IV.9 Pollutants without set limit values

IV.9.1 Volatile organic compounds

According to the Air Protection Act, a volatile organic substance is any organic compound or mixture of organic compounds, except methane, that has a vapour pressure of 0.01 kPa or more at 20 °C, or has a corresponding volatility under the specific conditions of its use. Volatile organic compounds (VOCs) play an important role in atmospheric chemistry and thus in the oxidation strength of the atmosphere, affecting the condition and quality of the air. Together with nitrogen oxides, VOCs play an important role in the process of the formation of ground-level ozone and other photo-oxidation pollutants. The conversion and decomposition of VOCs is usually initiated by reaction with a hydroxyl radical (Víden 2005). Because of the variability in the reactivity time of particular VOCs and their amounts, pollution limit levels have not been established for these substances.

Monitoring of VOCs was included in the EMEP programme on the basis of a decision by the EMEP Workshop on Measurements of Hydrocarbons/VOCs in Lindau in 1989 (EMEP 1990). Regular measurements at the Košetice Observatory were launched during 1992, and three years later were supplemented by identical measurements at the Prague-Libuš station. In the framework of EMEP, measurements were initially made at five stations; however, over 20 years the number of stations and range of measured hydrocarbons has changed several times. A homogeneous series of measurements has been maintained at the Košetice Observatory until the present. Since 2011, the Košetice Observatory has been involved in the ACTRIS project, carried out in the context of the EU 7th Framework Programme INFRA-2010-1-1.1.16: Research Infrastructures for Atmospheric Research. The successor ACTRIS-2 project, identified as H2020INFRAIA-20142015, followed on from this project and was implemented in the May 2015–April 2019 period. The subject of VOCs is part of the work of the Trace gases networking working group: Volatile organic carbon and nitrogen oxides, in an attempt to improve and harmonise VOC measurements in Europe. In the framework of the project, standard operational procedures were developed and the best measuring techniques for ensuring quality were tested. The CHMI laboratory regularly participated in a round-robin test, where the results of the analyses of VOCs confirmed that the laboratory has been complying with the recommended parameters of the GC system and has been meeting the required uncertainty values for all the substances in both standards and real samples. The ACTRIS-2 project was completed in 2019. VOC monitoring and research activities continue within the pan-European ACTRIS research infrastructure, which has been part of the Europe-

Tab. IV.9.1.1 Average annual concentrations of VOC in the ambient air at stations Košetice and Prague 4-Libuš

Volatile organic compound		Annual averge [μg·m^{-3}]									
		Košetice					Prague 4-Libuš				
		1995	2005	2010	2015	2021	1995	2005	2010	2015	2021
Alkane	etane	2.34	2.07	2.51	2.20	2.05	3.62	2.43	1.94	1.97	2.37
	propane	1.80	1.21	1.28	1.10	0.96	2.15	1.65	1.82	1.06	1.27
	butane	1.16	0.60	0.71	1.04	0.42	1.76	1.02	1.15	1.15	0.73
	2-methylpropane	0.68	0.37	0.47	0.32	0.30	1.14	0.80	1.03	0.45	0.59
	pentane		0.29	0.35	0.30	0.22	1.21	0.52	1.74	0.32	0.39
	2+3 - methylpentane		0.03	0.06	0.06	0.11	0.90	0.47	0.31	0.22	0.25
	hexane		0.09	0.11	0.07	0.08	0.60	0.16	0.18	0.09	0.13
	heptane		0.03	0.06	0.06	0.05	0.30	0.07	0.14	0.08	0.11
	oktane		0.02	0.05	0.10	0.04		0.06	0.09	0.11	0.08
Alkene	etene	1.28	0.77	0.55	0.55	0.64	2.52	1.32	0.45	0.62	0.94
	propene	0.32	0.15	0.16	0.12	0.14	0.68	0.34	0.30	0.14	0.23
	suma butene		0.14	0.20	0.18	0.20	0.87	0.42	0.38	0.26	0.38
	suma penetene		0.05	0.07	0.02	0.04		0.27	0.14	0.04	0.07
	isoprene	0.14	0.09	0.13	0.17	0.29		0.38	0.47	0.37	0.68
Aromatic hydrocarbon	benzene	1.05	0.42	0.58	0.41	0.46	1.51	0.62	0.72	0.42	0.62
	toluene	0.99	0.31	0.40	0.30	0.30	2.07	0.86	0.94	0.53	0.59
	ethylbenzene		0.06	0.06	0.19	0.11	0.42	0.19	0.18	0.27	0.15
	m,p-xylene		0.78	0.55	0.55	0.08	1.42	0.55	0.57	0.71	0.13
	o-xylene		0.05	0.04	0.29	0.05		0.16	0.14	0.35	0.06

