Atmospheric emissions of Benzo(a)pyrene in the Baltic Sea region

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Authors: Olga Rozovskaya, Victor Shatalov, Alexey Gusev, EMEP MSC-E

Key message

Annual emissions of benzo(a)pyrene in HELCOM countries have decreased by 40% during the period from 1990 to 2018.

Results and Assessment

Relevance of the indicator for describing the developments in the environment

This indicator shows the levels and trends in emissions of benzo(a)pyrene (B(a)P) from anthropogenic sources of HELCOM countries to the atmosphere. These emissions represent the pressure of emission sources on the atmosphere of the Baltic Sea region and subsequently on the Baltic Sea aquatic environment.

Policy relevance and policy reference

HELCOM adopted a Recommendation in May 2001 for the cessation of hazardous substance discharges/emissions by 2020, with the ultimate aim of achieving concentrations in the environment near to background values for naturally occurring substances and close to zero for man-made synthetic substances.

At the European level, the relevant policy to the control of emissions of B(a)P to the atmosphere is being taken in the framework of UN ECE Convention on Long-Range Transboundary Air Pollution (CLRTAP). The Executive Body of CLRTAP adopted the Protocol on Persistent Organic Pollutants on 24 June 1998 in Aarhus (Denmark). According to one of the basic obligations, Parties to the Convention shall reduce their emissions of B(a)P below their levels in 1990. The Protocol entered into force in 2003 and was signed and/or ratified by 40 countries.

Assessment

According to officially reported inventories, annual emissions of B(a)P in the HELCOM countries have decreased during the period from 1990 to 2018 by 40% (Figure 1). The most significant drop of B(a)P emissions (see Figure 2) is observed in Germany (80%) and Sweden (64%). At the same time emissions of Finland in 2018 were higher than emissions for 1990, by 41%.

In 2018, the total annual B(a)P emissions of the HELCOM countries amounted to 227 t. Among the HELCOM countries, the largest contributions to total annual B(a)P emissions belong to Russia (48%), Poland (32%), and Germany (12%).

Time-series of annual total B(a)P emissions of HELCOM countries are shown in Figure 2. The diagrams on the map also show the fractions of emissions deposited to the Baltic Sea. The highest fractions belong to Denmark and Sweden (13% and 12%, respectively), and the lowest one to the Russia (about 0.4%).

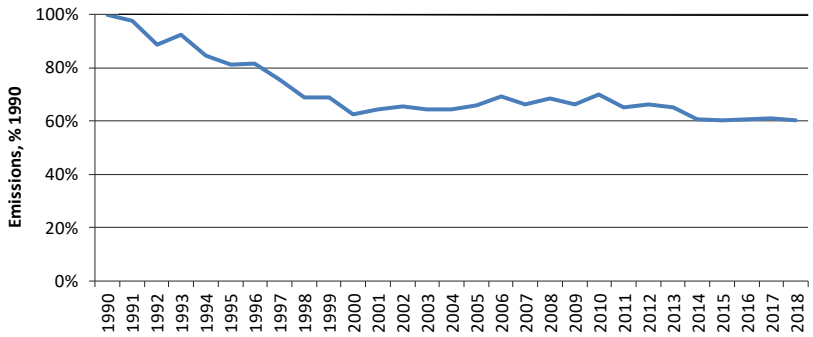

Figure 1. Total annual emissions of B(a)P to air from HELCOM countries in period 1990-2018 (% of 1990).

