	59	98	101	223	407
	310	265	180	115	50	70	50	60	100	105	215	420

ISOBUTANE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Pallas	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Utö	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Zingst	378	287	184	113	95	91	60	109	76	228	251	324
	349	227	166	103	76	75	56	107	50	212	178	323
Neuglobsow	347	417	164	147	104	51	61	88	102	220	224	430
	337	281	153	105	100	49	46	90	66	227	184	448
Waldhof	302	413	219	113	79	49	71	69	119	192	328	330
	268	367	201	109	68	52	47	66	91	165	287	271
Schmücke	244	228	180	136	80	60	55	58	124	182	241	295
	256	245	178	136	83	56	51	40	122	176	222	237
Schauinsland	110	249	176	94	-	79	53	53	82	111	156	187
	138	157	134	78	-	62	46	53	80	63	121	138
Hohenpeissenberg	160	209	160	121	78	75	53	50	98	113	166	255
	165	182	155	121	68	62	47	42	78	94	148	205
Starina	624	506	466	232	162	138	125	-	259	-	-	-
	558	398	428	238	145	120	124	-	304	-	-	-
Košetice	274	222	172	115	78	66	67	45	135	94	332	328
	201	212	174	98	73	58	53	42	106	68	316	301
Rigi	168	209	134	102	74	66	46	70	95	119	185	272
	171	187	126	96	71	57	44	62	91	90	154	208
La Tardière	232	194	155	154	75	74	29	26	72	82	259	270
	200	200	155	150	65	45	20	20	60	60	170	280
Peyrusse Vieille	176	149	113	115	39	32	24	51	58	61	133	222
	170	155	110	70	30	20	20	30	60	70	115	205

BUTENES

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Pallas	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Utö	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Zingst	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Neuglobsow	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Waldhof	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Schmücke	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Schauinsland	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Hohenpeissenberg	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Starina	76	71	56	58	61	60	74	-	69	-	-	-
	74	74	55	58	60	57	67	-	69	-	-	-
Košetice	61	54	51	42	42	35	37	36	44	54	189	209
	38	48	50	36	33	32	32	26	40	56	147	162
Rigi	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
La Tardière	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Peyrusse Vieille	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-

BUT_1_ENE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Pallas	-	11	-	-	8	10	8	12	10	14	25	25
	-	9	-	-	7	6	7	12	8	14	23	18
Utö	18	19	17	18	10	9	10	13	20	21	28	24
	16	15	16	16	10	7	8	14	19	20	32	19
Zingst	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Neuglobsow	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Waldhof	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Schmücke	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Schauinsland	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Hohenpeissenberg	13	22	21	9	5	5	4	5	7	13	14	29
	11	17	10	8	4	4	4	5	6	10	11	22
Starina	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Košetice	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Rigi	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
La Tardière	37	29	28	25	38	23	22	24	22	22	28	46
	40	30	25	25	35	20	20	30	20	20	30	40
Peyrusse Vieille	28	14	13	15	12	15	12	19	9	16	12	41
	30	15	10	15	10	10	10	20	10	20	10	30

TRANS_2_BUTENE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Pallas	-	6	-	-	-	-	-	-	-	-	-	-
	-	6	-	-	-	-	-	-	-	-	-	-
Utö	-	-	8	-	-	-	-	-	-	-	-	-
	-	-	8	-	-	-	-	-	-	-	-	-
Zingst	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Neuglobsow	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Waldhof	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Schmücke	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Schauinsland	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Hohenpeissenberg	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Starina	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Košetice	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Rigi	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
La Tardière	8	5	8	5	10	6	6	6	5	6	7	8
	5	5	5	5	5	5	5	5	5	5	5	5
Peyrusse Vieille	5	6	5	5	5	5	5	5	5	5	5	11
	5	5	5	5	5	5	5	5	5	5	5	5

CIS_2_BUTENE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Pallas	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Utö	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Zingst	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Neuglobsow	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Waldhof	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Schmücke	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Schauinsland	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Hohenpeissenberg	6	8	9	5	4	3	3	3	4	5	6	10
	6	8	7	5	4	3	3	2	4	4	5	7
Starina	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Košetice	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Rigi	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
La Tardière	6	6	8	5	7	6	7	5	5	5	6	8
	5	5	5	5	5	5	5	5	5	5	5	5
Peyrusse Vieille	5	6	5	5	5	5	5	5	5	5	5	10
	5	5	5	5	5	5	5	5	5	5	5	5

PENTANE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Pallas	96	125	139	-	17	16	8	15	18	30	84	127
	117	131	140	-	12	17	8	14	17	29	64	137
Utö	148	142	135	111	23	19	18	27	93	45	76	122
	148	104	116	96	15	15	13	26	26	37	73	118
Zingst	170	150	107	65	58	40	35	73	50	150	153	205
	168	143	91	48	48	41	32	80	44	144	125	192
Neuglobsow	210	209	73	57	49	43	48	53	72	137	169	281
	191	143	69	51	36	39	36	48	45	119	139	288
Waldhof	157	177	115	65	65	40	66	71	78	154	222	209
	149	183	97	57	31	36	47	60	72	110	186	170
Schmücke	155	127	92	93	65	50	50	48	89	135	164	175
	179	135	87	76	66	53	49	36	91	134	129	152
Schauinsland	60	144	86	52	-	59	58	45	69	86	110	111
	76	82	56	54	-	45	56	34	72	45	95	80
Hohenpeissenberg	77	115	110	77	69	69	53	52	77	106	141	152
	79	97	75	67	53	60	47	38	72	73	105	106
Starina	198	232	97	83	73	86	74	-	119	-	-	-
	186	191	89	90	57	91	74	-	151	-	-	-
Košetice	144	123	89	64	57	51	49	41	98	80	177	171
	107	115	87	62	54	41	45	40	85	58	180	160
Rigi	110	186	97	91	106	98	74	106	109	138	170	185
	102	139	80	78	98	86	62	70	95	97	146	129
La Tardière	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Peyrusse Vieille	95	70	45	34	29	24	30	35	45	45	98	210
	90	70	45	30	20	20	30	30	45	40	90	120

ISOPENTANE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Pallas	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Utö	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Zingst	238	204	151	87	109	73	59	160	79	234	195	291
	235	197	113	69	88	78	57	157	69	200	147	267
Neuglobsow	280	299	103	95	84	63	58	94	104	200	210	369
	273	225	104	86	87	68	50	79	77	179	161	372
Waldhof	212	253	147	97	86	68	107	94	121	208	254	284
	206	227	125	78	49	73	78	89	102	152	208	238
Schmücke	216	181	130	130	112	74	84	96	140	204	225	227
	236	192	128	100	107	67	79	67	143	195	183	220
Schauinsland	86	223	149	74	-	99	98	98	112	121	153	177
	101	118	89	69	-	85	80	75	109	76	133	134
Hohenpeissenberg	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Starina	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Košetice	195	172	124	86	99	88	79	70	153	112	290	273
	134	149	124	71	83	71	85	67	128	93	289	246
Rigi	196	298	144	168	204	200	162	210	216	241	254	280
	172	235	132	150	193	186	147	187	201	196	206	228
La Tardière	252	195	141	174	222	126	129	124	187	170	225	404
	240	200	125	160	210	120	60	130	190	160	170	320
Peyrusse Vieille	159	111	76	68	58	46	39	66	79	81	139	407
	140	110	75	50	40	50	30	60	80	80	135	190

HEXANE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Pallas	39	41	41	-	-	-	-	-	-	9	26	39
	37	42	43	-	-	-	-	-	-	9	21	41
Utö	47	62	40	31	-	-	-	11	-	-	26	41
	47	49	33	31	-	-	-	8	-	-	25	35
Zingst	77	77	46	32	34	29	35	63	59	78	83	101
	70	58	37	32	32	28	28	64	41	80	59	83
Neuglobsow	93	93	32	33	36	46	28	33	43	61	63	114
	94	59	32	29	29	28	24	32	28	54	54	115
Waldhof	66	71	56	32	39	26	32	37	40	72	78	80
	70	65	46	24	34	25	26	33	39	72	70	83
Schmücke	120	140	103	55	45	62	44	34	51	81	113	104
	102	119	98	59	43	50	38	25	49	66	97	80
Schauinsland	40	59	79	29	-	36	35	36	33	48	45	63
	41	44	73	32	-	35	27	36	36	34	38	51
Hohenpeissenberg	23	29	19	16	12	14	10	10	17	22	28	43
	23	25	18	14	9	13	9	8	13	16	24	32
Starina	83	95	31	29	24	29	26	-	34	-	-	-
	71	71	29	35	18	27	20	-	35	-	-	-
Košetice	35	30	21	13	10	16	11	9	21	13	47	46
	25	24	21	13	9	11	11	9	17	13	43	38
Rigi	31	40	25	21	21	22	16	22	23	30	40	56
	31	34	22	19	19	20	15	18	21	22	35	42
La Tardière	40	49	34	40	37	21	12	21	25	20	35	57
	40	40	35	40	35	20	5	10	20	20	30	50
Peyrusse Vieille	43	26	24	26	18	21	11	10	16	19	31	60
	40	25	20	25	20	20	10	5	10	15	30	40

ISOPRENE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Pallas	-	-	-	-	-	21	26	20	-	-	-	-
	-	-	-	-	-	14	26	20	-	-	-	-
Utö	-	-	-	-	-	87	41	13	-	-	-	-
	-	-	-	-	-	14	44	14	-	-	-	-
Zingst	34	12	11	13	35	388	559	389	134	27	13	18
	18	10	12	6	20	341	401	399	83	23	7	9
Neuglobsow	18	12	6	15	138	243	487	231	125	29	23	21
	18	8	3	16	84	98	195	117	78	26	10	21
Waldhof	15	7	7	9	27	67	132	70	38	20	11	12
	7	7	5	7	29	59	78	49	25	16	8	11
Schmücke	8	5	4	12	56	52	53	41	14	14	8	9
	6	5	5	12	36	46	36	39	11	12	6	6
Schauinsland	17	10	15	8	-	105	114	122	54	32	21	8
	9	7	16	6	-	88	69	87	37	14	5	7
Hohenpeissenberg	4	5	4	8	67	40	66	55	25	10	10	10
	3	4	3	6	18	21	26	24	10	7	6	7
Starina	25	10	16	11	52	161	207	-	49	-	-	-
	14	10	14	10	50	182	163	-	50	-	-	-
Košetice	19	10	5	20	29	144	72	112	37	9	143	30
	13	4	4	17	21	109	56	113	16	8	16	23
Rigi	8	11	8	10	32	52	53	47	26	20	11	11
	6	10	6	7	18	27	28	36	16	13	9	7
La Tardière	11	8	6	8	84	280	186	256	104	43	6	7
	5	5	5	5	65	270	170	260	90	50	5	5
Peyrusse Vieille	5	9	6	36	334	1137	866	1306	691	187	14	17
	5	5	5	10	230	940	650	1290	520	80	5	5

BENZENE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Pallas	216	190	231	-	60	23	17	26	28	54	116	176
	188	181	220	-	64	22	18	28	26	53	80	192
Utö	228	250	264	165	68	35	25	51	-	-	116	222
	185	177	209	144	52	32	19	45	-	-	109	207
Zingst	256	191	141	142	87	41	36	63	68	132	161	284
	208	154	149	140	80	43	31	63	57	115	120	235
Neuglobsow	266	251	142	128	88	41	46	53	80	144	220	417
	244	174	129	127	86	40	40	56	56	133	146	459
Waldhof	209	250	164	118	75	37	45	48	78	146	281	311
	185	246	150	121	78	36	44	45	76	127	191	209
Schmücke	224	196	162	160	97	49	43	53	98	146	195	262
	219	192	160	130	93	43	38	45	88	138	164	274
Schauinsland	104	253	147	107	-	64	52	65	83	107	128	164
	109	196	141	110	-	72	47	54	85	99	115	127
Hohenpeissenberg	155	226	148	127	69	56	41	38	84	101	151	252
	143	168	141	127	65	53	36	36	73	76	126	205
Starina	473	373	258	166	116	103	90	-	179	-	-	-
	421	256	211	150	99	92	88	-	227	-	-	-
Košetice	194	218	181	131	71	55	42	42	91	96	230	244
	146	150	182	116	66	47	39	39	78	75	225	174
Rigi	182	276	173	148	105	79	58	74	120	119	188	281
	162	216	161	140	101	72	51	66	126	98	165	225
La Tardière	194	198	138	133	113	76	39	44	100	79	139	257
	180	170	130	130	110	50	30	50	110	80	115	250
Peyrusse Vieille	174	149	99	74	43	32	17	21	50	58	110	196
	150	145	105	70	40	20	20	20	50	50	115	130