an Strategy Forum on Research Infrastructures (ESFRI) activities since 2016. The average annual VOC concentrations at the Košetice Observatory and the Prague 4-Libuš stations over 26 years of monitoring exhibit a statistically significant decreasing trend, reflecting the decrease in VOC emissions both in the CR and also in the entire European area (Tab. IV.9.1.1). The trend in ethane concentrations is much stronger at the suburban station of Prague 4-Libuš than at the background station. The only exception is isoprene, which is of natural origin (emitted by deciduous trees) and exhibited an increasing trend at both stations. At the Praha 4-Libuš station, we even register a slight increase in concentrations. In general, it can be stated that suburban concentrations of the main VOCs in the 1990's were approx. 1.5–2 times higher than at the background station. The differences between the two stations have decreased substantially in the past decade. The results obtained in 2021 do not in any way deviate from the long-term trends (Tab. IV.9.1.1). The annual variation in most VOC concentrations reflects emission levels, and thus maximum values in the winter and minima in the summer, with the situation for isoprene being opposite (Fig. IV.9.1.1).

It follows from the report on VOC measurements in the context of the EMEP (Solberg et al. 2018) that VOC concentrations are continuously decreasing on a regional scale and thus reflect the decreasing trend in emissions. Concentration levels at the Košetice Observatory are comparable with those at German, Swiss and French stations The Czech station has long been characterised by lower annual average ethane concentrations. For most VOCs the concentrations measured in the winter are usually similar to those at German stations, while the values at the Košetice Observatory are slightly lower in the summer.

The Geneva Protocol concerning the Control of Emissions of Volatile Organic Compounds or their Transboundary Transmission was adopted in November 1991, and came into effect in September 1997 (UN-ECE 1991). The Protocol contained three options for reducing VOCs:

1. A 30 % reduction in VOC emissions by 1999, where the base values used were those for 1984 and 1990;
2. The same reduction as under (1), with the provision that the overall national emissions in 1999 do not exceed the 1988 level;
3. Where 1988 emissions did not exceed the set limits, countries could adopt the 1999 level as the emission ceiling.