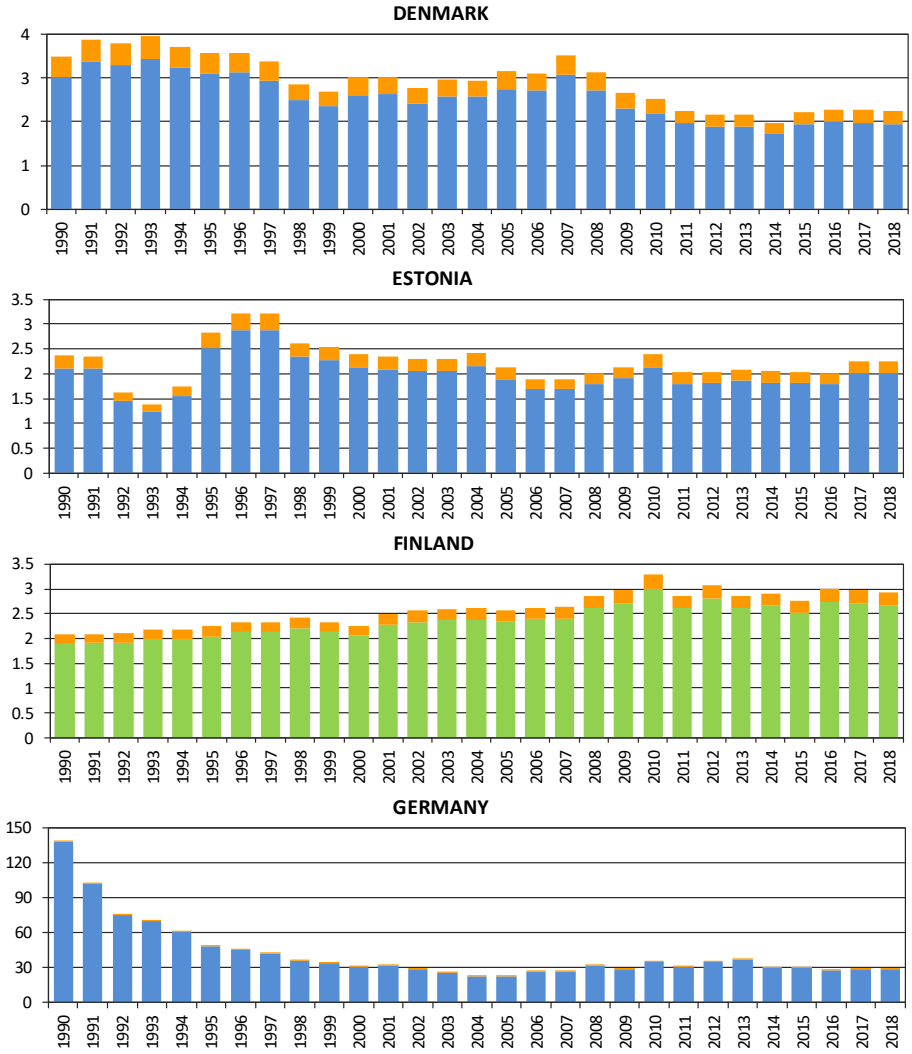

Figure 2. **B(a)P** emissions of HELCOM Contracting Parties (CP) to air as totals in tonnes/year for the period 1990-2018. Orange sections of the bars identify the fraction of emission deposited to the Baltic Sea. Green bars indicate expert estimates. The emission data of the CP refer to the total area of the CP except for Russian Federation, for which emissions from the territory of Russian Federation within the EMEP domain is used.

