CEIP umweltbundesamt

Methodologies applied to the CEIP GNFR gap-filling 2019

Part Ib:

Black Carbon (BC) of the year 2017

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1. Introduction

The EMEP Centre on Emission Inventories and Projections (CEIP) operates the UNECE/EMEP emission database (WebDab) which contains information on air pollutant emissions and projections from the Parties to the LRTAP Convention (UNECE 1979). Among these data sets, also emissions used in EMEP models (gap-filled emissions) and gridded emissions in Google maps are available from the CEIP website (www.ceip.at, CEIP 2019a).

Data used by CEIP were reported by the Parties to the LRTAP Convention as sectoral emissions (NFR14) and National Total emissions according to the UNECE guidelines for reporting emissions and projections data under the Convention on long-range transboundary air pollution, Annex I (UNECE 2014). For the use by CEIP, the sector data were aggregated to 13 GNFR sectors. In several cases, no data were submitted by the countries, or the reporting is not complete or contains errors. Before these emission data can be used by modelers, missing or erroneous information have to be filled in. To gap-fill those missing data, CEIP typically applies different gap-filling methods. After the gap-filling, sector emissions are used for spatial emission mapping, i.e. the EMEP grid. This documentation describes the gap-filling methods that have been used for the 2017 GNFR inventory as prepared in 2019 for Black Carbon.

2. Summary of the process

The first step is to collect the official submissions by the Parties to the LRTAP Convention. All submissions received **up to 9th May 2019** were used as a basis for the gap-filled data set. Parties report their emission inventories to the LRTAP Convention as sectoral emissions (NFR14) and National Total emissions according to the UNECE guidelines for reporting emissions and projections data under the LRTAP Convention, Annex I (UNECE 2014).

The second step is to aggregate the sector data to 13 GNFR sectors. The third step is plausibility checks of all reported data. If plausibility was not given, reported data were replaced (see section 4). The checks comprise:

- Data comparison of the reported data with previously reported data and with expert data from EDGAR (JRC 2016)
- Comparison of the reported sectoral distribution with expert data and with the mean sector distribution of the data from all countries that reported data
- Comparisons of the reported sectoral distributions among the Parties
- Comparisons of the sum of sectors with the National Total
- Comparisons of the share from BC to $PM_{2.5}$

The next step is the gap-filling or – in certain cases – replacements of (some) data of the inventory. Gap-filling or replacement of data is applied if

(1) no data are submitted by a Party,
(2) the reporting is not complete,
(3) the data are erroneous.

After that step, the inventory is assumed to be complete and will be used for the WebDab database (data as used in EMEP models) and for spatial emission mapping, i.e. the EMEP grid.

3. Gap-filling methods

3.1. Gap-filling of National Total data

If no submission is made, as a first step data of previous submissions are checked for plausibility. If previous reported data are plausible and complete, extrapolation of these data is done. This can be done either by extrapolation of sector data and the National Total is then calculated by the sum of the sectors, or by extrapolation of the National Total, and the sector data are then splitted up using a distribution of another year or an expert distribution.