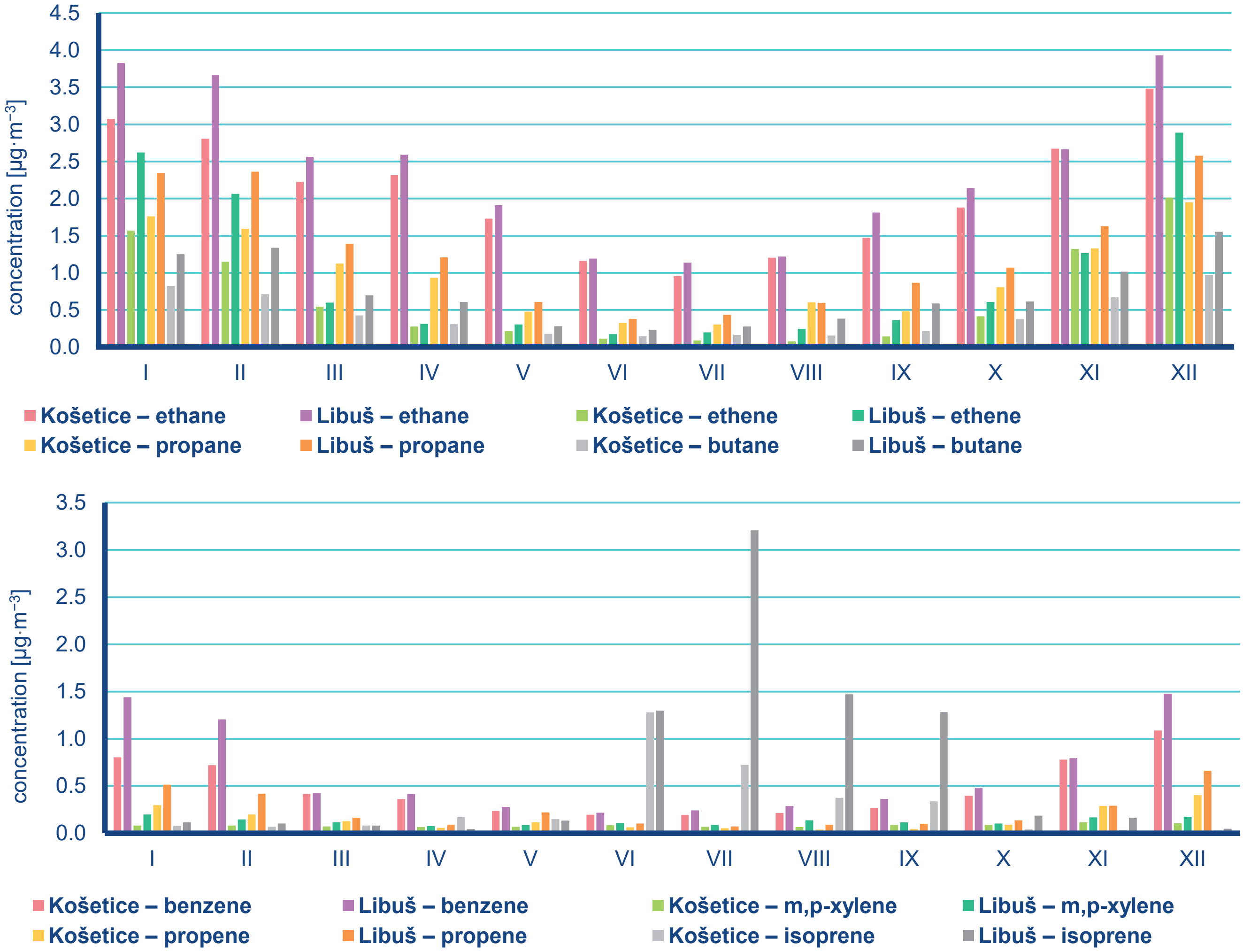

Fig. IV.9.1.1 Annual course of average monhtly concentrations of VOC, 2021

In 1999, the Göteborg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone was adopted, and came into effect on 17 May 2005 (UN-ECE 1999). The Protocol contains the emission ceilings for 2010 for four pollutants including VOCs. According to the Protocol, European VOC emissions were to be reduced by at least 40 % compared to 1990. The CR, similarly to most Central European countries (except Poland), has fulfilled this limit – VOC emissions in the CR decreased by 51 % in the 1990–2010 period (EEA 2013c).

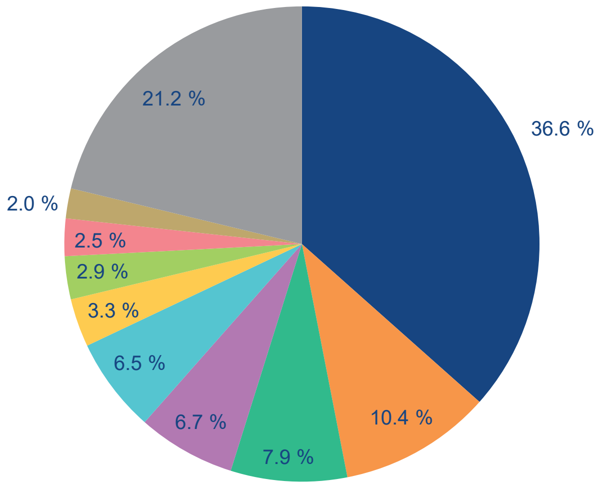

Fig. IV. 9.1.2 Share of NFR sectors in total emissions of NMVOC, 2020

Emissions of volatile organic compounds

Chemical products containing NMVOCs are used in a wide range of applications in households and industry as cleaning agents, solvents and degreasing agents. They can find use as components of paints, varnishes, adhesives and pharmaceutical products. NMVOCs are released during the storage and use of petroleum products. They are also formed during incomplete combustion.