TOLUENE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Pallas	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Utö	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Zingst	401	194	163	226	301	290	257	307	347	391	302	269
	313	179	135	204	272	326	266	307	232	366	328	285
Neuglobsow	278	303	174	159	319	235	273	279	261	352	255	380
	306	220	112	181	274	164	271	286	291	345	206	419
Waldhof	256	301	196	199	316	265	273	343	308	430	320	228
	251	281	155	190	308	240	277	327	272	394	281	218
Schmücke	249	250	158	255	344	279	303	322	291	323	306	279
	259	245	160	271	351	274	312	315	311	352	276	245
Schauinsland	194	282	206	206	-	194	313	382	307	441	233	171
	158	192	179	165	-	179	342	427	335	345	224	141
Hohenpeissenberg	98	173	90	99	66	82	60	63	93	148	165	201
	78	127	89	84	55	75	54	55	87	122	118	146
Starina	48	27	15	37	13	10	12	-	10	-	-	-
	54	21	12	13	12	11	10	-	11	-	-	-
Košetice	81	89	66	50	35	45	49	21	67	71	171	223
	64	77	59	38	32	36	41	19	56	67	134	166
Rigi	140	260	101	143	180	168	122	156	193	233	254	269
	99	191	80	109	157	153	106	119	167	155	189	179
La Tardière	374	204	116	114	163	81	210	89	141	163	183	370
	210	155	90	100	175	70	50	80	110	110	145	230
Peyrusse Vieille	139	81	43	55	39	47	34	54	59	69	120	430
	110	80	40	40	30	30	40	50	60	60	130	130

ETHYLBENZENE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Pallas	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Utö	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Zingst	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Neuglobsow	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Waldhof	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Schmücke	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Schauinsland	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Hohenpeissenberg	15	32	18	19	13	17	13	11	17	25	27	33
	14	25	16	17	10	16	12	10	15	23	20	22
Starina	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Košetice	18	18	11	8	7	7	7	4	7	5	46	48
	15	16	10	7	6	6	6	2	7	6	34	41
Rigi	21	35	15	21	29	30	21	26	29	35	38	45
	15	26	11	17	25	29	21	24	26	22	29	24
La Tardière	63	51	34	40	72	31	24	30	47	41	44	91
	50	40	35	40	75	30	20	30	40	30	40	60
Peyrusse Vieille	30	30	12	15	11	9	11	9	11	12	21	87
	30	25	10	15	5	10	5	5	10	10	20	30

m+p-XYLENE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Pallas	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Utö	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Zingst	87	49	37	21	23	21	18	37	16	53	66	92
	88	37	37	15	19	19	13	32	15	43	47	77
Neuglobsow	103	87	20	18	20	30	15	20	18	59	61	128
	103	60	19	21	14	13	11	19	10	48	33	107
Waldhof	68	77	65	33	25	11	17	25	24	67	77	83
	72	73	56	20	16	12	14	23	16	52	55	79
Schmücke	79	64	37	52	26	37	21	22	33	89	72	78
	73	64	33	52	29	19	22	13	28	75	65	48
Schauinsland	30	87	41	26	-	23	19	21	24	71	40	57
	24	40	31	22	-	18	18	19	24	49	32	29
Hohenpeissenberg	35	81	44	43	27	31	25	20	37	65	71	91
	27	64	39	34	15	30	21	16	33	51	48	55
Starina	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Košetice	44	37	18	17	11	12	15	12	17	8	125	135
	36	35	18	11	10	10	11	3	11	7	85	99
Rigi	45	83	35	52	77	98	61	67	79	92	97	123
	32	57	27	37	65	93	55	60	69	51	69	46
La Tardière	197	146	121	129	243	94	109	103	151	139	130	294
	150	140	120	135	240	80	80	110	110	130	120	140
Peyrusse Vieille	80	83	33	38	28	20	41	17	16	26	48	229
	80	45	30	30	20	20	30	20	20	20	35	40

o-XYLENE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Pallas	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Utö	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Zingst	32	19	10	8	10	9	8	19	8	24	28	37
	33	14	8	7	9	8	7	19	7	23	21	35
Neuglobsow	43	34	8	10	17	17	14	16	20	37	35	64
	43	23	8	10	13	8	9	14	11	29	25	53
Waldhof	24	30	20	12	11	8	11	15	13	36	38	46
	24	28	17	9	7	8	9	13	9	31	28	38
Schmücke	31	24	13	17	14	16	15	13	15	31	32	30
	31	24	13	12	14	13	16	9	12	28	25	17
Schauinsland	10	32	18	9	-	13	10	11	11	23	20	24
	10	17	16	8	-	11	9	11	12	17	16	13
Hohenpeissenberg	15	-	-	-	-	-	-	-	-	-	-	-
	14	-	-	-	-	-	-	-	-	-	-	-
Starina	355	244	147	127	155	187	254	-	206	-	-	-
	295	213	151	127	111	166	209	-	227	-	-	-
Košetice	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Rigi	22	34	13	20	31	37	24	25	29	33	39	51
	16	24	11	16	26	35	21	22	25	20	30	28
La Tardière	54	38	29	29	41	20	35	20	29	32	35	72
	40	35	25	30	45	20	20	20	20	30	30	60
Peyrusse Vieille	29	28	8	12	7	6	11	6	5	8	17	69
	25	20	5	5	5	5	10	5	5	5	15	20

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

METHANAL (FORMALDEHYDE)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
La Tardière	1.335	0.993	-	2.045	1.720	2.596	2.028	1.131	1.474	0.927	-	2.068
	0.812	0.928	-	0.868	1.690	2.589	1.886	0.952	1.483	0.849	-	1.665
Peyrusse Vieille	0.754	1.011	0.503	0.827	0.954	1.147	1.525	1.945	3.467	0.972	0.744	-
	0.694	1.017	0.392	0.749	0.926	1.069	1.903	1.946	1.943	0.954	0.619	-
Campisábalos	0.183	0.343	0.420	0.492	0.533	0.767	0.877	0.858	0.702	0.641	0.521	0.415
	0.160	0.310	0.220	0.455	0.510	0.800	0.860	0.820	0.660	0.640	0.490	0.400

ETHANAL (ACETALDEHYDE)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
La Tardière	1.017	0.621	-	0.699	1.192	1.208	0.937	0.427	0.746	0.763	-	1.148
	0.610	0.642	-	0.705	1.152	1.224	0.914	0.411	0.767	0.497	-	0.886
Peyrusse Vieille	0.472	0.557	0.293	0.486	0.744	0.763	0.496	0.756	0.961	0.687	0.571	-
	0.459	0.575	0.220	0.445	0.693	0.770	0.606	0.684	0.826	0.653	0.509	-
Campisábalos	1.154	1.400	1.333	1.026	1.132	1.570	1.628	1.926	2.302	2.152	1.480	1.426
	1.210	1.570	1.200	1.005	1.190	1.340	1.550	1.755	2.280	2.100	1.495	1.390

PROPANONE (ACETONE)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
La Tardière	1.915	1.646	-	2.122	3.989	3.990	2.718	1.872	2.803	2.183	-	2.241
	1.651	1.575	-	2.042	4.040	3.457	2.446	1.521	2.856	2.394	-	1.920
Peyrusse Vieille	1.254	1.752	1.030	1.672	2.722	2.598	1.963	2.309	3.211	1.986	2.079	-
	1.201	1.666	0.889	1.733	2.892	2.422	2.378	2.276	3.318	2.404	1.381	-
Campisábalos	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-

PROPANAL

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
La Tardière	0.162	0.107	-	0.132	0.153	0.116	0.096	0.030	0.084	0.073	-	0.215
	0.116	0.115	-	0.147	0.157	0.103	0.109	0.030	0.078	0.054	-	0.182
Peyrusse Vieille	0.066	0.083	0.037	0.069	0.068	0.045	0.037	-	0.134	0.080	0.065	-
	0.089	0.076	0.036	0.079	0.066	0.042	0.041	-	0.076	0.061	0.077	-
Campisábalos	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-

2-PROPENAL (ACROLEIN)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
La Tardière	0.015	0.015	-	0.045	0.025	0.024	0.019	0.028	0.014	0.015	-	0.015
	0.015	0.015	-	0.039	0.015	0.016	0.016	0.016	0.014	0.015	-	0.015
Peyrusse Vieille	0.015	0.015	0.015	0.015	0.015	0.016	0.015	-	0.024	0.015	0.020	-
	0.015	0.015	0.015	0.015	0.015	0.016	0.015	-	0.015	0.016	0.016	-
Campisábalos	0.025	0.025	0.025	0.025	0.025	0.028	0.025	0.035	0.025	0.025	0.156	0.196
	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.215	0.240

2-BUTANONE (METHYLETHYLKETONE)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
La Tardière	0.523	0.389	-	0.579	0.630	0.663	0.453	-	1.398	0.500	-	1.025
	0.378	0.380	-	0.578	0.570	0.598	0.376	-	0.665	0.298	-	0.552
Peyrusse Vieille	0.264	0.379	0.160	0.295	0.390	0.421	-	-	2.266	0.485	0.262	-
	0.245	0.393	0.126	0.248	0.373	0.304	-	-	1.968	0.379	0.226	-
Campisábalos	0.594	0.403	1.700	0.025	0.051	0.099	0.601	1.040	1.302	1.121	0.797	0.928
	0.710	0.052	1.610	0.025	0.060	0.100	0.580	0.885	1.300	1.070	0.805	0.980

3-BUTEN-2-ONE (METHYLVINYLKETONE)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
La Tardière	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Peyrusse Vieille	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Campisábalos	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-

2-METHYL PROPENAL (METHACROLEIN)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
La Tardière	0.018	0.011	-	0.014	0.037	0.129	0.122	-	0.044	0.017	-	0.015
	0.011	0.011	-	0.011	0.035	0.104	0.078	-	0.035	0.011	-	0.011
Peyrusse Vieille	0.011	0.011	0.011	0.011	0.097	0.091	0.184	-	0.283	0.068	0.011	-
	0.011	0.011	0.011	0.011	0.089	0.083	0.206	-	0.141	0.029	0.012	-
Campisábalos	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-

BENZENECARBALDEHYDE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
La Tardière	0.108	0.059	-	0.073	0.146	0.123	0.077	0.026	0.043	0.067	-	0.071
	0.071	0.070	-	0.071	0.147	0.129	0.056	0.016	0.044	0.073	-	0.055
Peyrusse Vieille	0.022	0.019	0.015	0.029	0.055	0.039	0.019	-	0.032	0.048	0.026	-
	0.016	0.015	0.015	0.016	0.054	0.042	0.015	-	0.028	0.051	0.016	-
Campisábalos	0.109	0.100	0.182	0.188	0.112	0.056	0.477	-	-	-	-	-
	0.100	0.025	0.170	0.215	0.120	0.025	0.455	-	-	-	-	-

PENTANAL

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
La Tardière	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Peyrusse Vieille	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-
Campisábalos	0.225	0.085	0.198	0.396	0.210	0.273	0.275	0.267	0.227	0.271	0.380	0.187
	0.220	0.100	0.190	0.310	0.210	0.270	0.270	0.285	0.230	0.250	0.375	0.190