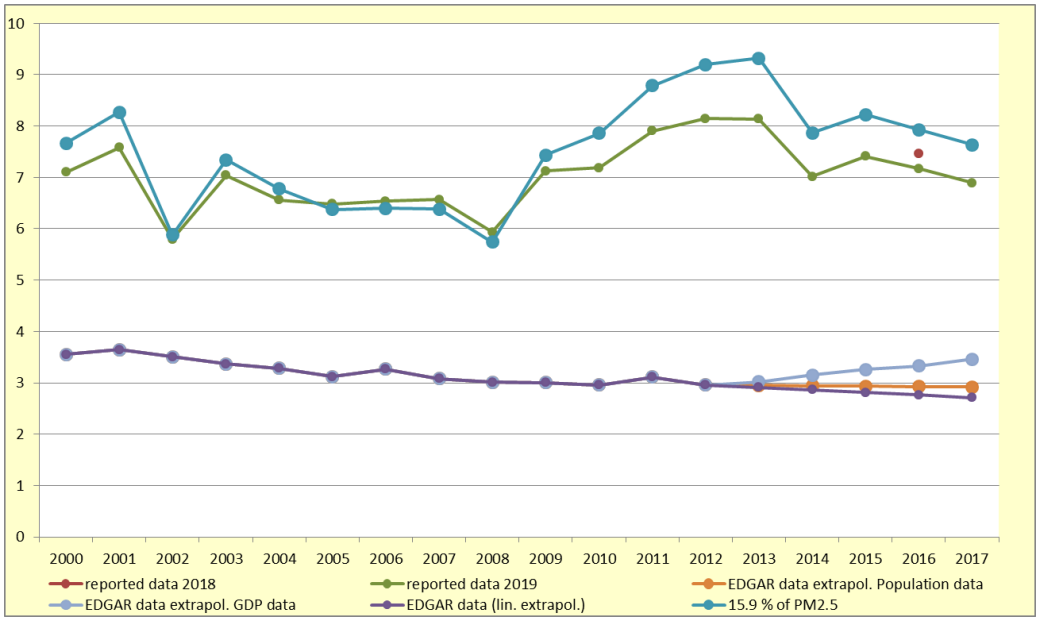
If no previous reported data are available or the data are not plausible, different estimates were made. These estimates comprise extrapolation of (previous reported or expert) data by using population or GDP data ([1]) of the respective country. Further, (inter-, extrapolation or copy from previous years of) expert data were used.

Available data for comparison are (example see Figure 3.1):

- EDGAR data: expert estimates from the Emission Database for Global Atmospheric Research (JRC 2016) for the years 2000 to 2012.
- Median share of gap-filled $PM_{2.5}$ emissions: Of the gap-filling made in 2019 by CEIP (CEIP 2019b). The median share was calculated using only data of countries that reported both, BC and $PM_{2.5}$ data for the year 2017 in 2019.

([1]) Population data from database: Population estimates and projections (Last Updated: 04/10/2019). Indicator: Population, total. Total population is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship. The values shown are midyear estimates.
GDP data from database: World Development Indicators (Last Updated: 04/10/2019). Indicator: GDP, PPP (constant 2011 international $).

Figure 3.1 Example: BC data (reported data and expert estimates) available for Hungary



3.2. Gap-filling of sectoral data

Estimates on the sectoral distribution of the emissions are available EDGAR (JRC 2016), and a mean sector distribution from the 2019 reported data set (of those countries, which reported data).

In case of a missing or erroneous sector distribution, all available sector distributions for a country (reported and expert estimates) were compared, and the most suitable distribution chosen for splitting up the National Total into GNFR sectors. An example for the sector comparison is shown in Figure 3.2, and the reported sectors compared with the gap-filled sectors in Figure 3.3.

Figure 3.2 Example for sectoral distributions of BC emissions from different reported data sets and expert estimates for Belgium