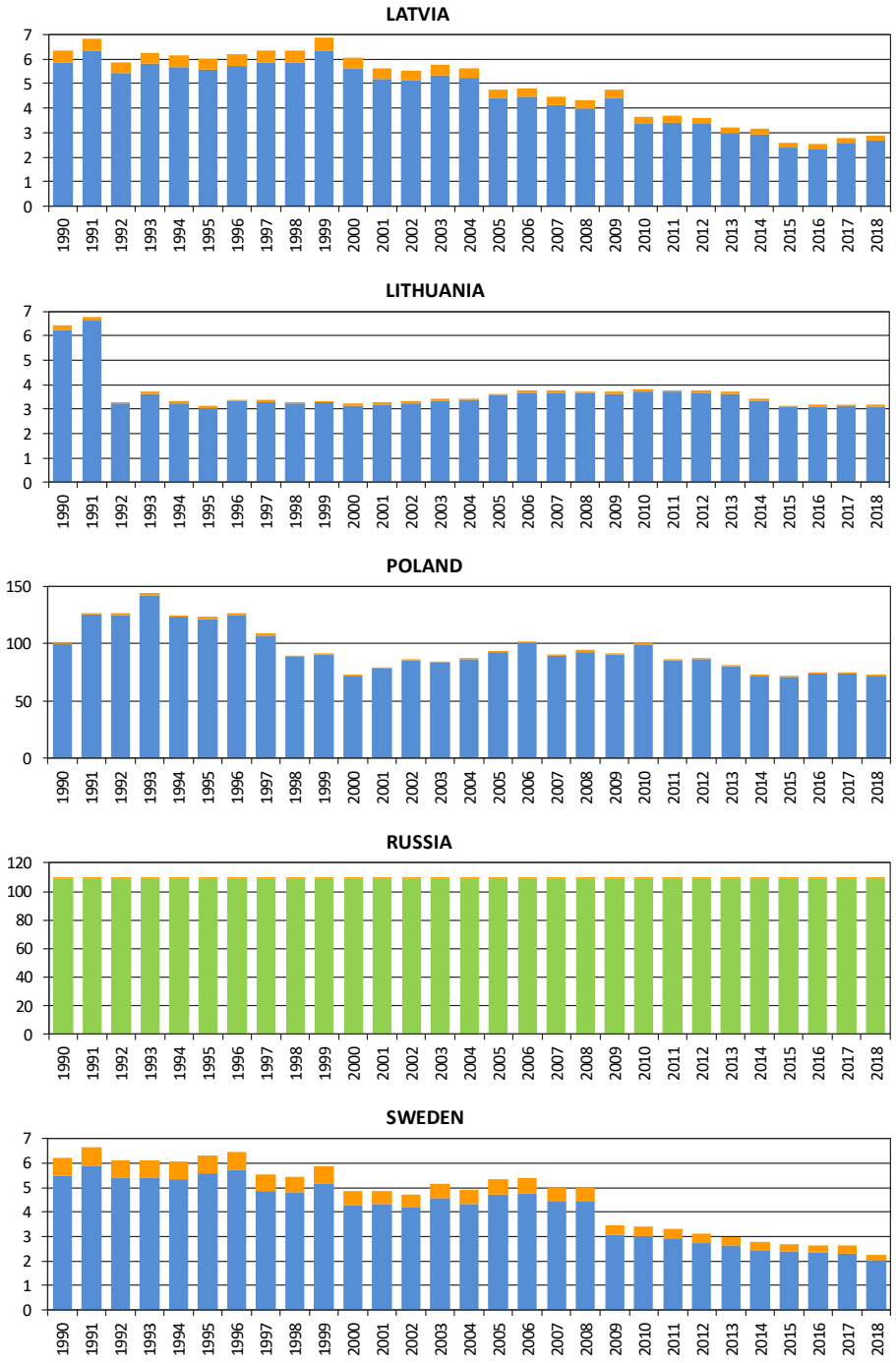

Figure 2. (continued) B(a)P emissions of HELCOM Contracting Parties (CP) to air as totals in tonnes/year for the period 1990-2018. Orange sections of the bars identify the fraction of emission deposited to the Baltic Sea. Green bars indicate expert estimates. The emission data of the CP refer to the total area of the CP except for Russian Federation, for which emissions from the territory of Russian Federation within the EMEP domain is used.