ETHANEDIAL (GLYOXAL)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
La Tardière	0.011	0.011	-	0.011	0.019	0.016	0.023	0.011	0.054	0.011	-	0.027
	0.011	0.011	-	0.011	0.019	0.012	0.026	0.011	0.038	0.011	-	0.036
Peyrusse Vieille	0.011	0.011	0.011	0.011	0.022	0.018	0.028	0.031	-	0.026	0.011	-
	0.011	0.011	0.011	0.011	0.011	0.018	0.011	0.014	-	0.012	0.012	-
Campisábalos	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-

HEXANAL

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
La Tardière	0.026	0.039	-	0.086	0.092	0.100	0.073	0.039	0.059	0.042	-	0.069
	0.015	0.044	-	0.079	0.082	0.100	0.077	0.032	0.059	0.040	-	0.054
Peyrusse Vieille	0.015	0.025	0.026	0.048	0.125	0.101	0.047	-	0.175	0.054	0.020	-
	0.015	0.015	0.024	0.053	0.112	0.097	0.041	-	0.101	0.044	0.016	-
Campisábalos	0.147	0.130	0.150	0.328	0.256	0.186	0.157	0.127	0.194	0.228	0.306	0.211
	0.150	0.145	0.130	0.255	0.260	0.190	0.140	0.125	0.190	0.220	0.295	0.190

2-OXOPROPANAL (METHYLGLYOXAL)

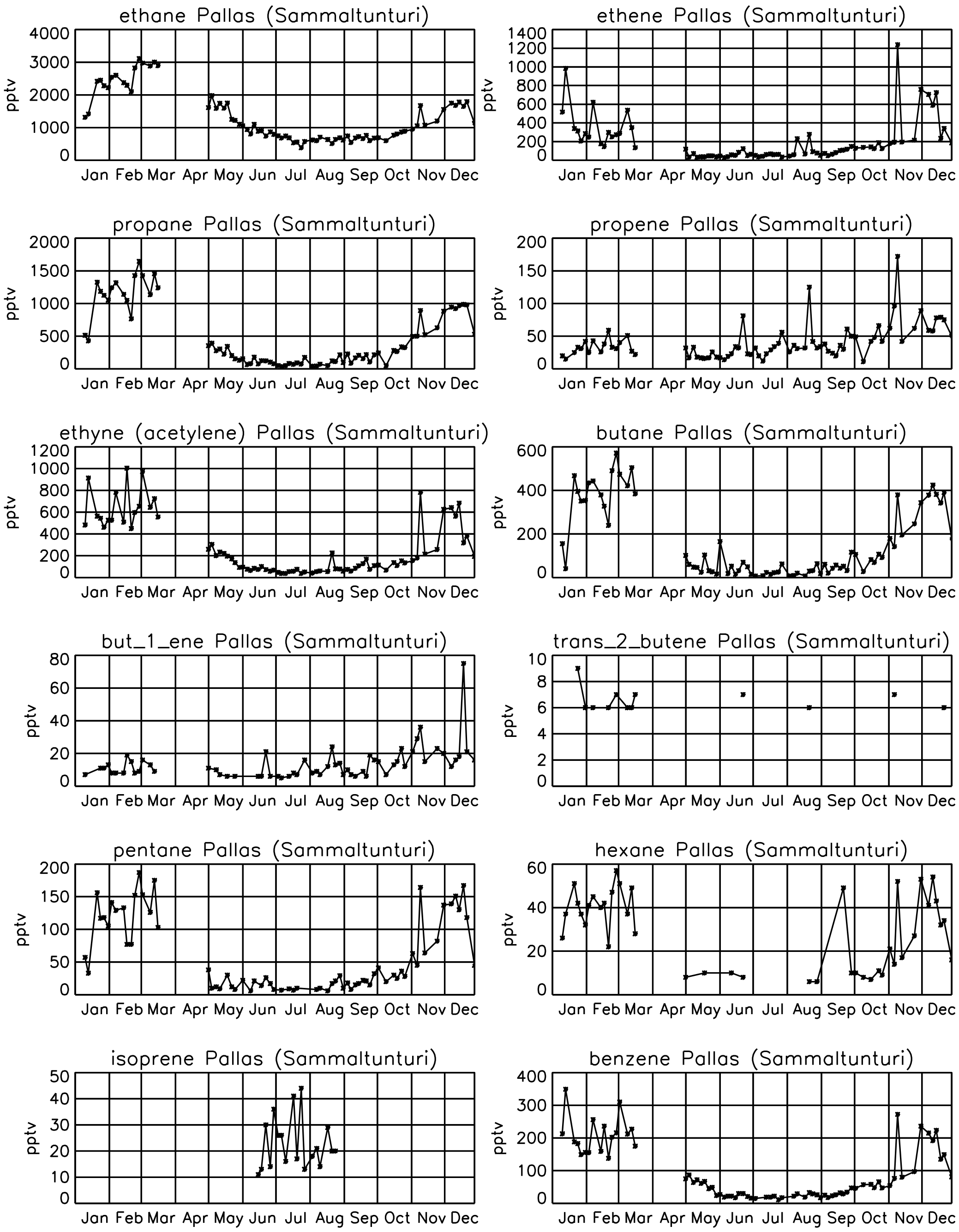
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
La Tardière	0.032	0.032	-	0.095	0.085	0.270	0.101	0.035	0.021	0.022	-	0.201
	0.015	0.031	-	0.046	0.073	0.094	0.091	0.016	0.015	0.015	-	0.166
Peyrusse Vieille	0.019	0.024	0.024	0.019	0.050	0.091	0.091	0.386	0.182	0.031	0.020	-
	0.015	0.015	0.023	0.015	0.054	0.067	0.104	0.082	0.160	0.016	0.015	-
Campisábalos	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-

Appendix B

Time series of VOC measured in 2008

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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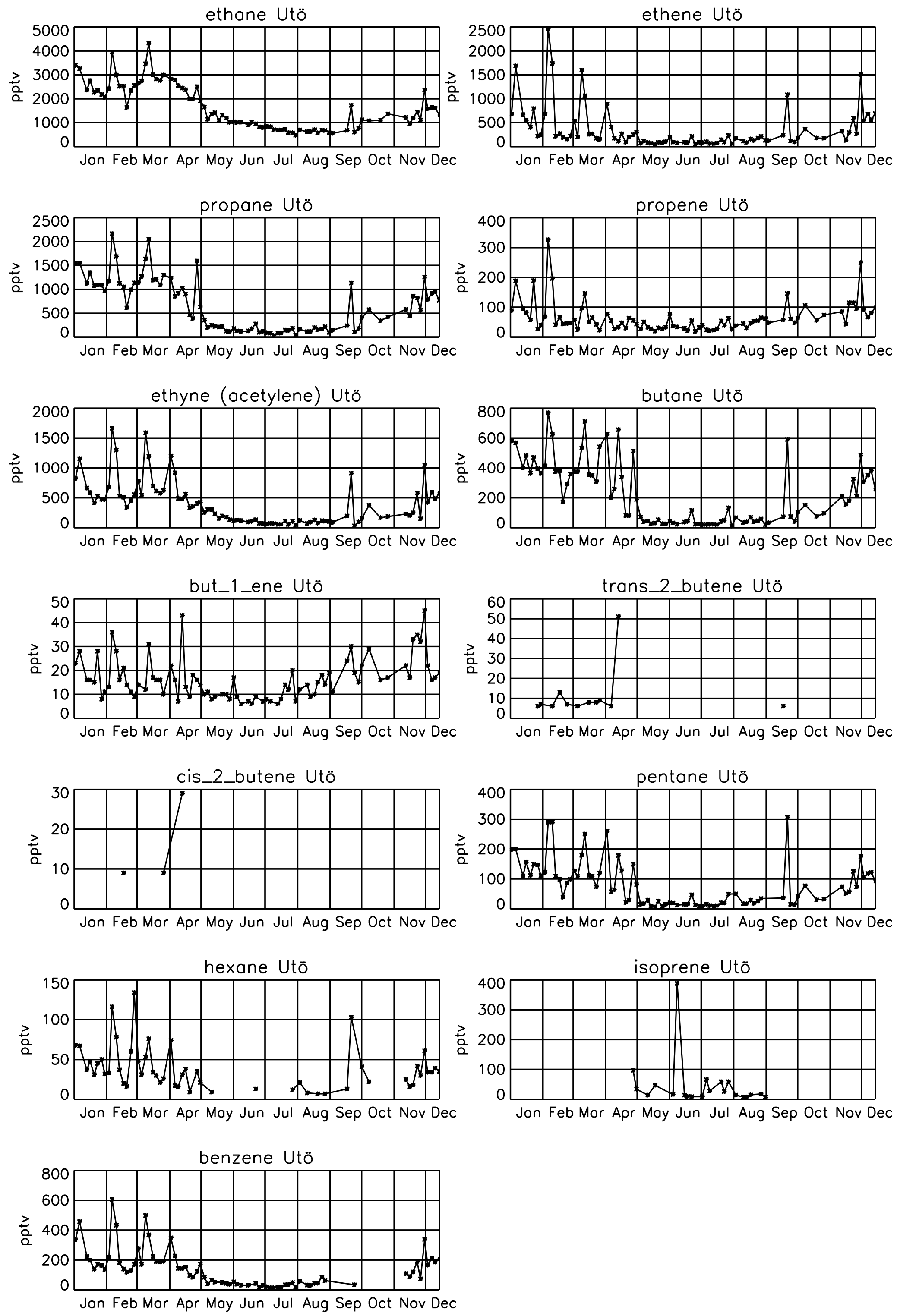
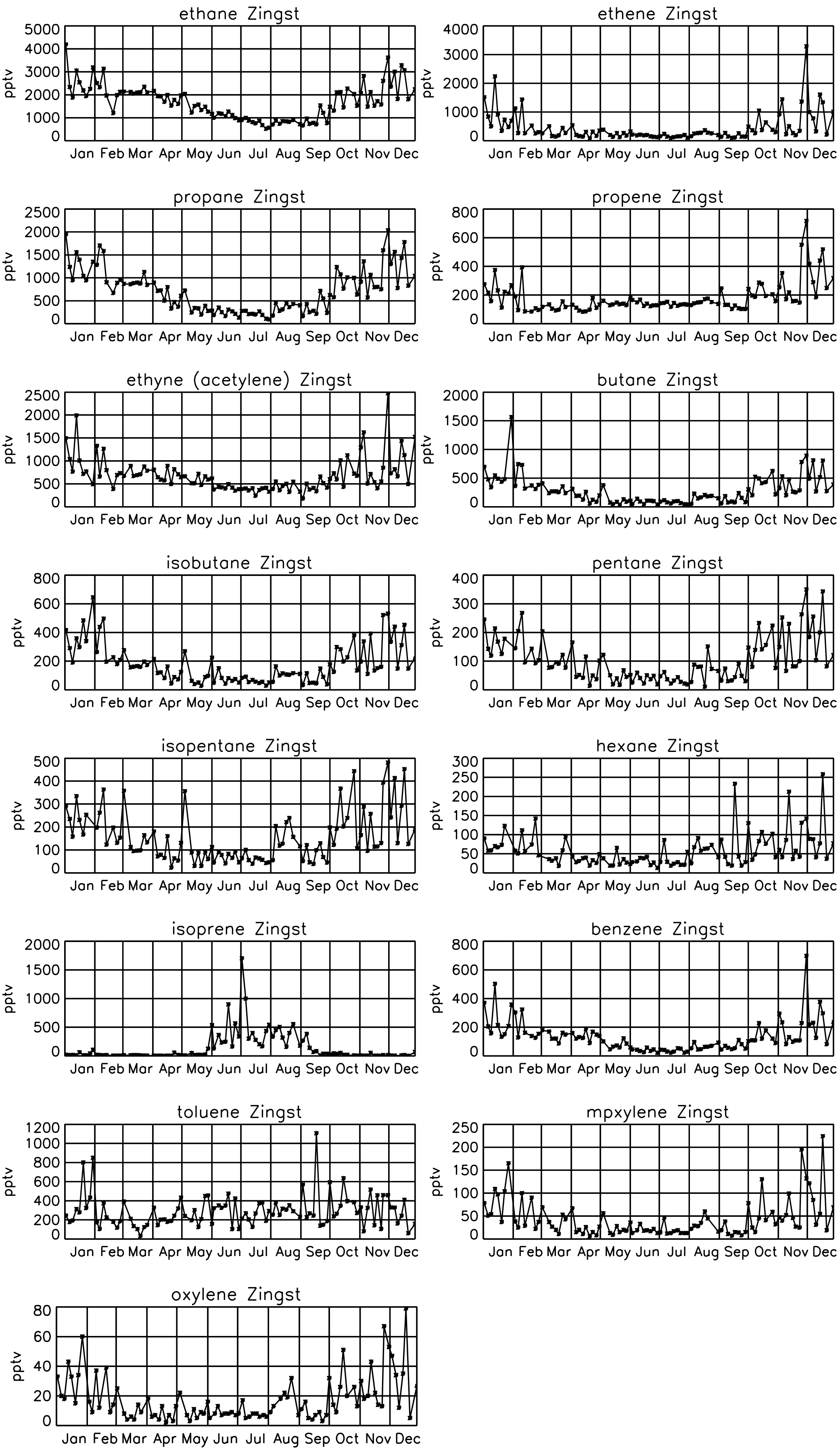
ethene Pallas (Sammaltunturi)
propane Pallas (Sammaltunturi)
propene Pallas (Sammaltunturi)
ethyne (acetylene) Pallas (Sammaltunturi)
butane Pallas (Sammaltunturi)
but_1_ene Pallas (Sammaltunturi)
trans_2_butene Pallas (Sammaltunturi)
pentane Pallas (Sammaltunturi)
hexane Pallas (Sammaltunturi)
isoprene Pallas (Sammaltunturi)
benzene Pallas (Sammaltunturi)
pptv
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec