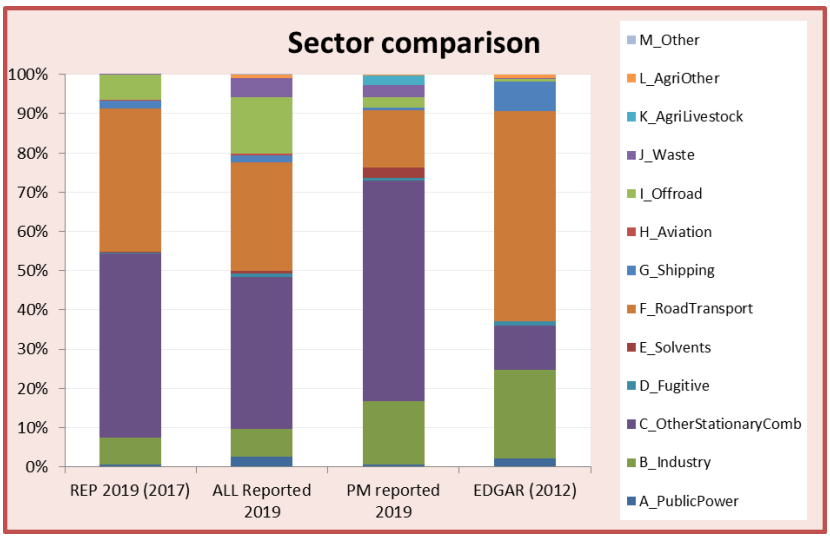
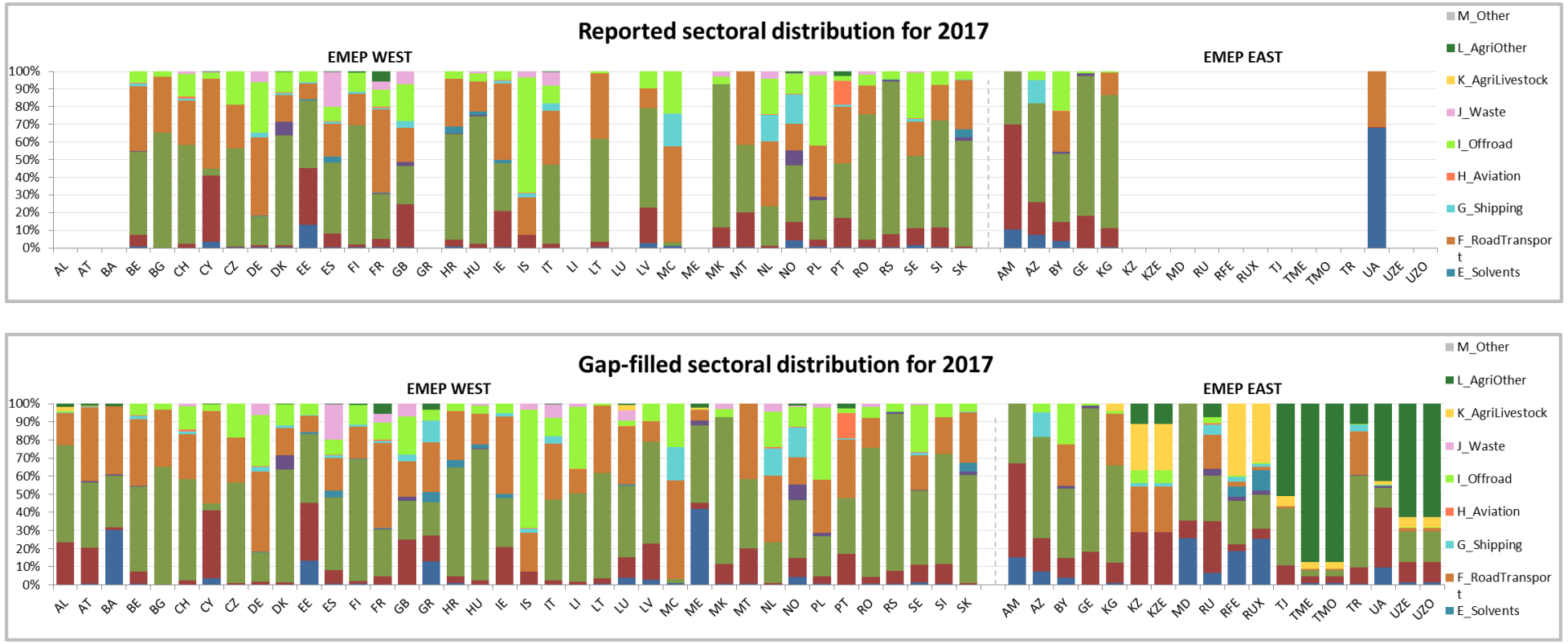


Figure 3.3 Reported and gap-filled sectoral distributions of BC emissions in the year 2017



4. Reasons for replacement of reported data

4.1. Replacements of data

In cases, where data are in all probability erroneous, these data are replaced

In 2019, data of three countries were (partly) replaced. Table 4.1 provides an overview of all replaced data of the gap-filled inventory 2019, including a short rationale. For more information see section 5, information of the respective country.

Table 4.1 Overview of and reasons for replaced data

Country	NT, Sectors,…	Reason
Armenia	National Total, Sectors A-C	The National Total reported for 2017 seemed to be far too low. Replaced by 2018 reported data and the sector distribution of $PM_{2.5}$
Kyrgyzstan	National Total, Sectors A-C, F, I	The National Total reported for 2017 seemed to be far too low and the sum of the sectors did not equal to the National Total. Replaced by the median share of $PM_{2.5}$ and the sector distribution of $PM_{2.5}$
Ukraine	National Total, Sectors A, B, F	The National Total reported for 2017 seemed to be far too low. Replaced by the median share of $PM_{2.5}$ and the sector distribution of $PM_{2.5}$