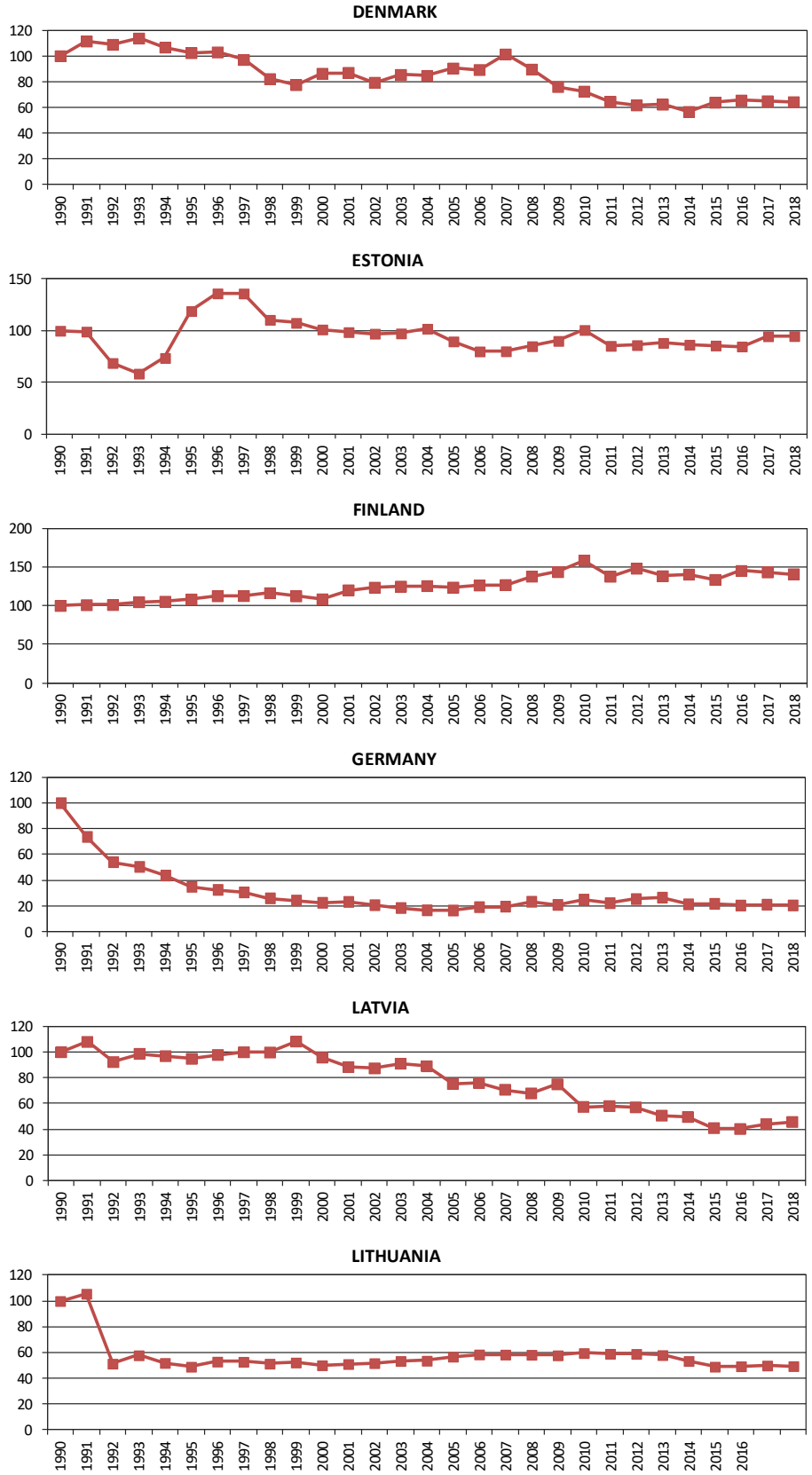

Figure 3. Trends in annual atmospheric emissions of B(a)P from HELCOM Contracting Parties from 1990 to 2018, plotted as percentage of the 1990 value. Unit: %. The emission data of the CP refer to the total area of the CP except for Russia, where emissions from the territory of Russia within the EMEP domain is used.