In 2020, the largest amount of NMVOC emissions (Fig. IV.9.1.2) originated from the sector 1A4bi – Residential: Heating, water heating, cooking (36.6 %). The proportion of transport, including evaporation from the fuel system of vehicles, was 5.4 %. Significant sources of NMVOC emissions in the CR belong to the sector of the use and application of organic solvents (NFR 2D3), which contributed 26.6 % of the air pollution from these substances. This sector encompasses activities 2D3a – Domestic solvent use including fungicides (6.5 %), 2D3d – Coating applications (10.4 %), 2D3e – Degreasing (2 %), 2D3f – Dry cleaning (0.02 %), 2D3g – Chemical products (2.9 %), 2D3h – Printing (1.5 %) and 2D3i – Other solvent use (2.9 %). Some of these emissions are released into the air in a controlled manner, but a substantial proportion escape into the air in the form of fugitive emissions, which are difficult to control. Another significant sector producing NMVOC emissions is agriculture with a total proportion of almost 19 %. Among other sectors, e.g., emissions from combustion processes in the production of electricity, fugitive emissions in the transformation of solid fuels or in the food production are relevant. Due to a lack of data, the output for 2020 does not include the expected increase in emissions from disinfectants used during the

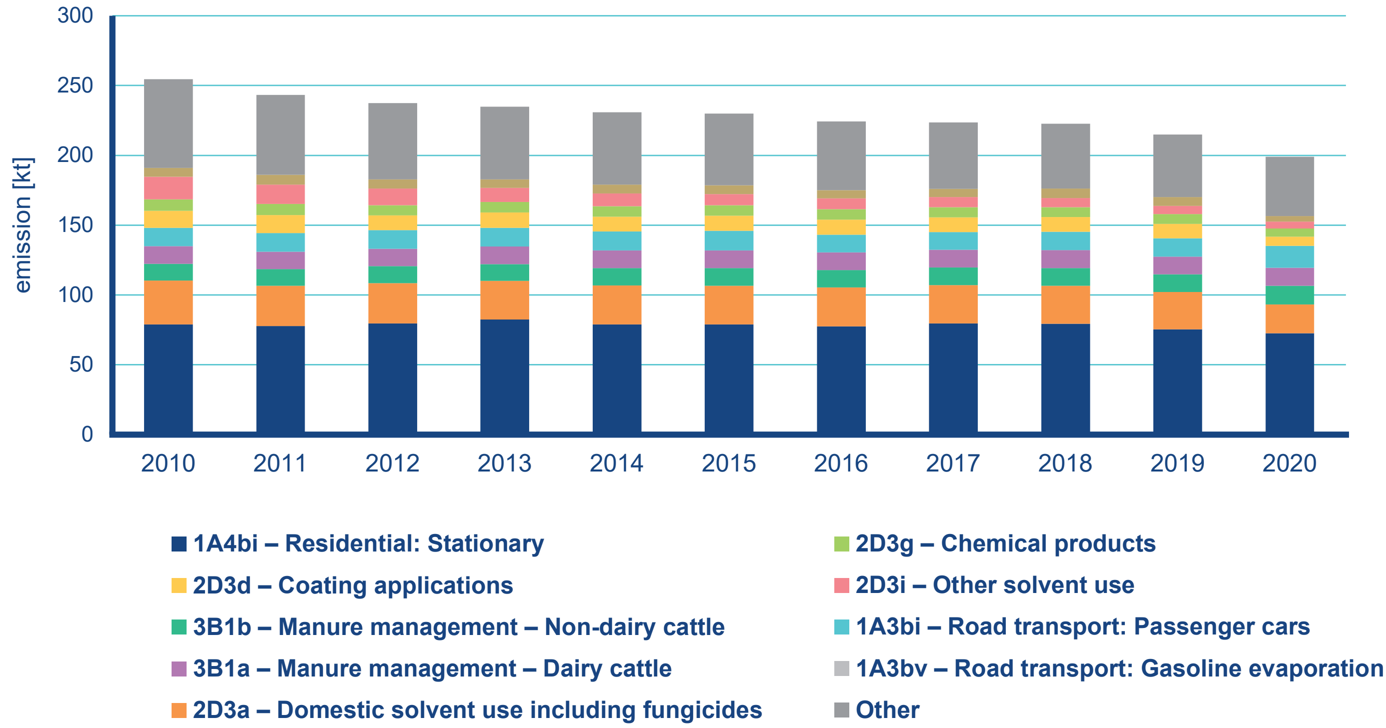

Fig. IV. 9.1.3 Total emissions of NMVOC, 2010–2020

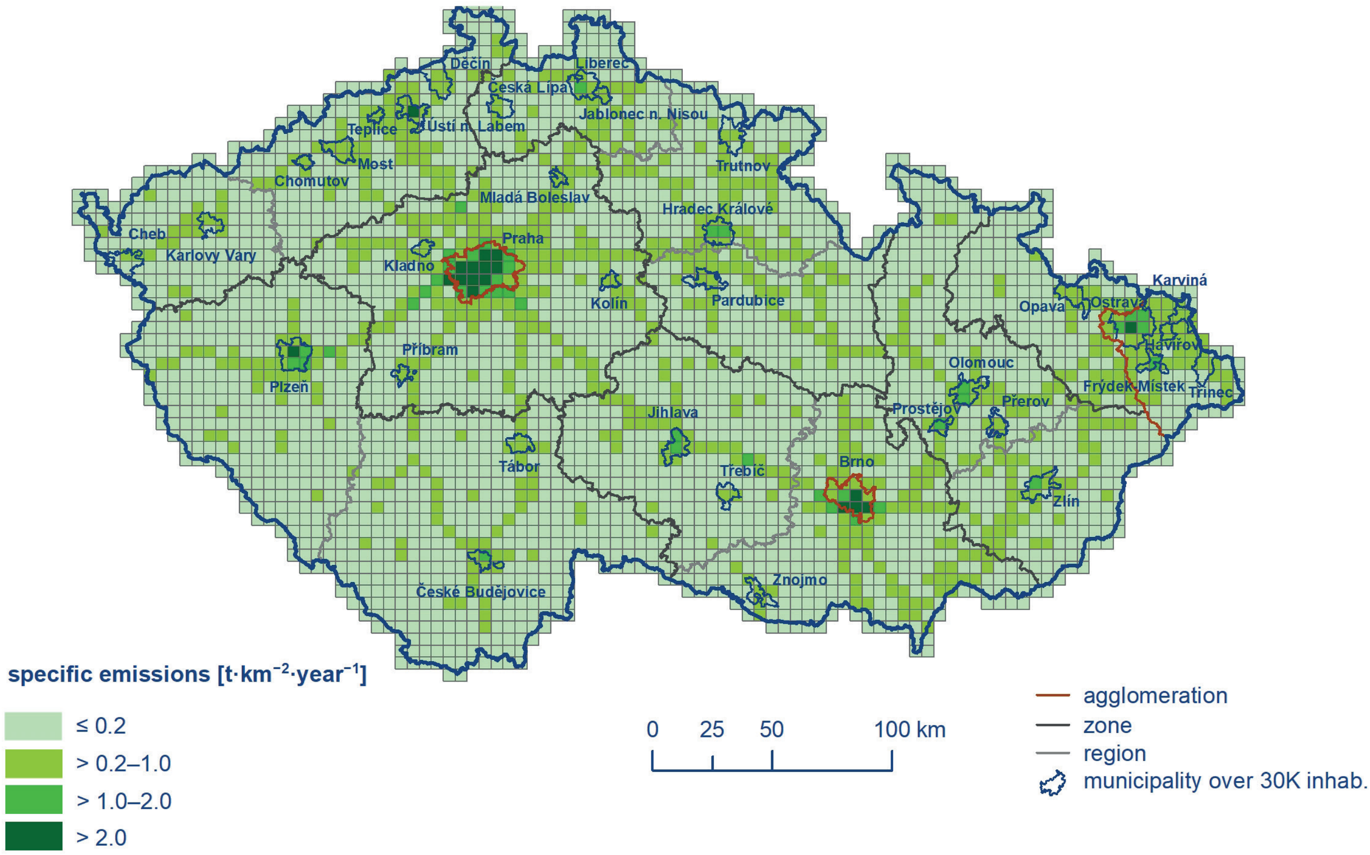

Fig. IV. 9.1.4 VOC total emission in 5×5 km resolution, 2020

SARS-CoV-2 pandemia. It is assumed that results of foreign studies will be used to update the emissions inventory for 2020 and the new inventory for 2021.

Total NMVOC emissions in the 2010–2020 period exhibited a decreasing trend (Fig. IV.9.1.3), caused by the use of products with lower volatile organic compound contents, e.g., water-based paints and plastic powders. Legislative regulations govern the retail packaging of paints, limiting the maximum solvent contents in products placed on the market. The ongoing renewal of the vehicle fleet has resulted in continuous reductions in NMVOC emissions from transport.

The proportion of individual types of sources in total emissions varies according to the specific composition of sources in a given area. In addition to areal emissions from household heating, the production of NMVOC emissions is concentrated, among other locations, along motorways, roads with intensive traffic, in large cities, and regions where more important energy and industrial production facilities are located (Fig. IV.9.1.4).