5. Data availability and gap-filling method per country

6.1. Countries without gap-filling or replacements

The following countries submitted data for BC for the year 2017, that seem to be plausible. No gap-filling or replacements took place:

- Azerbaijan (AZ)
- Belgium (BE)
- Bulgaria (BG)
- Belarus (BY)
- Switzerland (CH)
- Cyprus (CY)
- Czechia (CZ)
- Germany (DE)
- Estonia (EE)
- Spain (ES)
- Finland (FI)
- France (FR)
- The United Kingdom (GB)
- Croatia (HR)

- Hungary (HU)
- Ireland (IE)
- Iceland (IS)
- Italy (IT)
- Lithuania (LT)
- Latvia (LV)
- Monaco (MC)
- North Macedonia (MK)
- The Netherlands (NL)
- Norway (NO)
- Poland (PL)
- Portugal (PT)
- Romania (RO)
- Serbia (RS)
- Sweden (SE)
- Slovenia (SI)
- Slovakia (SK)

6.2. Albania (AL)

No BC data were reported. Expert data are far below the median share of the reported $PM_{2.5}$ share of Albania. Thus, BC data for Albania were gap-filled using the median share of the $PM_{2.5}$ emissions (see section 3.1), and the sector distribution like $PM_{2.5}$.

6.3. Armenia (AM)

The National Total reported for 2017 seemed to be far too low and thus was replaced by 2018 reported data. The gap-filled sector split of $PM_{2.5}$ (see CEIP 2019b) was used.

6.4. Austria (AT)

No BC data were reported. Expert estimates from EDGAR were used, whereas for the National Total linear extrapolation of the EDGAR National Total data was made, and the EDGAR sector distribution of the year 2012 was used to split the National Total into sectors.

6.5. Bosnia and Herzegovina (BA)

No BC data were reported. Expert estimates from EDGAR were used, whereas for the National Total linear extrapolation using GDP data of the EDGAR National Total data was made, and the EDGAR sector distribution of the year 2012 was used to split the National Total into sectors.

6.6. Denmark (DK)

BC data were reported, but BC emissions in the sector “D_Fugitive” was higher than the PM2.5 emissions. Therefore the reported National Total BC emission was split among the sectors like PM2.5.

6.7. Georgia (GE)

BC data were reported, but BC emissions in the sector “D_Fugitive” was higher than the PM2.5 emissions. Therefore the reported National Total BC emission was split among the sectors like PM2.5.

6.8. Greece (GR)

No BC data were reported. Data reported for the year 2016 was copied for the year 2017.

6.9. Kyrgyzstan (KG)

The National Total reported for 2017 seemed to be far too low and the sum of the sectors did not equal to the National Total. Thus, National Total and sector data were replaced by the median share of the gap-filled $PM_{2.5}$ data of Kyrgyzstan (see CEIP 2019b) and the sector distribution of $PM_{2.5}$.

6.10. Kazakhstan (KZT): Kazakhstan (KZ) and Rest of Kazakhstan in the extended EMEP domain (KZE)

No BC data were reported. No expert data are available for Kazakhstan and the sector distribution of previously reported data seem not plausible. Thus, BC data were gap-filled using the median share of the gap-filled PM2.5 emissions (see section 3.1), and the sector distribution like PM2.5. Data between KZ and KZE are splitted up by 15 % vs. 85 %.

6.11. Liechtenstein (LI)

No BC data were reported. No expert data are available for Liechtenstein. Thus, BC data were gap-filled using the median share of the gap-filled PM2.5 emissions (see section 3.1), and the sector distribution like PM2.5.

6.12. Luxembourg (LU)

No BC data were reported. Expert data are far too high compared with the median share of the reported $PM_{2.5}$ data of Luxembourg. Thus, BC data for Luxembourg were gap-filled using the median share of the $PM_{2.5}$ emissions (see section 3.1), and the sector distribution like $PM_{2.5}$.

6.13. Republic of Moldova (MD)

No BC data were reported. Data reported for the year 2015 seem to be plausible and thus were copied for the year 2017.

6.14. Malta (MT)

BC data were reported, but BC emissions in the sectors “B_Industry” and “C_OtherStationaryComb” were higher than the PM2.5 emissions. Therefore the reported National Total BC emission were split among the sectors like PM2.5.