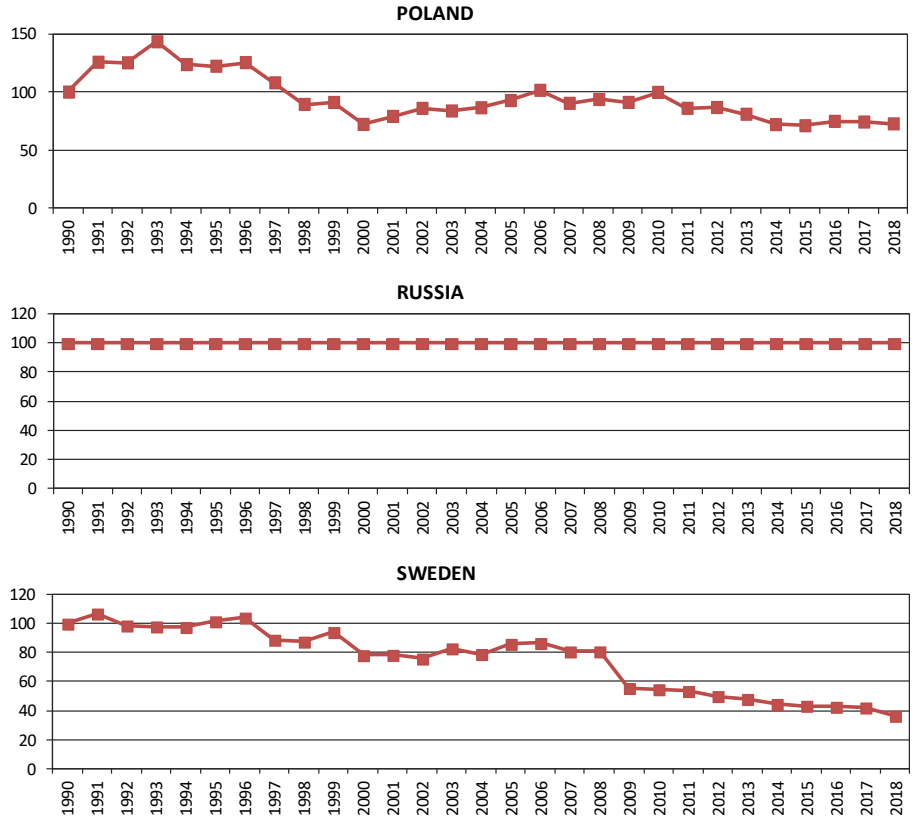

Figure 3. **(continued)** Trends in annual atmospheric emissions of B(a)P from HELCOM Contracting Parties from 1990 to 2018, plotted as percentage of the 1990 value. Unit: %. The emission data of the CP refer to the total area of the CP except for Russia, where emissions from the territory of Russia within the EMEP domain is used.

Data

Numerical data on B(a)P anthropogenic emissions of HELCOM countries are given in the following table.

Table 1. Total annual B(a)P emissions from anthropogenic sources of HELCOM countries in period from 1990 to 2018. Units: tonnes/year

	DK	EE	FI	DE	LV	LT	PL	RU	SE	HELCOM	Other
1990	3.480	2.368	2.073	139.27	6.349	6.412	100.87	110.0	6.22	377.0	531.1
1991	3.879	2.349	2.093	102.60	6.856	6.773	126.93	110.0	6.65	368.1	524.9
1992	3.789	1.628	2.097	75.21	5.860	3.294	126.43	110.0	6.14	334.4	480.1
1993	3.959	1.384	2.173	70.06	6.266	3.711	144.74	110.0	6.10	348.4	460.9
1994	3.715	1.743	2.185	60.67	6.152	3.330	124.85	110.0	6.07	318.7	441.8
1995	3.565	2.820	2.245	48.46	6.019	3.141	123.41	110.0	6.32	306.0	421.4
1996	3.584	3.225	2.332	45.10	6.211	3.395	126.56	110.0	6.48	306.9	421.0
1997	3.380	3.223	2.338	42.38	6.345	3.388	108.94	110.0	5.53	285.5	408.6
1998	2.862	2.619	2.414	35.92	6.333	3.293	90.11	110.0	5.45	259.0	388.4
1999	2.699	2.549	2.329	33.54	6.875	3.351	91.83	110.0	5.86	259.0	353.5
2000	3.007	2.397	2.249	31.09	6.081	3.215	72.68	110.0	4.87	235.6	344.7
2001	3.030	2.337	2.491	32.06	5.609	3.276	79.67	110.0	4.88	243.4	342.1
2002	2.763	2.301	2.562	28.50	5.547	3.320	86.68	110.0	4.72	246.4	329.7
2003	2.974	2.307	2.590	25.42	5.779	3.428	84.39	110.0	5.16	242.1	340.0
2004	2.948	2.415	2.604	22.95	5.650	3.440	87.20	110.0	4.92	242.1	338.8
2005	3.148	2.124	2.565	22.72	4.773	3.642	93.44	110.0	5.35	247.8	341.5
2006	3.107	1.894	2.621	26.38	4.820	3.752	102.41	110.0	5.39	260.4	338.8
2007	3.528	1.898	2.632	26.93	4.489	3.746	91.07	110.0	5.03	249.3	339.9
2008	3.119	2.014	2.859	32.23	4.308	3.737	94.40	110.0	5.03	257.7	351.2
2009	2.649	2.135	2.979	28.81	4.757	3.709	91.86	110.0	3.46	250.4	345.1
2010	2.523	2.386	3.288	34.56	3.640	3.821	100.64	110.0	3.40	264.3	346.6
2011	2.246	2.022	2.856	30.69	3.680	3.786	86.70	110.0	3.33	245.3	334.1
2012	2.151	2.039	3.071	35.11	3.619	3.780	87.43	110.0	3.11	250.3	337.4
2013	2.171	2.090	2.868	36.69	3.208	3.720	81.55	110.0	2.99	245.3	341.7
2014	1.973	2.049	2.912	29.44	3.142	3.427	72.50	110.0	2.77	228.2	319.5
2015	2.223	2.029	2.769	29.97	2.591	3.144	71.51	110.0	2.69	226.9	323.3
2016	2.282	2.008	3.009	28.12	2.547	3.164	75.33	110.0	2.65	229.1	327.4
2017	2.262	2.242	2.972	29.06	2.788	3.201	74.74	110.0	2.62	229.9	323.3
2018	2.237	2.245	2.921	28.21	2.894	3.172	73.15	110.0	2.27	227.1	318.5