ethane Utö
ethene Utö
propane Utö
propene Utö
ethyne (acetylene) Utö
butane Utö
but_1_ene Utö
trans_2_butene Utö
cis_2_butene Utö
pentane Utö
hexane Utö
isoprene Utö
benzene Utö
pptv
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec


ethane Zingst
ethene Zingst
propane Zingst
propene Zingst
ethyne (acetylene) Zingst
butane Zingst
isobutane Zingst
pentane Zingst
isopentane Zingst
hexane Zingst
isoprene Zingst
benzene Zingst
toluene Zingst
mpxylene Zingst
oxylene Zingst
pptv
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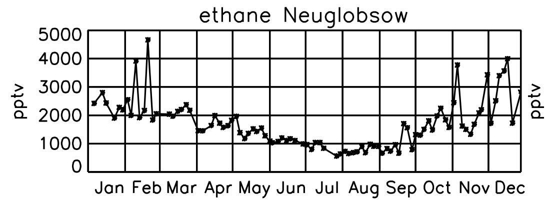
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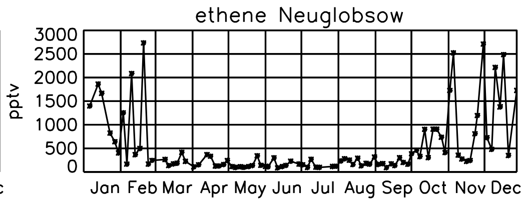
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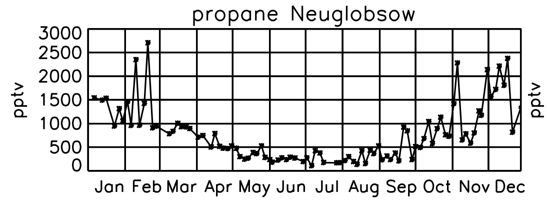
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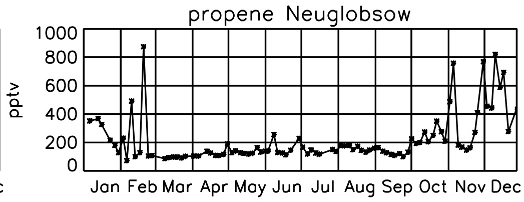
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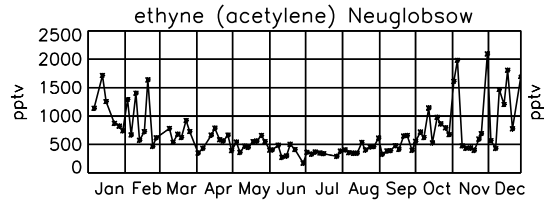
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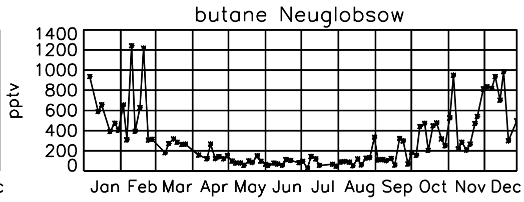
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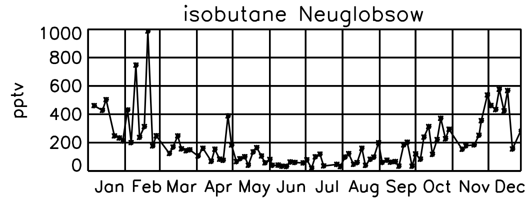
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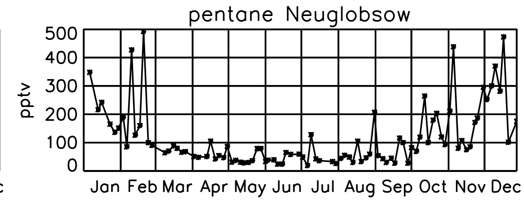
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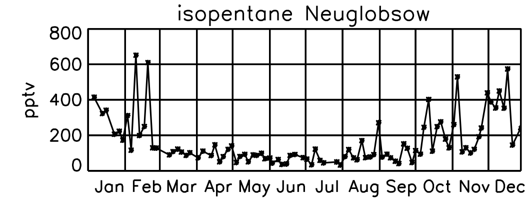
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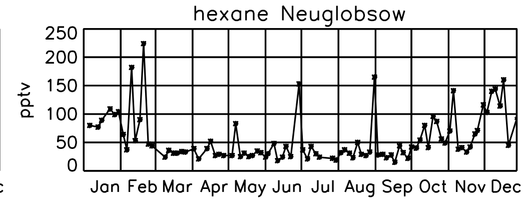
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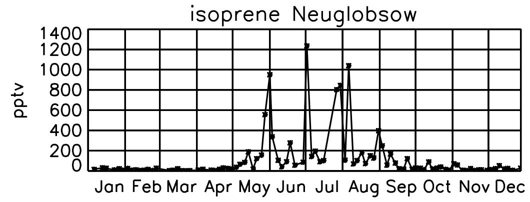
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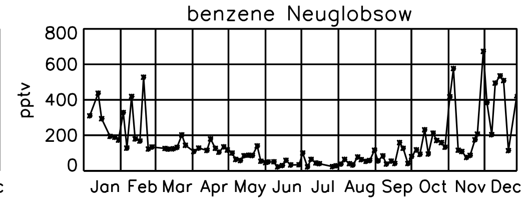
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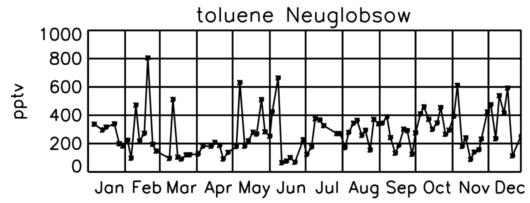
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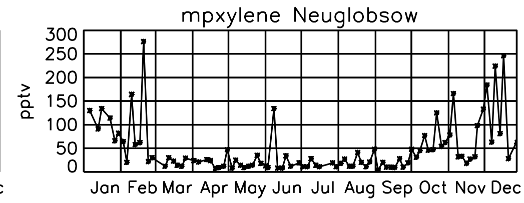
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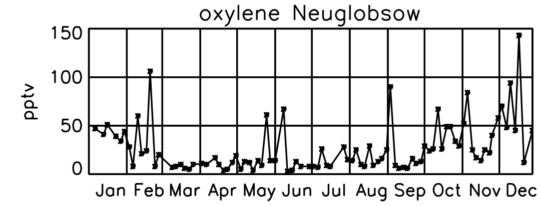
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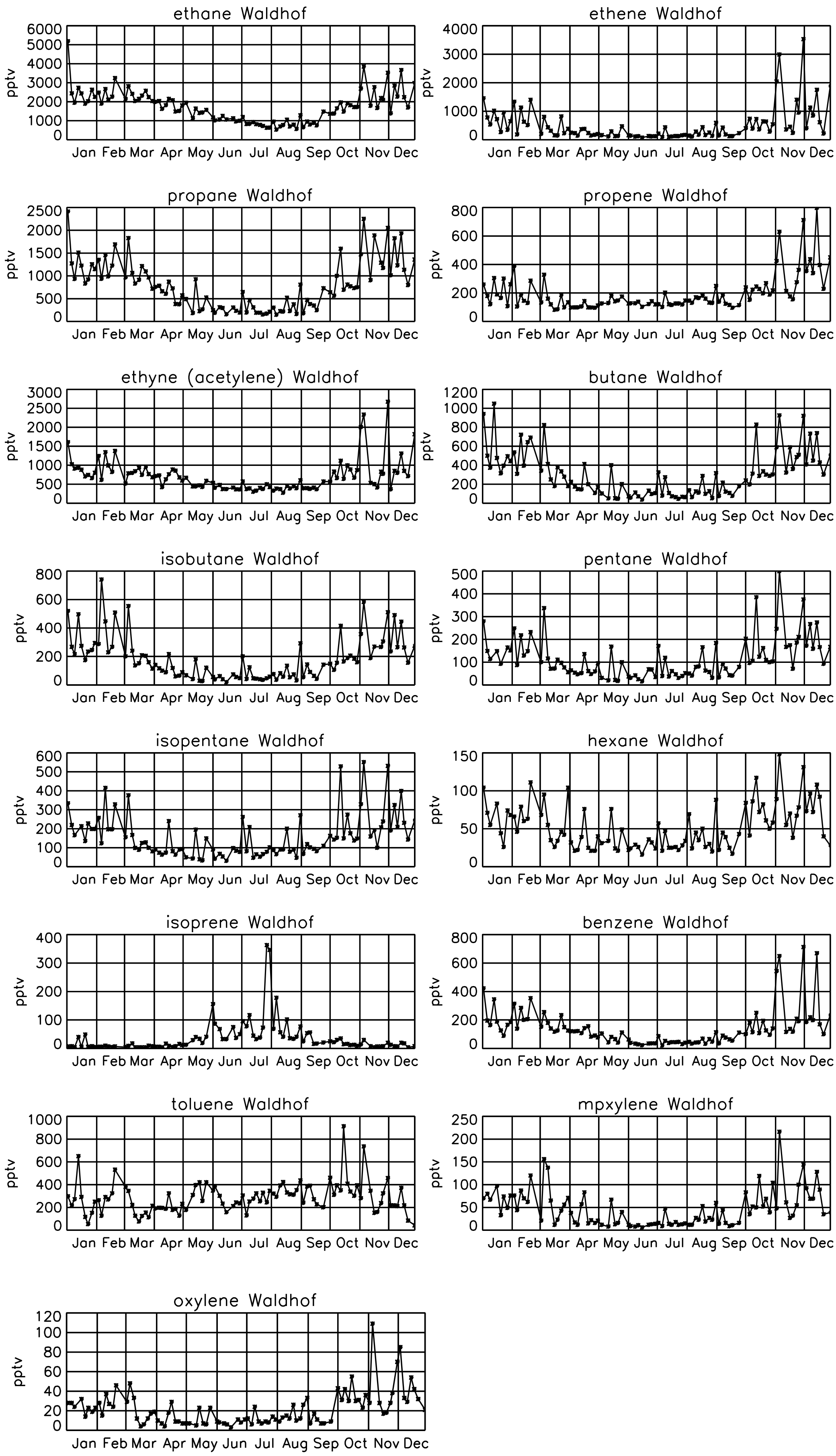
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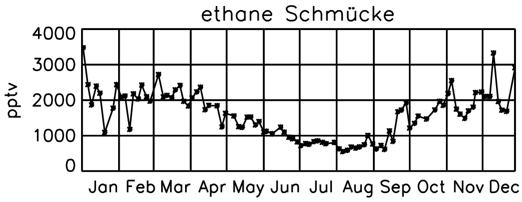
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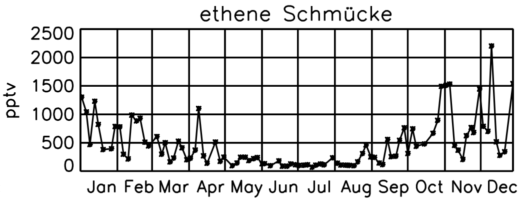
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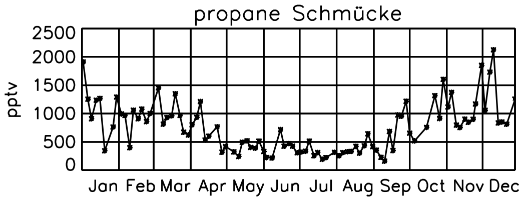
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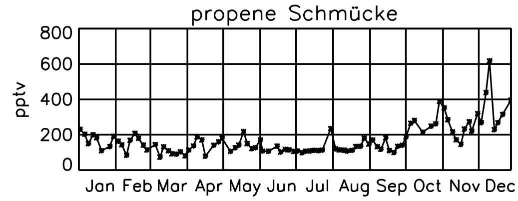
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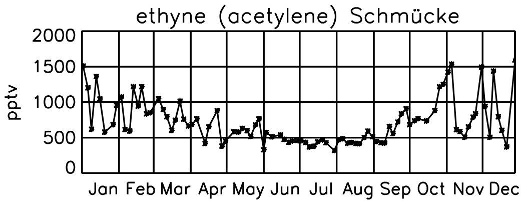
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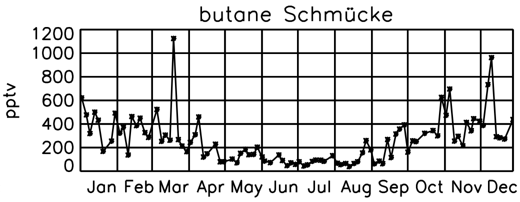
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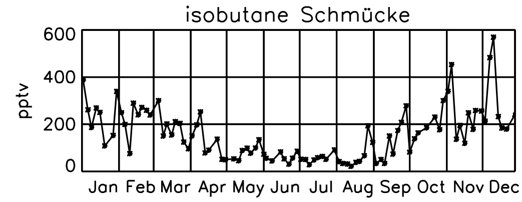
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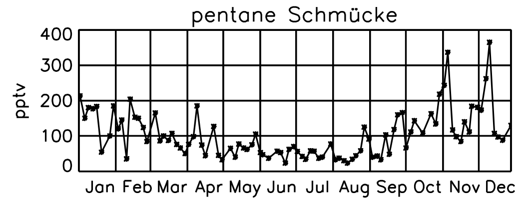
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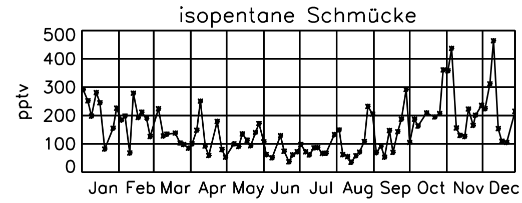
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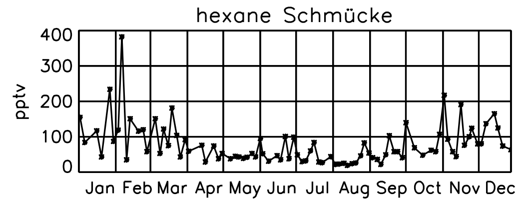
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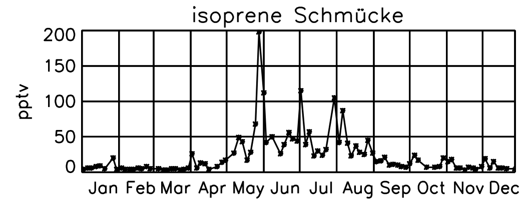
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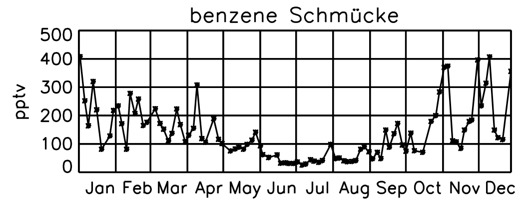
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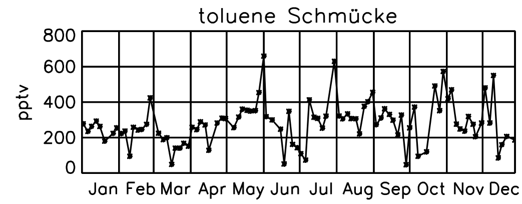