6.15. Montenegro (ME)

No BC data were reported. No expert data are available for Montenegro. Thus, BC data were gap-filled using the median share of the gap-filled PM2.5 emissions (see section 3.1), and the sector distribution like PM2.5.

6.16. Russian Federation in the former official EMEP domain (RU)

No BC data were reported. Expert estimates from EDGAR were used, whereas for the National Total linear extrapolation of the EDGAR National Total data was made, and the EDGAR sector distribution of the year 2012 was used to split the National Total into sectors.

6.17. Tajikistan (TJ)

No BC data were reported. No expert data are available for Tajikistan. Thus, BC data were gap-filled using the median share of the gap-filled $PM_{2.5}$ emissions (see section 3.1), and the sector distribution like PM2.5.

6.18. Turkmenistan (TM): Rest of Turkmenistan in the extended EMEP domain (TME) and Turkmenistan in the former official EMEP domain (TMO)

No BC data were reported. No expert data are available for Turkmenistan. Thus, BC data were gap-filled using the median share of the gap-filled PM2.5 emissions (see section 3.1), and the sector distribution like $PM_{2.5}$. The parts “TME” and “TMO” were split up according to 80 % and 20 % of the emissions of Turkmenistan.

6.19. Turkey (TR)

No BC data were reported. Expert estimates from EDGAR were used, whereas for the National Total linear extrapolation using GDP data of the EDGAR National Total data was made, and the EDGAR sector distribution of the year 2012 was used to split the National Total into sectors.

6.20. Ukraine (UA)

The National Total reported for 2017 seemed to be far too low. Thus, National Total and sector data were replaced by the median share of the gap-filled $PM_{2.5}$ data of the Ukraine (see CEIP 2019b) and the sector distribution of $PM_{2.5}$.

6.21. Uzbekistan (UZ): Rest of Uzbekistan in the extended EMEP domain (UZE) and Uzbekistan in the former official EMEP domain (UZO)

No BC data were reported. No expert data are available for Uzbekistan. Thus, BC data were gap-filled using the median share of the gap-filled $PM_{2.5}$ emissions (see section 3.1), and the sector distribution like $PM_{2.5}$. The parts “UZE” and “UZO” were split up according to 97 % and 3 % of the emissions of Turkmenistan.

6. Data availability and gap-filling method for other regions

Other Regions were gap-filled using the median share of the gap-filled $PM_{2.5}$ data (=15.9 % of $PM_{2.5}$) of the respective region (see CEIP 2019b). These regions are:

- Sea regions: Atlantic Ocean (ATL), Baltic Sea (BAS), Black Sea (BLS), Caspian Sea (CAS), Mediterranean Sea (MED), North Sea (NOS)
- Aral Lake: Rest of Aral Lake in the extended EMEP domain (ARE), Aral Lake in the former official EMEP domain (ARO)
- Russian Federation in the extended EMEP domain (RUE): Rest of Russian Federation in the extended EMEP domain (RFE) and EMEP-external part of Russian Federation (RUX)
- Remaining Asian Areas in the extended EMEP domain (ASE) and Modified Remaining Asian Areas in the former official EMEP domain (ASM)
- North Africa (NOA)

7. References

CEIP 2019a: *'WebDab - EMEP database'*. CEIP website https://www.ceip.at/ms/ceip_home1/ceip_home/webdab_emepdatabase/

CEIP 2019b: *Methodologies applied to the CEIP GNFR gap-filling 2019. Part Ia: Main pollutants (NOx, NMVOCs, SOx, NH3, CO) of the years 1990 to 2017 and Particulate Matter (PM2.5, PM10, PMcoarse) of the years 2000 to 2017*. Technical report CEIP 01a/2019

JRC 2016: European Commission, Joint Research Centre (EC-JRC)/Netherlands Environmental Assessment Agency (PBL): *Emissions Database for Global Atmospheric Research (EDGAR), release EDGAR v4.3.2 (1970 - 2012)* of March 2016, http://edgar.jrc.ec.europa.eu

UNECE 1979: *The 1979 Geneva Convention on Long-range Transboundary Air Pollution.* United Nations Economic Commission for Europe. http://www.unece.org/fileadmin//DAM/env/lrtap/full%20text/1979.CLRTAP.e.pdf