Meta data

Technical information:

1. Source:

EMEP/MSC-E, EMEP/CEIP.

2. Description of data:

Annual total emissions of 4 PAHs including benzo(a)pyrene are officially reported to the UN ECE Secretariat by HELCOM countries. These data are available from the EMEP Centre on Emission Inventories and Projections (CEIP) (http://www.ceip.at/).

3. Geographical coverage:

EMEP region

4. Temporal coverage:

Data on annual emissions of benzo(a)pyrene for the period 1990 – 2018 were reported by all HELCOM countries with the exception of Finland and Russia. For these countries emissions of B(a)P were prepared by CEIP [*Poupa et al.*, 2020]. In particular, expert estimates, worked out by Shen et al. (2013), were applied to estimated B(a)P emissions in Russia. Finland submitted speciated PAH emission data, however the sum of 4 PAH emissions did not match reported total PAH emission. Therefore, the reported emissions of individual PAHs were replaced by splitting up the total PAHs in accordance with the distribution reported by Finland.

5. Methodology and frequency of data collection:

National data on emissions of 4 PAHs including benzo(a)pyrene are annually submitted by countries Parties to LRTAP Convention to the UN ECE Secretariat. The methodology is based on combination of measurements of releases to the atmosphere and estimation of emission based on activity data and emission factors. Submitted emission data are processed using quality assurance and quality control procedure and stored in the UN ECE/EMEP emission database at EMEP/CEIP Centre.

Quality information:

6. Strength and weakness:

Strength: gridded information on PAH emissions

Weakness: gaps in time series of national emissions, uncertainties in national emissions, lack of gridded emissions, and information on congener composition of emissions.

7. Uncertainty:

Among the HELCOM countries the level of uncertainties of official data on PAH or B(a)P emissions were reported by Denmark, Estonia, Finland, Latvia, Poland and Sweden. From other EMEP countries the information on uncertainties of officially reported PAH or/and B(a)P emissions is available for Austria, Belarus, Belgium, Croatia, Cyprus, France, Republic of Moldova, Switzerland and the United Kingdom. The uncertainty of reported data on PAH emissions expressed as percentage relative to mean value of emission is as follows:

Denmark:	B(a)P	750%
Estonia:	B(a)P	103%
Finland:	PAH	-81% to 196%
Latvia:	PAH	45%
Poland:	PAH	74%
Sweden:	PAH	680%
Austria:	PAH	148%
Belarus:	PAH	237%
Belgium:	PAH B(a)P	269% 281%
Croatia:	PAH	381%
Cyprus:	PAH	201%
France:	PAH	63%
Republic of Moldova:	PAH	238%
Switzerland:	PAH	>50%
UK:	B(a)P	393%

8. Further work required:

Further work of national experts on emissions of PAH is required to fill the gaps in the emission time-series and to reduce their uncertainties. The information on seasonal variations of PAH emissions and its congener composition is essential for modeling.

References

Poupa S., Tista M. and R.Wankmueller [2020] Methodologies applied to the CEIP GNFR gap-filling 2020. Part III: Persistent organic pollutants (Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, Total polycyclic aromatic hydrocarbons, Dioxin and Furan, Hexachlorobenzene, Polychlorinated biphenyls). Technical Report CEIP 3/2020. (https://www.ceip.at/ceip-reports)

Shen H., Huang Y., Wang R., Zhu D., Li W., Shen G., Wang B., Zhang Y., Chen Y., Lu Y., Chen H., Li T., Sun K., Li B., Liu W., Liu J., Tao S. [2013] Global atmospheric emissions of polycyclic aromatic hydrocarbons from 1960 to 2008 and future predictions, Environ. Sci. Technol., 47, 6415–6424.