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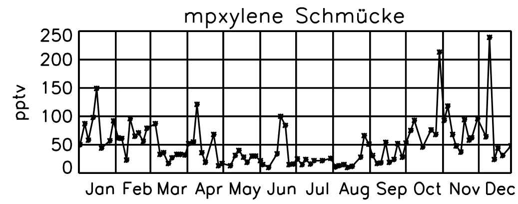
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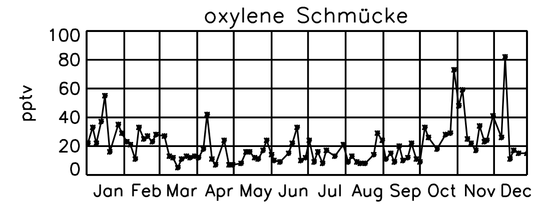
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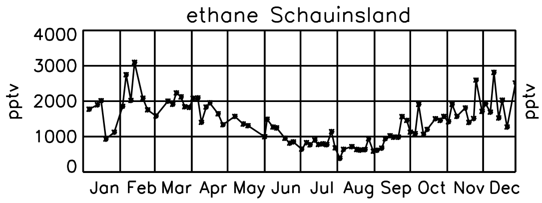
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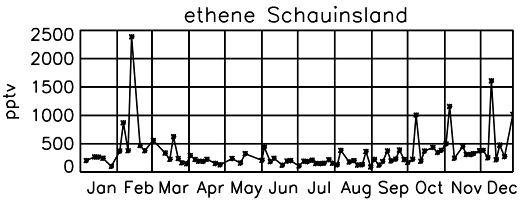
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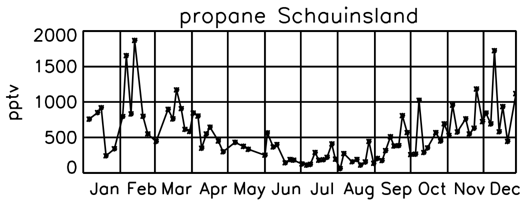
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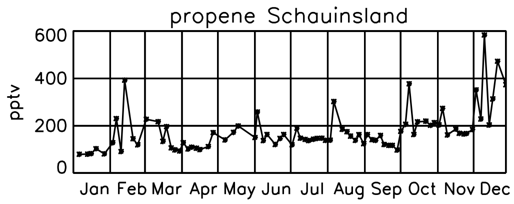
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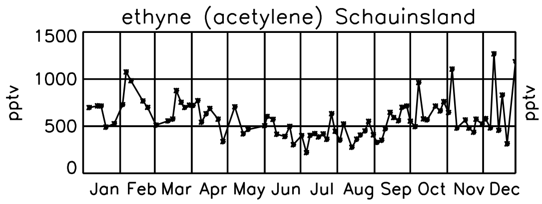
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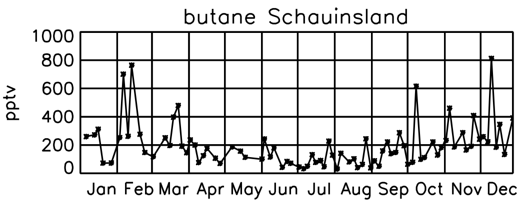
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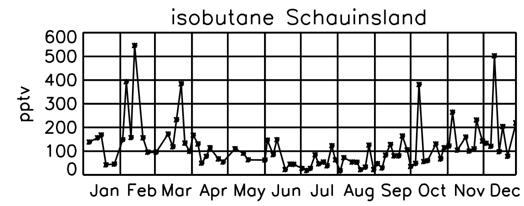
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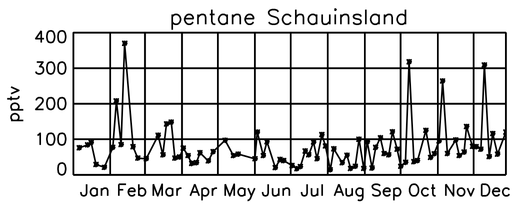
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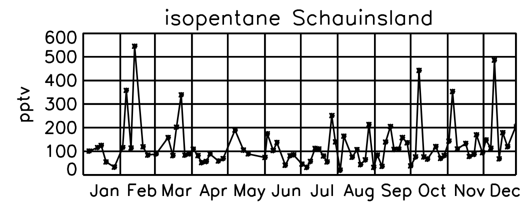
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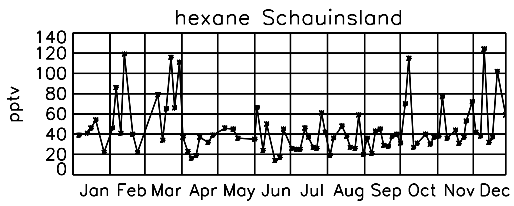
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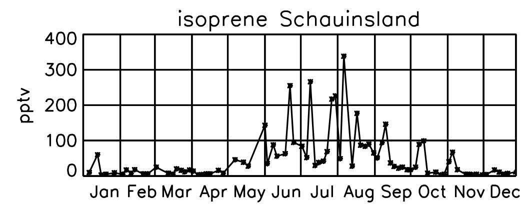
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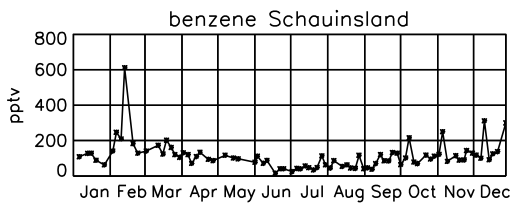
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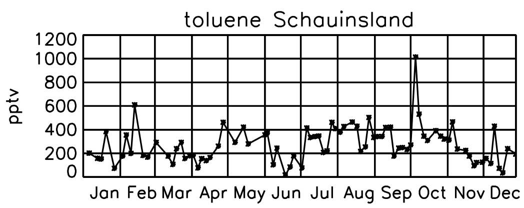
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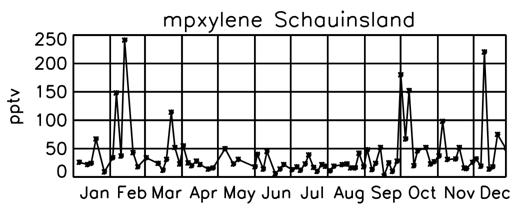
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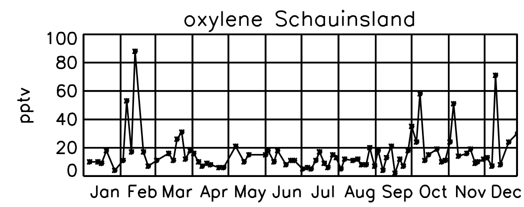
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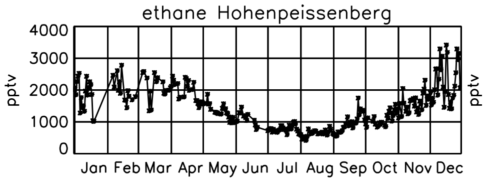
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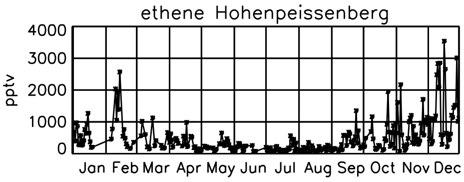
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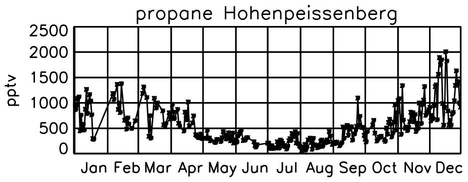
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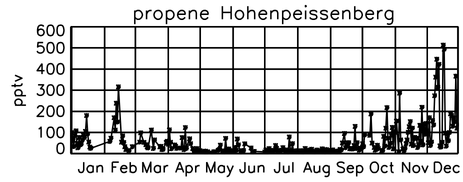
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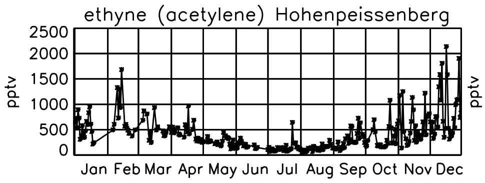
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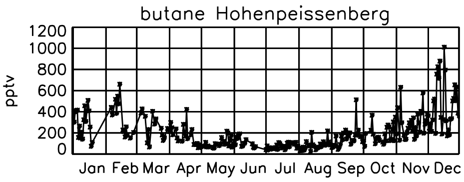
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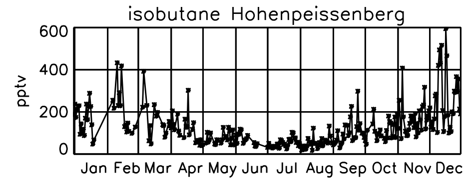
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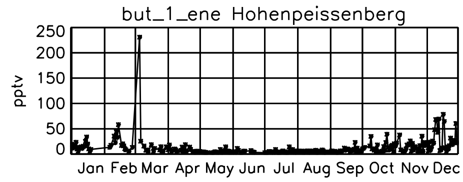
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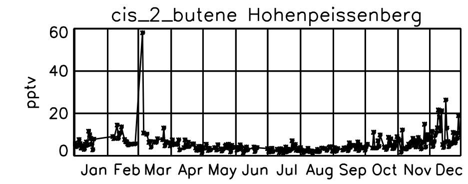
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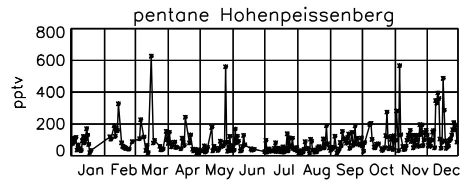
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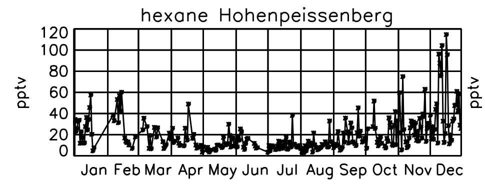
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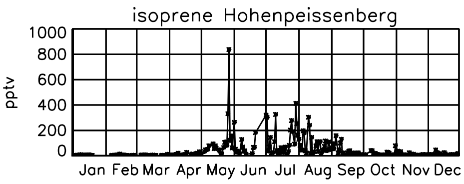
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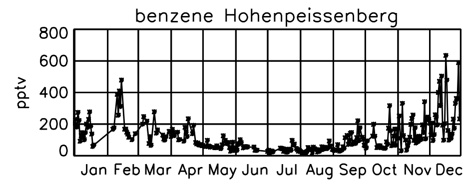
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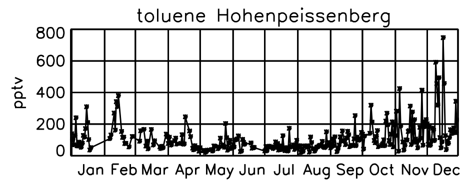
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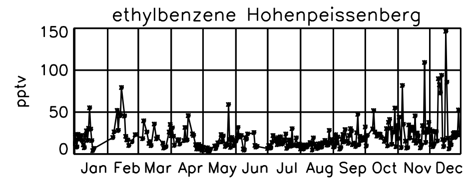
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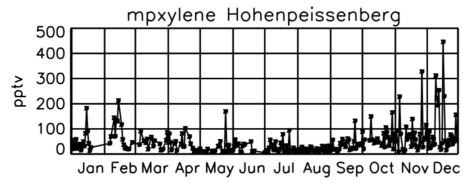
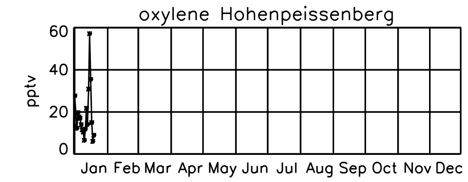
pptv
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec


mpxylene Hohenpeissenberg
pptv
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec


oxylene Hohenpeissenberg
pptv
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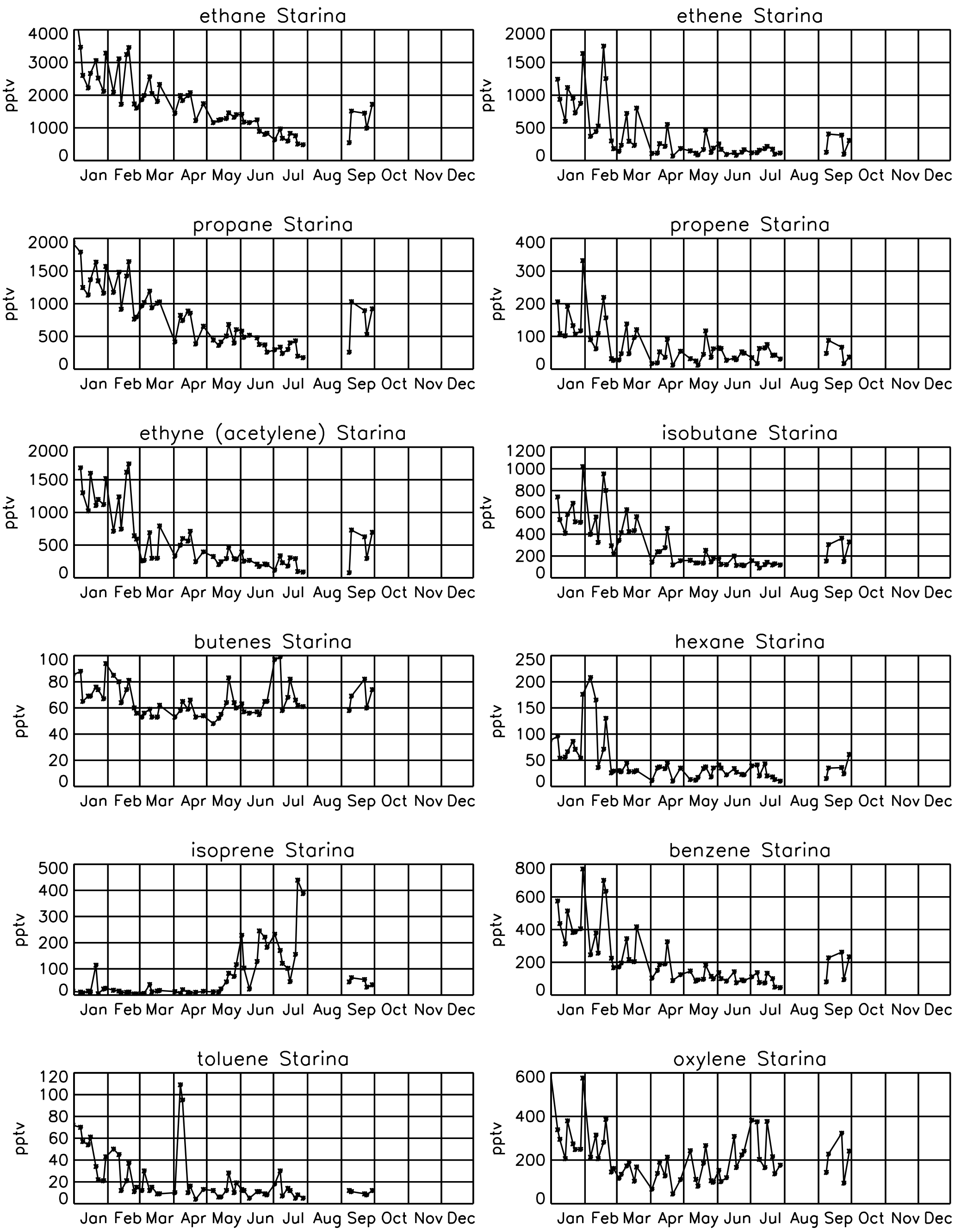
ethane Starina
ethene Starina
propane Starina
propene Starina
ethyne (acetylene) Starina
isobutane Starina
butenes Starina
hexane Starina
isoprene Starina
benzene Starina
toluene Starina
oxylene Starina
pptv
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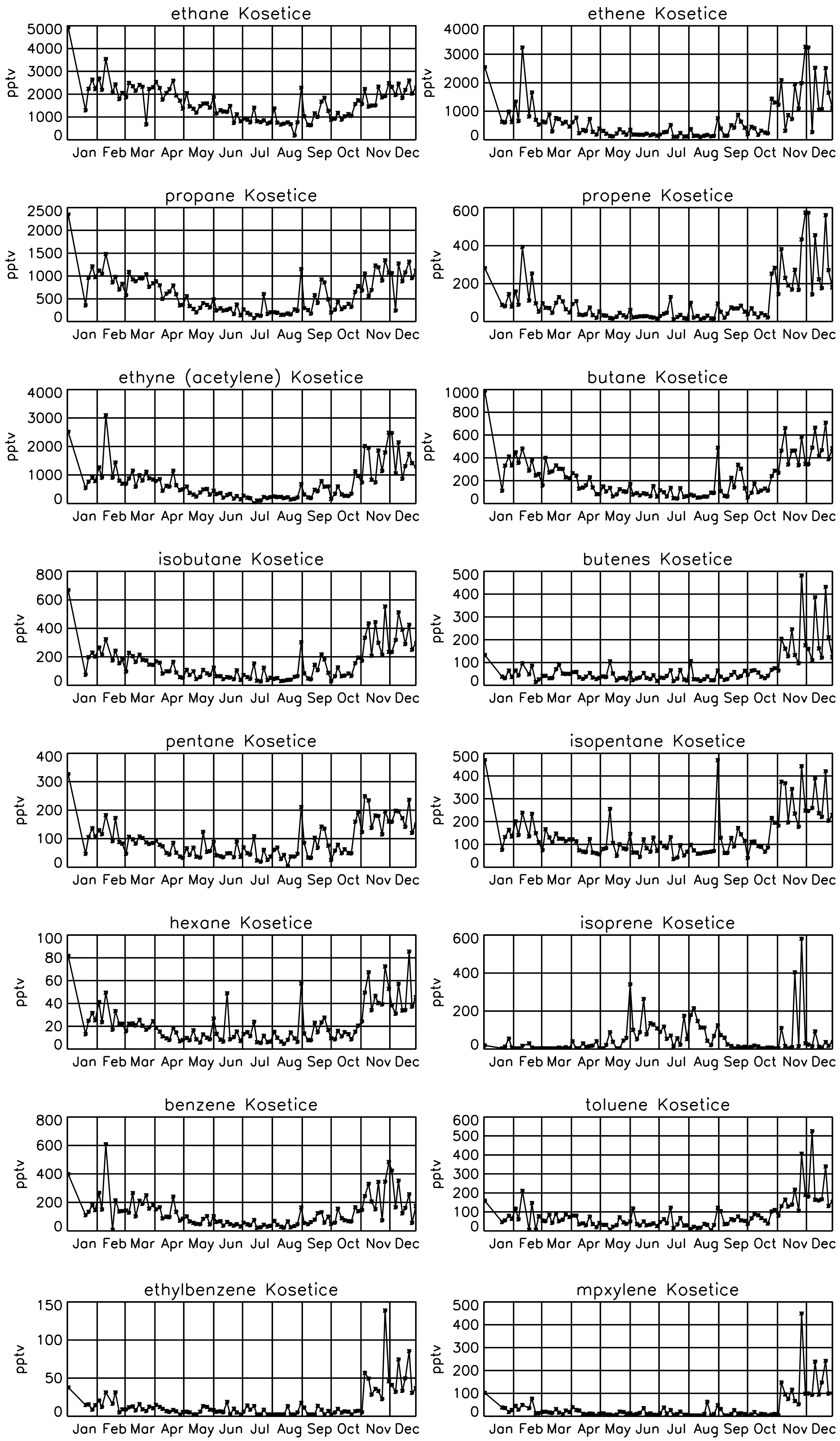
ethane Kosetice
ethene Kosetice
propane Kosetice
propene Kosetice
ethyne (acetylene) Kosetice
butane Kosetice
isobutane Kosetice
butenes Kosetice
pentane Kosetice
isopentane Kosetice
hexane Kosetice
isoprene Kosetice
benzene Kosetice
toluene Kosetice
ethylbenzene Kosetice
mpxylene Kosetice
pptv
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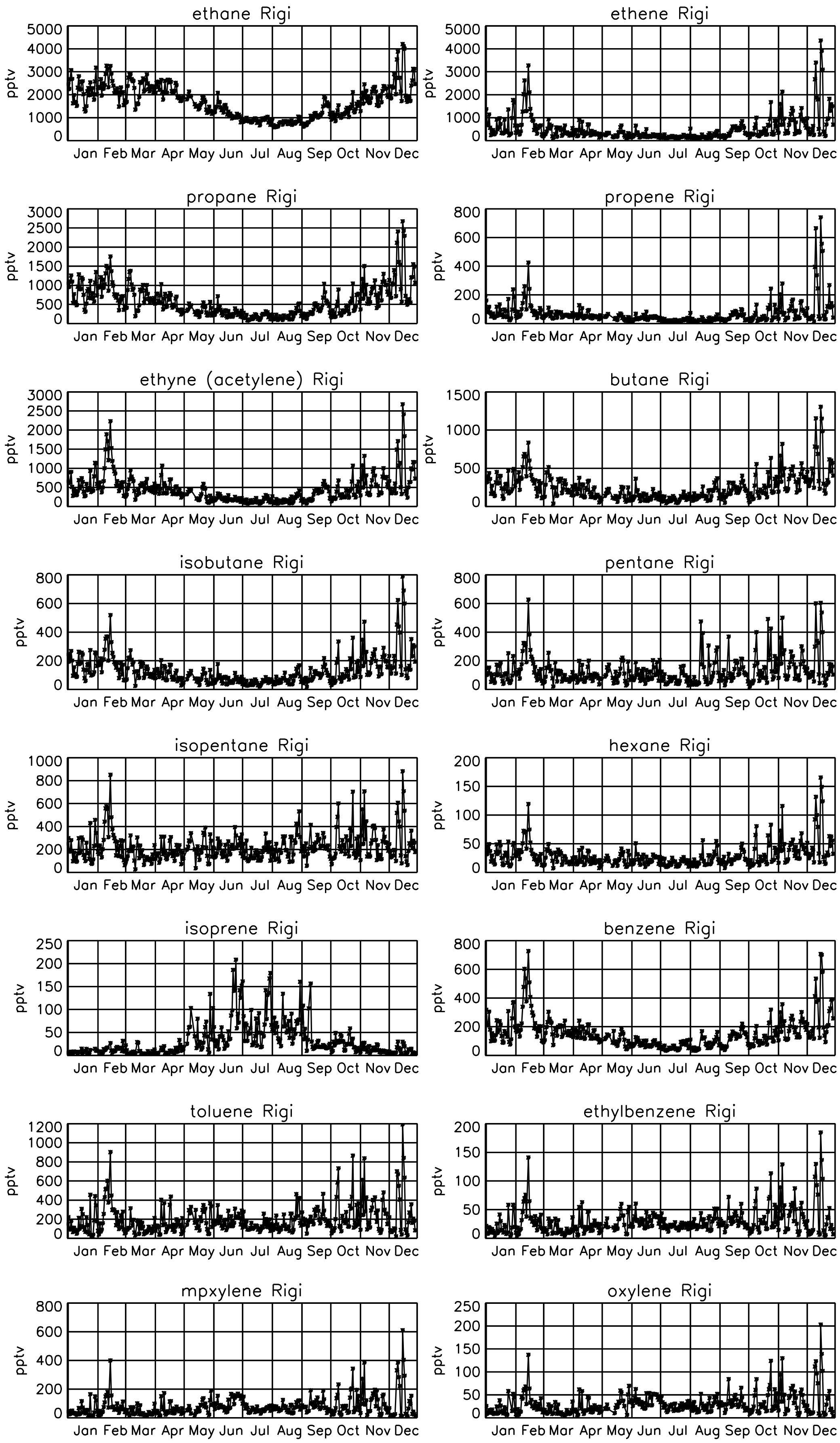
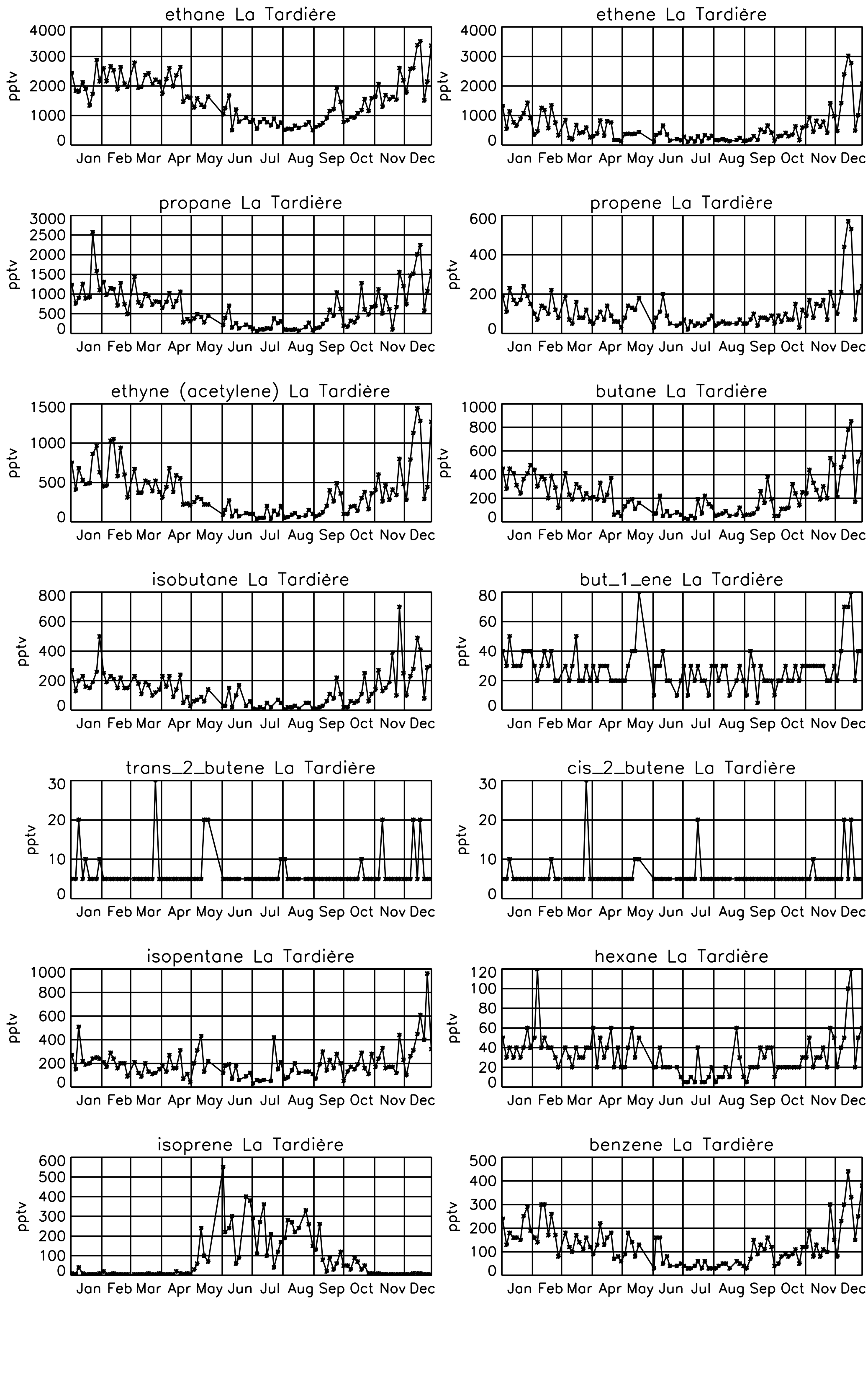
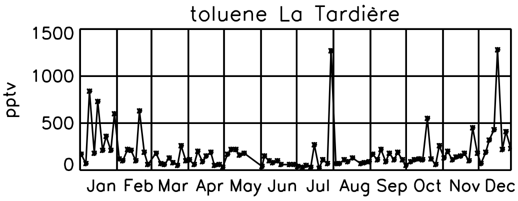

ethane Rigi
ethene Rigi
propane Rigi