UNECE 2014: *Guidelines for Reporting Emissions and Projections Data under the Convention on Long-range Transboundary Air Pollution*. United Nations Economic Commission for Europe (ECE/EB.AIR/125). http://www.ceip.at/fileadmin/inhalte/emep/2014_Guidelines/ece.eb.air.125_ADVANCE_VERSION_reporting_guidelines_2013.pdf

8. EMEP Country Codes

AL	Albania
AM	Armenia
AOE	Arctic Ocean in the extended EMEP domain
ARE	Rest of Aral Lake in the extended EMEP domain
ARO	Aral Lake in the former official EMEP domain
AST	Asian areas in the extended EMEP domain (ASM+ASE+ARO+ARE+CAS)
AT	Austria
ATL	Remaining North-East Atlantic Ocean
ATX	EMEP-external Remaining North-East Atlantic Ocean
AZ	Azerbaijan
BA	Bosnia and Herzegovina
BAS	Baltic Sea
BE	Belgium
BG	Bulgaria
BLS	Black Sea
BY	Belarus
CA	Canada
CAS	Caspian Sea
CH	Switzerland
CY	Cyprus
CZ	Czechia
DE	Germany (FGD+FFR)
DK	Denmark
EE	Estonia
ES	Spain
EU	European Union
FFR	Former Federal Republic of Germany (FGD+FFR = DE)
FGD	Former German Democratic Republic (FGD+FFR = DE)
FI	Finland
FR	France
GB	United Kingdom
GE	Georgia
GL	Greenland
GR	Greece
HR	Croatia
HU	Hungary
IE	Ireland
IS	Iceland
IT	Italy
KG	Kyrgyzstan
KZ	Kazakhstan in the former official EMEP domain (KZ+KZE = KZT)
KZE	Rest of Kazakhstan in the extended EMEP domain (KZ+KZE = KZT)
KZT	Kazakhstan (KZ+KZE)
LI	Liechtenstein
LT	Lithuania
LU	Luxembourg
LV	Latvia
MC	Monaco
MD	Republic of Moldova
ME	Montenegro
MED	Mediterranean Sea
MK	North Macedonia
MT	Malta
NL	Netherlands
NO	Norway
NOA	North Africa
NOS	North Sea
PL	Poland
PT	Portugal
RFE	Rest of Russian Federation in the extended EMEP domain (RUX+RFE = RUE)
RO	Romania
RS	Serbia
RU	Russian Federation in the former official EMEP domain (RUO+RUP+RUA+RUR)
RUA	Kaliningrad (RUO+RUP+RUA+RUR = RU)
RUE	Russian Federation in the extended EMEP domain (RFE+RUX)
RUO	Kola & Karelia (RUO+RUP+RUA+RUR = RU)
RUP	St.Petersburg & Novgorod-Pskov (RUO+RUP+RUA+RUR = RU)
RUR	Rest of the Russian Federation (RUO+RUP+RUA+RUR = RU)

RUX	EMEP-external part of Russian Federation (RUX+RFE = RUE)
SE	Sweden
SI	Slovenia
SK	Slovakia
TJ	Tajikistan
TM	Turkmenistan (TMO+TME)
TME	Rest of Turkmenistan in the extended EMEP domain (TMO+TME = TM)
TMO	Turkmenistan in the former official EMEP domain (TMO+TME = TM)
TR	Turkey
UA	Ukraine
US	United States
UZ	Uzbekistan (UZO+UZE)
UZE	Rest of Uzbekistan in the extended EMEP domain (UZO+UZE = UZ)
UZO	Uzbekistan in the former official EMEP domain (UZO+UZE = UZ)

Table 8.1 Countries of the EMEP West and EMEP East region

EMEP West countries	AL, AT, BA, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LI, LT, LU, LV, MC, ME, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK
EMEP East countries (9 EECCA countries + TR)	AM, AZ, BY, GE, KG, KZT, MD, RU, TR, UA
Non-EMEP EECCA countries (CLRTAP not ratified)	TJ, TM, UZ
EMEP countries outside the EMEP domain	CA, US

Note: EECCA = Eastern Europe, Caucasus and Central Asia