propene Rigi
ethyne (acetylene) Rigi
butane Rigi
isobutane Rigi
pentane Rigi
isopentane Rigi
hexane Rigi
isoprene Rigi
benzene Rigi
toluene Rigi
ethylbenzene Rigi
mpxylene Rigi
oxylene Rigi
pptv
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec


ethane La Tardière
ethene La Tardière
propane La Tardière
propene La Tardière
ethyne (acetylene) La Tardière
butane La Tardière
isobutane La Tardière
but_1_ene La Tardière
trans_2_butene La Tardière
cis_2_butene La Tardière
isopentane La Tardière
hexane La Tardière
isoprene La Tardière
benzene La Tardière
pptv
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec


toluene La Tardière
pptv
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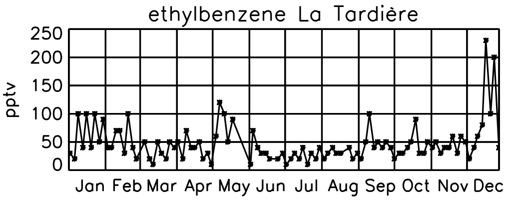
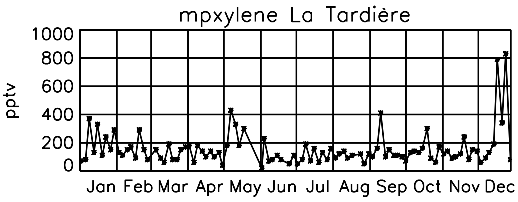
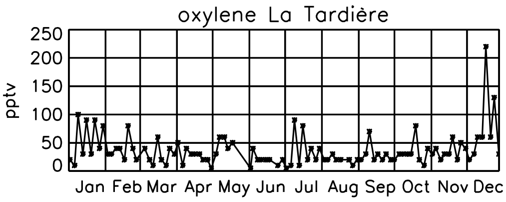
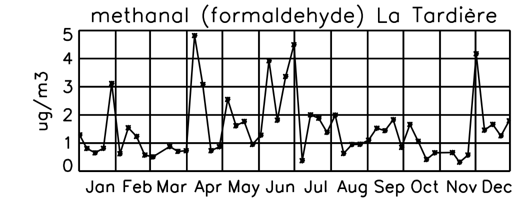
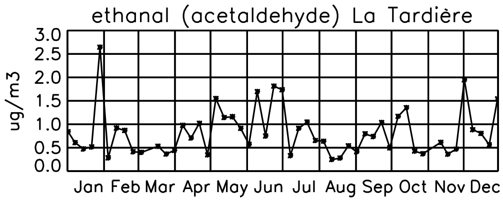
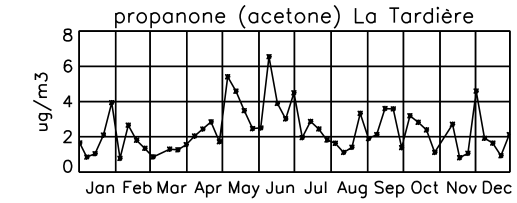

ethylbenzene La Tardière
pptv
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

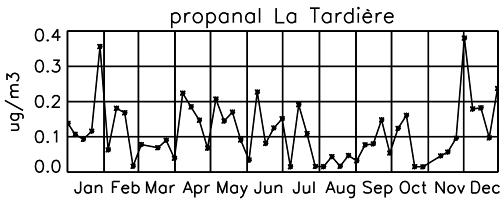

mpxylene La Tardière
pptv
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

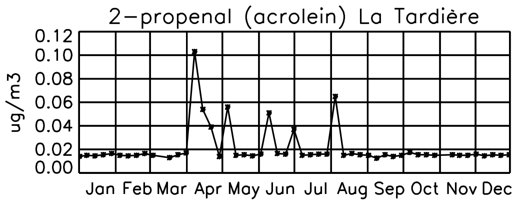

oxylene La Tardière
pptv
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

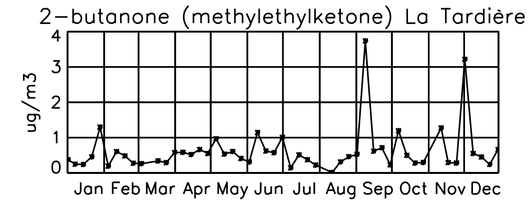

methanal (formaldehyde) La Tardière
ug/m3
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

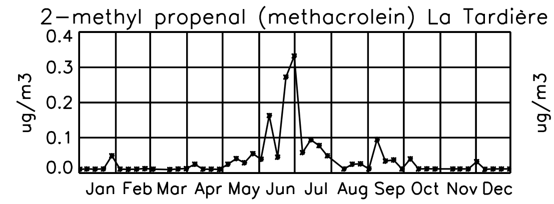

ethanal (acetaldehyde) La Tardière
ug/m3
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

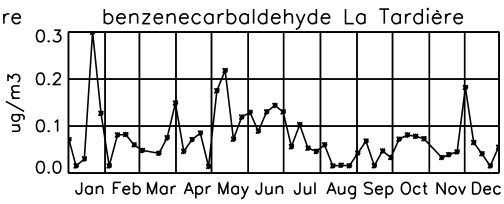

propanone (acetone) La Tardière
ug/m3
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

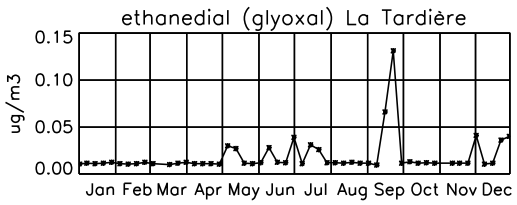

propanal La Tardière
ug/m3
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

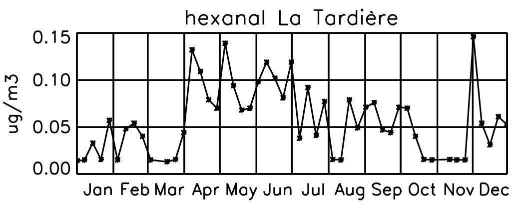

2−propenal (acrolein) La Tardière
ug/m3
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

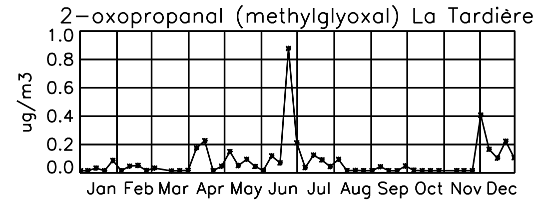

2−butanone (methylethylketone) La Tardière
ug/m3
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

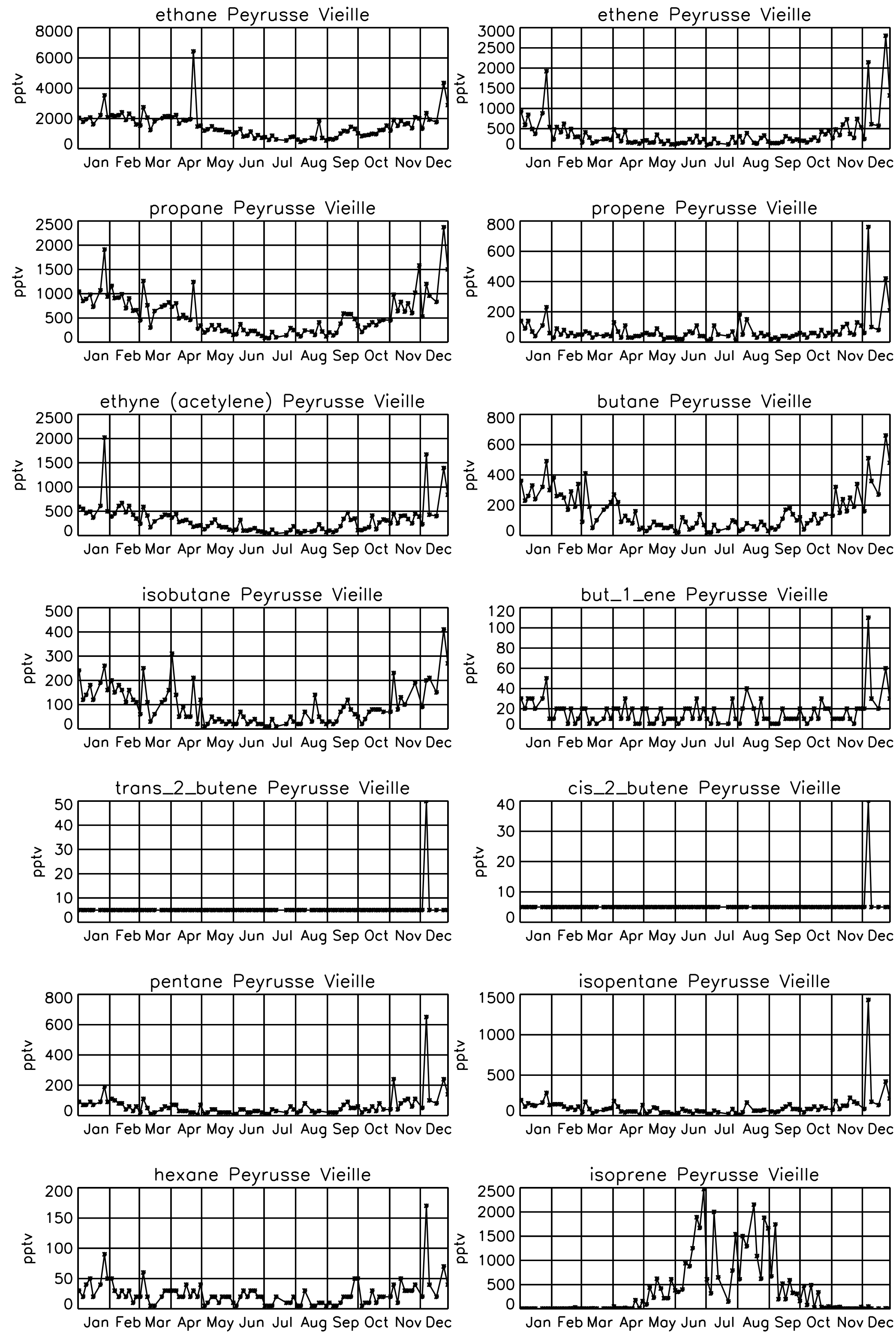

2−methyl propenal (methacrolein) La Tardière
ug/m3
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec


benzenecarbaldehyde La Tardière
ug/m3
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec


ethanedial (glyoxal) La Tardière
ug/m3
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec


hexanal La Tardière
ug/m3
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec


2−oxopropanal (methylglyoxal) La Tardière
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
trans_2_butene Peyrusse Vieille
cis_2_butene Peyrusse Vieille
pentane Peyrusse Vieille
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isoprene Peyrusse Vieille
pptv
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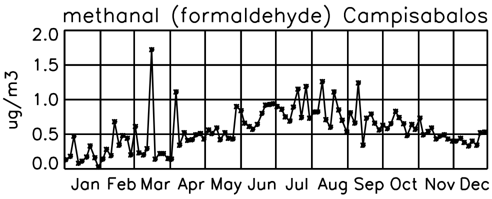
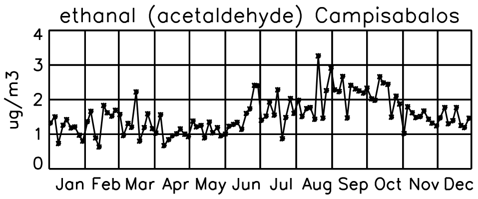
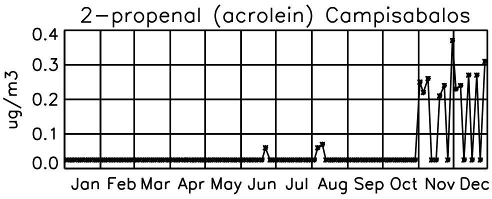
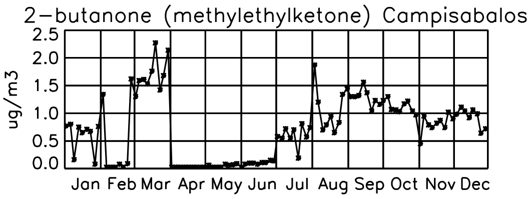
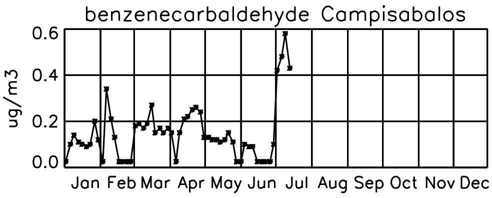
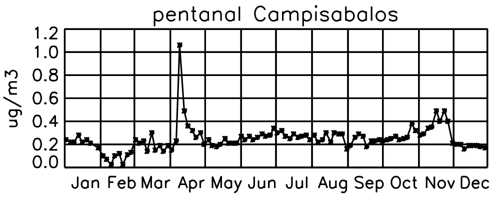

methanal (formaldehyde) Campisabalos
ug/m3
2.0
1.5
1.0
0.5
0.0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec


ethanal (acetaldehyde) Campisabalos
ug/m3
4
3
2
1
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec


2−propenal (acrolein) Campisabalos
ug/m3
0.4
0.3
0.2
0.1
0.0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec


2−butanone (methylethylketone) Campisabalos
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


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


pentanal Campisabalos
ug/m3
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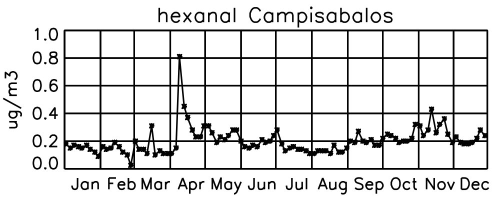
1.0
0.8
0.6
0.4
0.2
0.0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec


hexanal Campisabalos
ug/m3
1.0
0.8
0.6
0.4
0.2
0.0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec