CEIP umweltbundesamt

Methodologies applied to the CEIP GNFR gap-filling 2019

Part Ia:

Main pollutants (NO_x, NMVOCs, SO_x, NH_3, CO) of the years 1990 to 2017

and Particulate Matter ($PM_{2.5}$, PM_{10}, PM_{coarse}) of the years 2000 to 2017

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CONTENTS

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 2019).

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 1990 (PMs: 2000) to 2017 GNFR inventory (as prepared in 20189 for NO_x, NMVOCs, SO_x, NH_3, CO, $PM_{2.5}$, PM_{10}, PM_{coarse}. It illustrates reasons of replacements of reported data, discusses problems of the procedure and gives an overview on the data availability and gap-filling of each country or area.

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 2th 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:

- Time series comparison of the reported data with previously reported data, gap-filled data from 2018, CRF data (EU 2013) and expert data from IIASA (IIASA 2014), TNO (Kuenen et al. 2014), EDGAR (JRC 2013), CAMS (ECCAD 2019)
- Comparisons of the ratio of the reported data to population data and to GDP data with all other Parties
- Comparison of the reported sectoral distribution with expert data, CRF data, previously reported data of the respective country, and with the mean sector distribution from the 2017 gap-filled data set of all countries
- Comparisons of the reported sectoral distributions among the Parties
- Comparisons of the sum of sectors with the National Total
- Comparisons of $PM_{2.5}$ and PM_{10}

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,
(4) there is no reporting obligation for a certain area and thus no reported data are available.

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.

Data for PM_{coarse} are not reported but in all cases calculated as the difference between PM_{10} and $PM_{2.5}$. When this results in negative values for PM_{coarse}, data of PM_{10} are replaced by data from $PM_{2.5}$ (see Table 4.1).

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 and reported CRF data were used.

Available data for comparison are:

- IIASA data: Data from the GAINS model (Greenhouse Gas and Air Pollution Interactions and Synergies) were provided by the International Institute for Applied Systems Analysis (IIASA 2014). Two data sets (on NFR level) were provided by IIASA:
  - One was generated in spring 2014 and covers the period from 1990 to 2010 (i.e. 1990, 1995, 2000, 2005 and 2010)
  - The other data set was generated in October 2014 and covers the period 2005 to 2030 (i.e. 2005, 2010, 2015, 2020, 2025 and 2030)

  The data were converted to GNFR level by CEIP. Not for all Parties the second data set was available. If both data sets were available for the overlapping years (2005 and 2010) the data set from October 2014 was used.
- CRF data under the EU Greenhouse Gas Monitoring Mechanism (EU 2013) reported by the Parties in 2019.

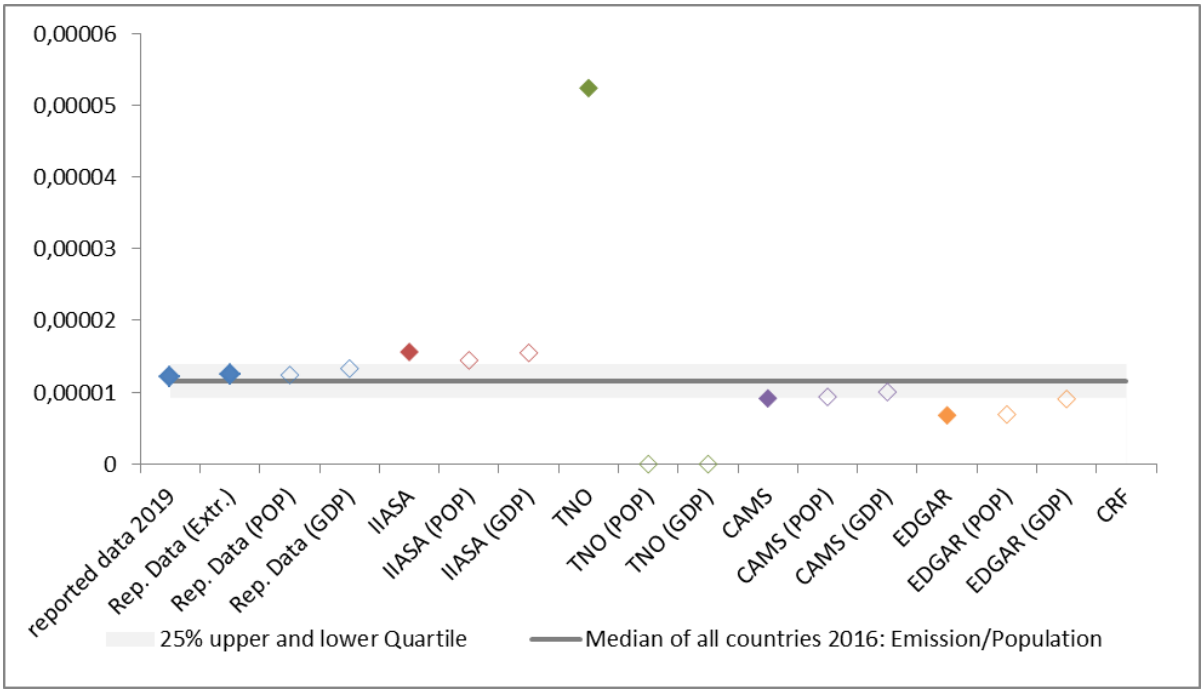
([1]) Population data from database: Population estimates and projections (Last Updated: 04/10/2019). Indicator: Population, total. Total population is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship. The values shown are midyear estimates.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

- TNO data: expert estimates from the Dutch institute TNO (Kuenen et al. 2014) for the years 2003-2009.
- CAMS data: Data set CAMS-REG-AP-v2.2 (ECCAD 2019)
- EDGAR data: expert estimates from the Emission Database for Global Atmospheric Research (JRC 2016) for the years 2000 to 2010.

In several cases, not only one estimate is given for a country. To facilitate the choice of the estimate for the gap-filling, ratios for each pollutant between emissions and population data and GDP were calculated by using data of the gap-filled inventory from 2018 (separate for EMEP West and EMEP East countries, for the country grouping see Table 9.1) for the year 2016. The distance of the different estimates to this ratio shows how similar the estimates are to the mean. An example for NMVOC estimates of Albania is shown in

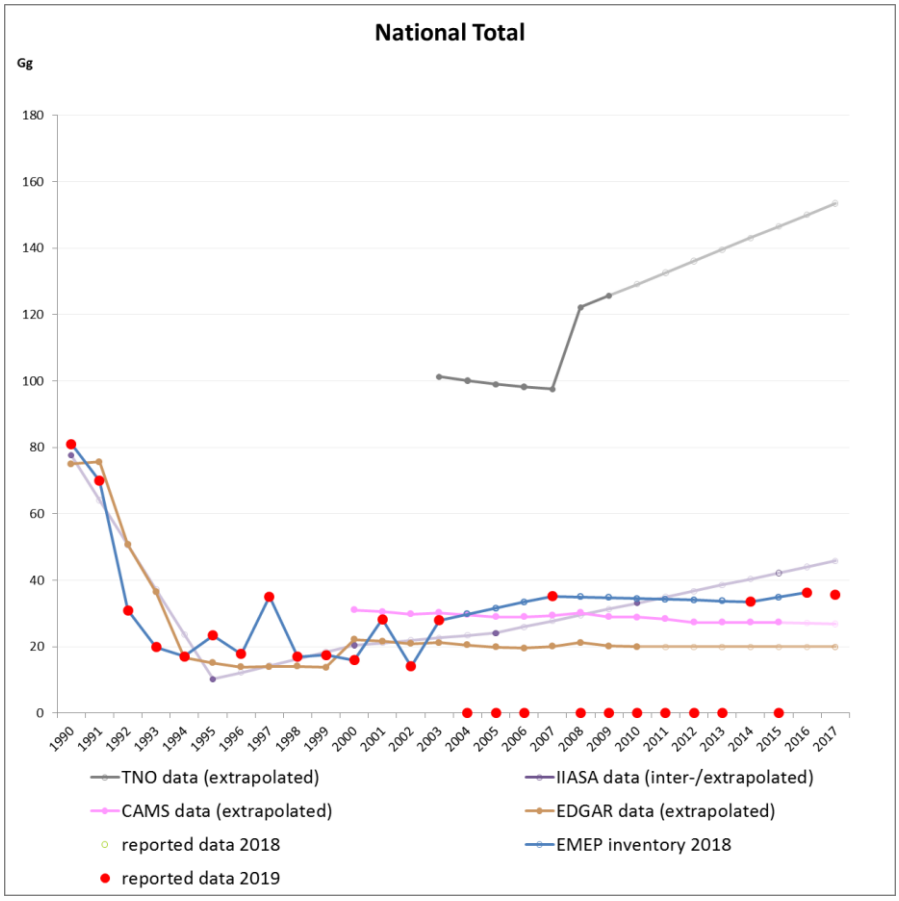
Figure **3.1**.

Figure 3.1 Example for different NMVOC estimates for Armenia



Note: reported CRF data from 2019 were not available from Armenia.

Figure 3.2 NMVOC data (reported data and expert estimates) available for Armenia



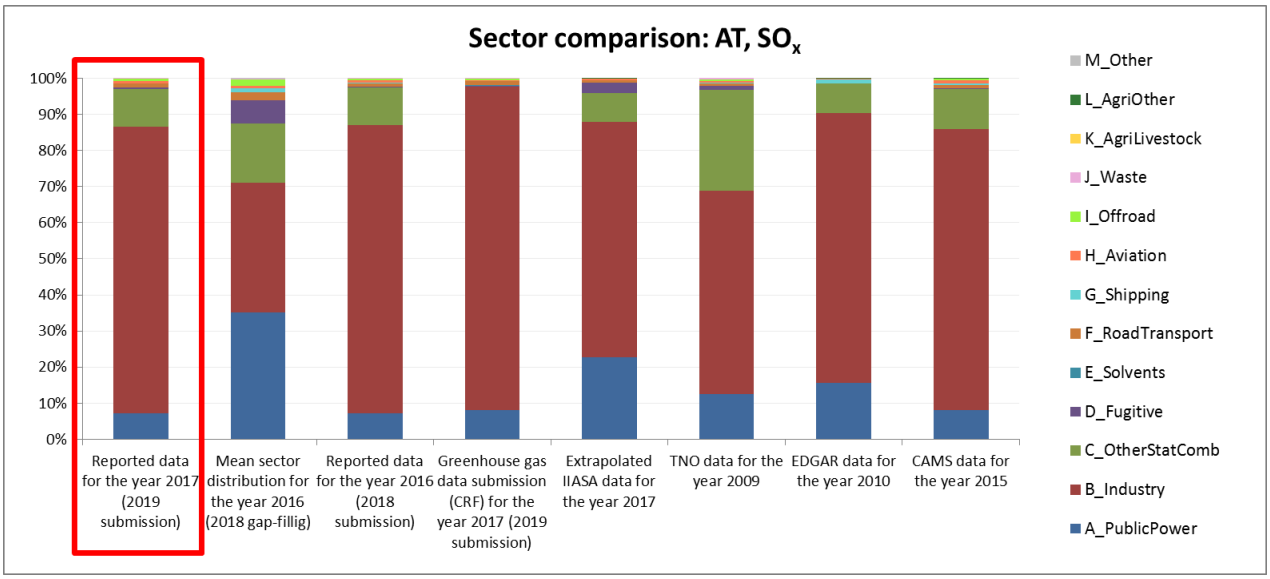
Note: reported CRF data from 2019 were not available from Armenia.

3.2. Gap-filling of sectoral data

Estimates on the sectoral distribution of the emissions are available from IIASA (2014), TNO (Kuenen at al. 2014), EDGAR (JRC 2013), CRF (EU 2013), CAMS (ECCAD 2019) from previous reported submissions and a mean sector distribution from the 2018 gap-filled data set of all countries.

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 3.3.

Figure 3.3 Example for sectoral distributions of SO_x emissions from different reported data sets and expert estimates for Austria



3.3. Gap-filling effects

Figure 3.4, Figure 3.5 and

Figure 3.6 show examples on the effects of the gap-filling. Figure 3.4 shows time series of Azerbaijan for NO_x as reported with their submission in 2019, and after the gap-filling. Figure 3.5 and

Figure 3.6 show the sectoral distribution as reported and after gap-filling of NO_x and $PM_{2.5}$ emissions in the year 2017 for all countries.

Figure 3.4 Reported and gap-filled time series of NO_x emissions from Azerbaijan

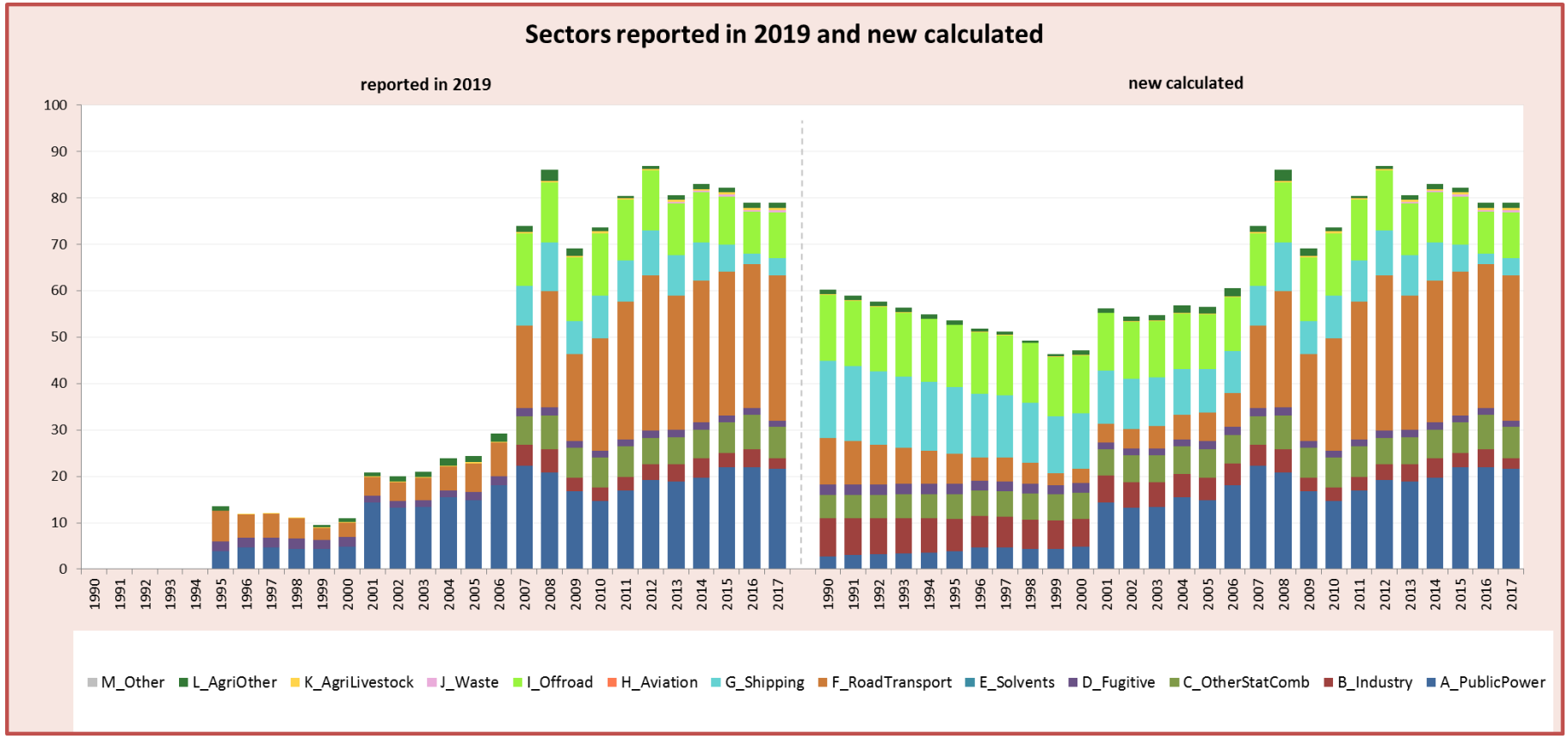


Figure 3.5 Reported and gap-filled sectoral distributions of NO_x emissions in the year 2017

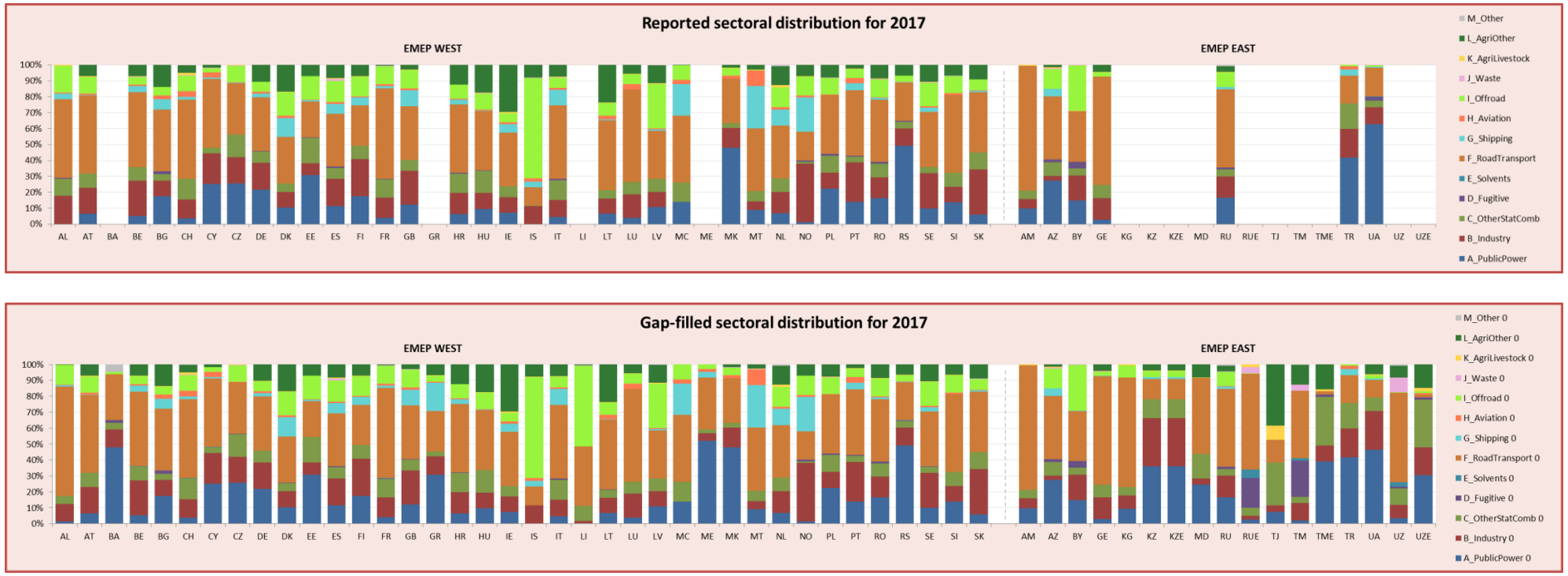
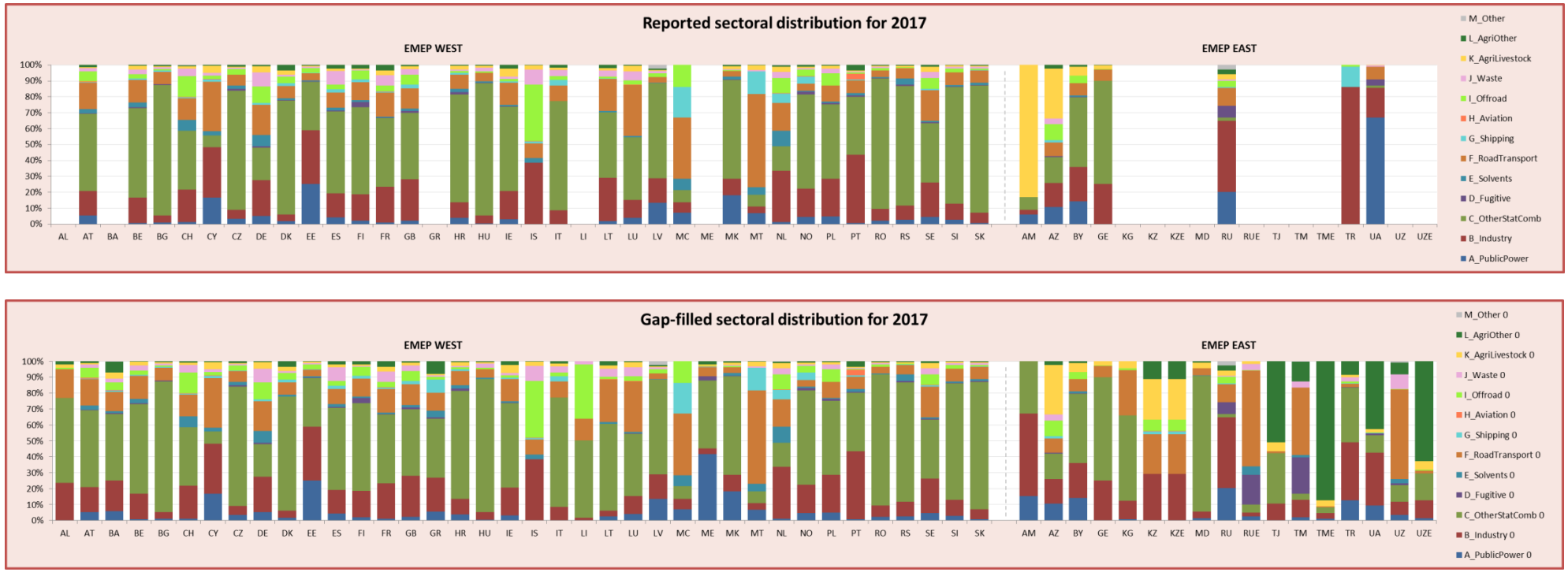


Figure 3.6 Reported and gap-filled sectoral distributions of $PM_{2.5}$ emissions in the year 2017

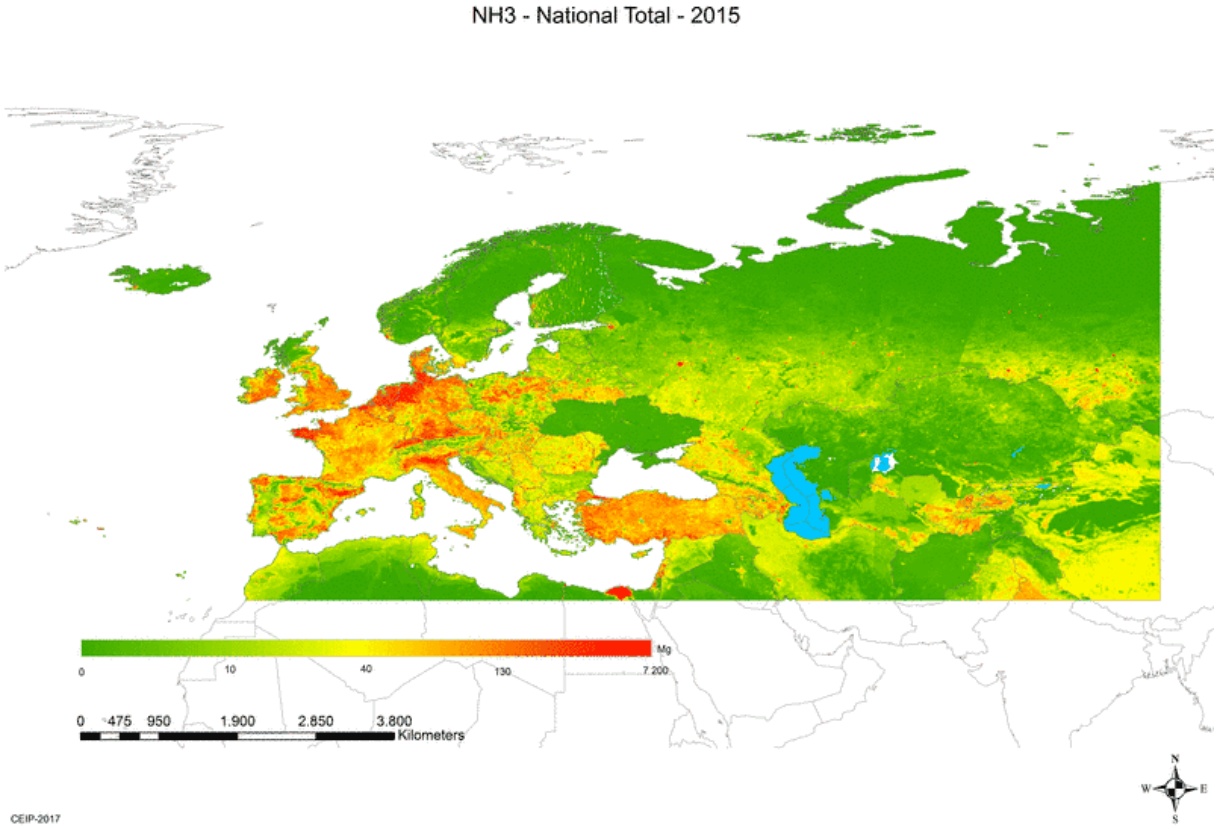


4. Reasons for replacement of reported data

4.1. Replacements of data

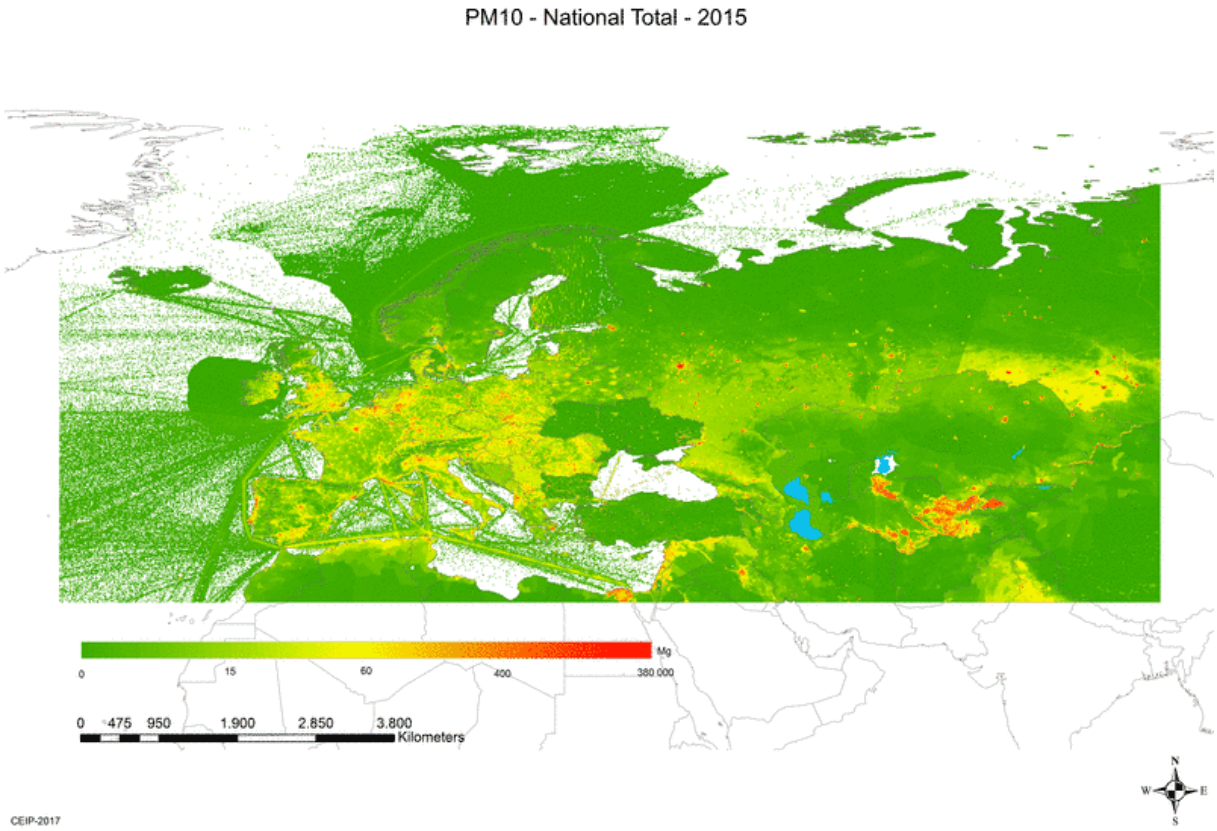
In cases, where data are in all probability erroneous, these data are replaced. If data in such cases will not be replaced, it is likely to get a wrong picture in gridded maps. As example, Figure 4.1 shows not replaced NH_3 data of the Ukraine in gridded maps of the year 2015. In that case, the reported National Total was far too low (compared with expert estimates and with the data of other countries).

Figure 4.1 Example for too low National Total emissions of the Ukraine, showing a peculiar picture in gridded maps: NH_3 emissions of the year 2015



Another example is shown in Figure 4.2, where the National Total seem to be correct, but an unusual sector distribution of PM_{10} data of the Ukraine and Turkey led to a conspicuous picture.

Figure 4.2 Example for unusual sector distribution of the Ukraine and Turkey, reflected in gridded maps: PM_{10} emissions of the year 2015



In 2019, data of 18 countries were (partly) replaced (including replacements of $PM_{2.5}$ and PM_{10} because of negative values for PM_{coarse}). Data for PM_{coarse} are calculated as the difference between PM_{10} and $PM_{2.5}$. When this results in negative values for PM_{coarse}, data of PM_{10} are replaced by values available for $PM_{2.5}$.

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 6, information of the respective country.

Table 4.1 Overview of and reasons for replaced data

Country	Pollutant	Year(s)	NT, Sectors,…	Reason
Albania	NO_x, SO_x	2008-2017	National Totals	National Total data showed strong discrepancy to expert data and to data of other years. National Totals were replaced by inter-/extrapolated TNO data.
Albania	NMVOC, CO	2009-2017	National Totals	National Total data showed strong discrepancy to expert data and to data of other years. National Totals were replaced by inter-/extrapolated TNO data.
Albania	NH_3	2016-2017	National Totals	National Total data showed strong discrepancy to expert data and to data

				of other years. National Totals were replaced by extrapolation of reported data.
Albania	$PM_{2.5}$	2009	National Total	National Total data showed strong discrepancy to expert data and to data of other years. National Total was replaced by TNO data.
Albania	PM_{10}	2009-2017	National Totals	National Total data showed strong discrepancy to expert data and to data of other years. National Totals were replaced first by inter-/extrapolated TNO data, then corrected by the sum of sectors (due to subsequent changes of the sector data).
Albania	NO_x, SO_x	2008-2017	Sectors B, C, D, F, G, H, I, K, L	Sector distribution showed strong discrepancy to expert data. Sector distribution of 2007 used.
Albania	NMVOC	2009-2017	Sectors B- L	Sector distribution showed strong discrepancy to expert data. Sector distribution of 2008 used.
Albania	NH_3	2016-2017	Sectors B, C, D, F, I, J, K, L	Sector distribution showed strong discrepancy to expert data. Sector distribution of 2015 used.
Albania	$PM_{2.5}$	2009	Sectors B, C, F, G, I, K, L	Sector distribution showed strong discrepancy to expert data. Sector distribution of 2008 used.
Albania	PM_{10}	2009-2017	Sectors B, C, F, G, H, I, K, L	Sector distribution showed strong discrepancy to expert data. Sector distribution of 2008 used, Sectors G, H, I corrected by copy of $PM_{2.5}$ values (to avoid negative PM_{coarse} data)
Albania	CO	2009-2017	Sectors B, C, F, G, H, I, J, L	Sector distribution showed strong discrepancy to expert data. Sector distribution of 2008 used.
Armenia	NH_3	1991-2001	National Totals	National Totals are far too low compared with expert data and data of other years. Interpolated.
Armenia	$PM_{2.5}$, PM_{10}	2007, 2014, 2016, 2017	National Totals	National Total data showed strong discrepancy to expert data. Replaced by (inter-/extrapolated) IIASA data
Armenia	NMVOC	2016	Sectors A, B, C, F, K	Sector distribution showed strong discrepancy to other years; missing sector. Replaced by sector distribution of the year 2017.
Armenia	SO_x, CO	2007, 2014, 2016, 2017	Sectors A, B, C, F	Sector distribution showed strong discrepancy to expert data (SO_x: especially the share of sector B, CO: especially the share of the sector F). SO_x data eplaced by sector distribution from TNO (2008). CO data replaced by sector distribution from IIASA (extrapolated 2017)

Armenia	NH_3	2007, 2014, 2016, 2017	Sectors B, K	Sector distribution showed strong discrepancy to expert data. Replaced by sector distribution from IIASA (extrapolated 2017).
Armenia	$PM_{2.5}$, PM_{10}	2007, 2014, 2016, 2017	Sectors A, B, C, K	Sector distribution showed strong discrepancy to expert data and reported data of other years.
Azerbaijan	NO_x, PM_{10}	1990-2014	National Totals	Gap-filled and corrected sector data. National Totals did not equal to the sum of sectors. Replaced by sum of sectors.
Azerbaijan	NMVOC	1990-2017	National Totals	Gap-filled and corrected sector data. National Totals did not equal to the sum of sectors. Replaced by sum of sectors.
Azerbaijan	SO_x	1995-2014	National Totals	Gap-filled and corrected sector data. National Totals did not equal to the sum of sectors. Replaced by sum of sectors.
Azerbaijan	NH_3	1990-1994, 1996-1998, 2000-2017	National Totals	Gap-filled and corrected sector data. National Totals did not equal to the sum of sectors. Replaced by sum of sectors.
Azerbaijan	$PM_{2.5}$	1990-2008, 2010-2014	National Totals	Gap-filled and corrected sector data. National Totals did not equal to the sum of sectors. Replaced by sum of sectors.
Azerbaijan	CO	1995-2011, 2013-2014	National Totals	Gap-filled and corrected sector data. National Totals did not equal to the sum of sectors. Replaced by sum of sectors.
Azerbaijan	NO_x	2005-2006	Sector B	Error correction, extrapolation.
Azerbaijan	NMVOC	1995-1999, 2001-2004	Sector B	Error correction, extrapolation.
Azerbaijan	SO_x	1995-2007, 2009-2014	Sector A, B	Error correction, extrapolation.
Azerbaijan	NH_3	2013-2017	Sector L	Error correction, extrapolation.
Azerbaijan	CO	2005-2011	Sector B	Error correction, extrapolation.
Belarus	NO_x, NH_3, $PM_{2.5}$	2013	National Totals	Gap-filled and corrected sector data. National Totals did not equal to the sum of sectors. Replaced by sum of sectors.
Belarus	NMVOC	2012-2013	National Totals	Gap-filled and corrected sector data. National Totals did not equal to the sum of sectors. Replaced by sum of sectors.
Belarus	SO_x	2009, 2013	National Totals	Gap-filled and corrected sector data. National Totals did not equal to the sum of sectors. Replaced by sum of sectors.

Belarus	$PM_{2.5}$	2000-2016	National Totals	Gap-filled and corrected sector data. National Totals did not equal to the sum of sectors. Replaced by sum of sectors.
Belarus	PM_{10}	2005-2006, 2013, 2015-2016	National Totals	Gap-filled and corrected sector data. National Totals did not equal to the sum of sectors. Replaced by sum of sectors.
Belarus	NO_x, SO_x	2001-2006	Sectors A, C, D, F, G, H	Sector distribution showed strong discrepancy to expert data and reported data of other years. Replaced by sector distribution of 2007
Belarus	NMVOC	2002-2006	Sectors A, C, D, F, G, H	Sector distribution showed strong discrepancy to expert data and reported data of other years. Replaced by sector distribution of 2007
Belarus	NH_3	1990-1999, 2001-2006	Sectors A, C, D, F	Sector distribution showed strong discrepancy to expert data and reported data of other years. Replaced by sector distribution of 2007
Belarus	$PM_{2.5}$, PM_{10}	2000-2006	Sectors A, C, F	Sector distribution showed strong discrepancy to expert data and reported data of other years. Replaced by sector distribution of 2007
Bosnia and Herzegovina	SO_x	1990	National Total	Reported National Total seemed to be far too high. Replaced by EDGAR estimates.
Bulgaria	PM_{10}	1990-2017	National Total	Correction necessary due to missing sector. Replaced by sum of sector.
Georgia	NMVOC	1990-2006	National Total	National Total data showed strong discrepancy to expert data and to data of the years 2007-2017. National Totals were replaced by EDGAR data.
Georgia	SO_x	1990-2006	National Total	National Total data showed strong discrepancy to expert data and to data of the years 2007-2017. National Totals were replaced by the sum of the sector data.
Georgia	$PM_{2.5}$, PM_{10}	2007-2012	National Total	National Total data showed strong discrepancy to expert data and to data of the years 2007-2017. National Totals were replaced by inter-/extrapolated GAINS data.
Georgia	PM_{10}	2000-2012	National Total	National Total data showed strong discrepancy to expert data and to data of the years 2007-2017. Further, some sector data were corrected by using $PM_{2.5}$ data. National Totals were replaced by the sum of the sectors.
Georgia	SO_x	2007-2017	Sectors A, B, C, D, F, I, J, L	Sector distribution showed strong discrepancy to expert data (especially the share of sector B)

Georgia	CO	2007-2012	Sectors A, B, D, F	Sector distribution showed strong discrepancy to expert data and reported data of other years
Georgia	$PM_{2.5}$, PM_{10}	2007-2012	Sectors B, D, F, K, L	Sector distribution showed strong discrepancy to expert data and reported data of other years
Georgia	PM_{10}	2000-2012	Sectors C, G, I	Correction of PM_{10} data with $PM_{2.5}$ values, as $PM_{2.5}$ emissions showed higher values.
Kyrgyzstan	NO_x, NMVOC, SO_x, CO	1990-2005, 2010-2012, 2014-2015	National Total	National Total data showed strong discrepancy to expert data and to data of the year 2016. National Totals were replaced by inter-/extrapolated GAINS data.
Kyrgyzstan	NH_3	1999, 2010-2012, 2014-2015	National Total	National Total data showed strong discrepancy to expert data and to data of the year 2016. National Totals were replaced by inter-/extrapolated GAINS data.
Kyrgyzstan	$PM_{2.5}$	2014-2015	National Total	National Total data showed strong discrepancy to expert data and to data of the year 2016. National Totals were replaced by inter-/extrapolated GAINS data.
Kyrgyzstan	PM_{10}	2010-2012, 2014-2015	National Total	National Total data showed strong discrepancy to expert data and to data of the year 2016. National Totals were replaced by inter-/extrapolated GAINS data.
Kyrgyzstan	NO_x	2010-2012, 2014-2015	Sectors A, B, D, K	The sector distribution showed strong discrepancy to expert data and to data of the year 2016. Sector distributions were replaced by the distribution of 2016.
Kyrgyzstan	NMVOC	2010-2012, 2014-2015	Sectors A, B, D, E, K	The sector distribution showed strong discrepancy to expert data and to data of the year 2016. Sector distributions were replaced by the distribution of 2016.
Kyrgyzstan	SO_x	2010-2012, 2014-2015	Sectors A, B	The sector distribution showed strong discrepancy to expert data and to data of the year 2016. Sector distributions were replaced by the distribution of 2016.
Kyrgyzstan	NH_3	2010-2012, 2014-2015	Sectors B, K	The sector distribution showed strong discrepancy to expert data and to data of the year 2016. Sector distributions were replaced by the distribution of 2016.
Kyrgyzstan	$PM_{2.5}$	2010-2012, 2014-2015	Sectors A, B, C, E, K	The sector distribution showed strong discrepancy to expert data and to data of the year 2016. Sector distributions

				were replaced by the distribution of 2016.
Kyrgyzstan	PM_{10}	2010-2012, 2014-2015	Sectors A, B, K	The sector distribution showed strong discrepancy to expert data and to data of the year 2016. Sector distributions were replaced by the distribution of 2016.
Kyrgyzstan	CO	2010-2012, 2014-2015	Sectors A, B, D	The sector distribution showed strong discrepancy to expert data and to data of the year 2016. Sector distributions were replaced by the distribution of 2016.
Kazakhstan	NO_x	1990-2000, 2005, 2009-2015	National Total	National Total adjusted to sum of sectors
Kazakhstan	NMVOC	1991-1999, 2005, 2009, 2011, 2015-2016	National Total	National Total adjusted to sum of sectors
Kazakhstan	SO_x	1990-2000, 2005, 2009-2016	National Total	National Total adjusted to sum of sectors
Kazakhstan	NH_3	1991-1994, 1996-1999, 2001-2004, 2005-2010	National Total	National Total adjusted to sum of sectors
Kazakhstan	$PM_{2.5}$, PM_{10}	1990-2016	National Total	National Total data showed strong discrepancy to expert data. National Totals were replaced by (extrapolated) EDGAR data.
Kazakhstan	CO	1990-1999, 2005, 2009-2015	National Total	National Total adjusted to sum of sectors
Kazakhstan	NO_x, NMVOC, CO	1993-1998	Sector G	Error correction, extrapolation (1991-1999)
Kazakhstan	SO_x	1990-2016	Sector F	Error correction, divided by factor 10
Kazakhstan	NH_3	2010	Sector B	Error correction, extrapolation (2005-2011)
Kazakhstan	$PM_{2.5}$	1990-2016	Sectors B, F, G, H, I, J, K, L	Error correction, extrapolation (1991-1999), sector distribution adjusted to new National Totals
Kazakhstan	PM_{10}	1990-2016	Sectors B, G, I, J, K, L	Error correction, extrapolation (1991-1999), use of $PM_{2.5}$ sector distribution adjusted to new National Totals
Lithuania	NMVOC	1990-2004	National Total	National Total adjusted to sum of sectors
Lithuania	$PM_{2.5}$	1990-2017	National Total	National Total adjusted to sum of sectors
Lithuania	PM_{10}	1990-2017	National Total	Replaced by the sum of sectors (due to changes of the sectors)

Lithuania	NMVOC	1990-2004	Sector B	Error correction, extrapolation (2005-2017)
Lithuania	$PM_{2.5}$	2005-2017	Sector B	Error correction, replaced by data reported in 2018, inter-/extrapolation of years 2012 and 2017
Lithuania	PM_{10}	1990-2017	Sector G	Correction of PM_{10} data with $PM_{2.5}$ values, as $PM_{2.5}$ emissions showed higher values.
Monaco	PM_{10}	1990-2017	National Total	Replaced by the sum of sectors (due to changes of the sectors)
Monaco	PM_{10}	1990-2017	Sector I	Correction of PM_{10} data with $PM_{2.5}$ values, as $PM_{2.5}$ emissions showed higher values.
Republic of Moldova	NO_x, NMVOC, $PM_{2.5}$, PM_{10}, CO	2000-2015	National Total	National Total adjusted to sum of sectors
North Macedonia	PM_{10}	1990-2017	National Total	Due to missing and gap-filled PM_{10} data of Sector H, the National Total was adjusted
Malta	NMVOC	2000-2004	National Totals	National Total adjusted to sum of sectors (because of changes in/gap-filling of sector data)
Malta	SO_x	2000-2003, 2017	National Totals	National Total adjusted to sum of sectors (because of gap-filling of sector data)
Malta	$PM_{2.5}$, PM_{10}	2000-2004	National Totals	National Total adjusted to sum of sectors (because of gap-filling of sector data)
Malta	CO	2000-2004	National Totals	National Total adjusted to sum of sectors (because of gap-filling of sector data)
Malta	NMVOC	2000-2004	Sector J	Error correction, extrapolation (2005-2017)
Malta	SO_x	2000-2003	Sectors A, B, C, F, G, H, I, J, M	Error correction, sectors adjusted according to reported sector distribution and new National Total
Malta	SO_x	2017	Sector A	Error correction, extrapolation (2010-2016)
Malta	$PM_{2.5}$, PM_{10}	2000-2004	Sector F	Error correction, extrapolation (2005-2017)
Russian Federation	NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$, PM_{10}, CO	2002-2009	National Totals	Replaced by corrected data sent from the Russian Federation by e-mail directly to CEIP
Russian Federation	PM_{10}	2002	National Total	Replaced by the sum of sectors (due to changes of the sectors)
Russian Federation	NO_x, NMVOC, SO_x, NH_3, $PM_{2.5}$,	2009	Sector F	Replaced by corrected data sent from the Russian Federation by e-mail directly to CEIP

	PM_{10}, CO			
Russian Federation	NO_x, SO_x, $PM_{2.5}$	2002-2008	Sectors A, M	Missing sectors, Sector distribution showed strong discrepancy to expert data and reported data of other years. Replaced by sector distribution like 2009.
Russian Federation	NMVOC, CO	2002, 2007-2008	Sectors A, M	Missing sectors, Sector distribution showed strong discrepancy to expert data and reported data of other years. Replaced by sector distribution like 2009.
Russian Federation	NH_3	2007-2008	Sectors A, M	Missing sectors, Sector distribution showed strong discrepancy to expert data and reported data of other years. Replaced by sector distribution like 2009.
Russian Federation	PM_{10}	2002-2005, 2006-2008	Sectors F, I	Correction of gap-filled PM_{10} data with $PM_{2.5}$ values, as $PM_{2.5}$ emissions showed higher values.
Slovakia	PM_{10}	1994	National Total	Replaced by the sum of sectors (due to changes of the sectors)
Slovakia	PM_{10}	1994	Sector H	Correction of PM_{10} data with $PM_{2.5}$ values, as $PM_{2.5}$ emissions showed higher values.
Turkey	NMVOC, NH_3, SO_x	2011	National Total	National Totals did not equal to sum of sectors. Replaced by sum of sectors.
Turkey	$PM_{2.5}$	1990-1993, 1995-2017	National Total	National Totals showed strong discrepancy to expert data. Replaced by (inter-/extrapolated) data from IIASA and TNO.
Turkey	PM_{10}	1990-2002, 2014	National Total	Replaced by the sum of sectors (due to changes of the sectors)
Turkey	$PM_{2.5}$	1990-1993, 1995-2017	Sectors B, G, I	Sector distribution showed strong discrepancy to expert data (especially the share of sector B). Replaced by (inter-/extrapolated) data from IIASA and TNO.
Turkey	PM_{10}	1990-2017	Sectors A, B, C, F, G, I, J	Sector distribution showed strong discrepancy to expert data (especially the share of sector B). Replaced by sector distributions from TNO (and copy of $PM_{2.5}$ for Sector I 1994-2001).
Turkey	CO	1990-1993	National Total	Replaced by the sum of sectors (due to gap-filling of sector F)
Ukraine	NO_x	1990-2017	National Totals	National Totals showed strong discrepancy to expert data. For the years 2002-2007, the sum of sectors did not equal to the National Total. Replaced by (extrapolated) EDGAR data.
Ukraine	NMVOC,	1990-1999,	National	National Totals showed strong

	CO	2001-2017	Totals	discrepancy to expert data. For the years 2002-2007, the sum of sectors did not equal to the National Total. Replaced by (extrapolated) EDGAR data.
Ukraine	SO_x	2010-2013, 2017	National Totals	Replaced by the sum of sectors (due to changes of the sectors)
Ukraine	NH_3	2010-2017	National Totals	National Totals showed strong discrepancy to expert data. Replaced by (inter-/extrapolated) IIASA data.
Ukraine	$PM_{2.5}$, PM_{10}	2002, 2004, 2005, 2010-2017	National Totals	National Totals showed strong discrepancy to expert data. Replaced by (inter-/extrapolated) IIASA data.
Ukraine	NO_x, NMVOC, SO_x, NH_3, CO	2002-2007	Sectors A, H, M	Sector distribution showed strong discrepancy to expert data. Replaced by (extrapolated) EDGAR data (NO_x, NMVOC), replaced by sector distribution like 2008 (SO_x, CO).
Ukraine	NO_x, NMVOC, CO	2008-2017	Sectors A-L	Sector distribution showed strong discrepancy to expert data. Replaced by (extrapolated) EDGAR data.
Ukraine	SO_x	2017	Sector A	Sector data are far too low compared with expert data. Replaced by extrapolation of reported data.
Ukraine	NH_3	2010-2017	Sectors A-G, I-L	Data are far too low compared with expert data. Replaced by split (distribution like 2009) of National Totals from IIASA.
Ukraine	$PM_{2.5}$, PM_{10}	2002, 2004-2005	Sectors A, H, M	Sector distribution showed strong discrepancy to expert data. Replaced by (extrapolated) EDGAR data.
Ukraine	$PM_{2.5}$, PM_{10}	2010-2017	Sectors A-F, I-L	Sector distribution showed strong discrepancy to expert data. Replaced by (extrapolated) EDGAR data.

5. Improvements of the gap-filling procedure

Many countries (26 of 51 countries) submitted data that seem to be complete and plausible. Problems occur especially, where no data at all are available, or when submitted data are not plausible.

In autumn 2017, a new tool was developed that simplify comparisons of emission data with other countries, expert data and previously reported and gap-filled data. Comparisons comprise National Totals, sector data, and data in relation to population and GDP data. This tool was used for the gap-filling 2018, and was further improved and used for the gap-filling 2019.

In January 2019, all countries (24 countries) where data were replaced during the gap-filling 2018 or where conspicuous data were submitted, have been contacted and asked for reasons and explanations. Data of three countries (Georgia, the Ukraine, Russian Federation) were examined in more detail. CEIP got answers from 13 countries.

6. Data availability and gap-filling method per country

6.1. Albania (AL)

Albania reported data for the years 1990 to 2017. Several sector data were missing and the sector distribution of some years differ largely to other years.

NO_x, SO_x

Sector distribution up to 2007 seems to be plausible, whereas from 2008 to 2015 data for some sectors are missing, and the sector distribution of the years 2016 and 2017 differ largely. National Totals from 2008 to 2017 are far higher than all expert estimates.

As the National Total data of the years 2003 to 2007 are similar to estimates from TNO, National Totals and sector distributions from the years 1990 to 2007 are used from Albania's submission. National Totals for the years 2008 to 2009 are taken from TNO estimates. National Totals from 2010-2017 are extrapolated data from TNO estimates (2003-2009). The sector distribution reported by Albania for the year 2007 is used to split the National Totals of the years 2008-2017.

NMVOC, $PM_{2.5}$, PM_{10}, CO

National Totals of the years 2003 to 2008 are similar to estimates from TNO, and sector distribution up to 2008 seems to be plausible.

The National Total for the year 2009 is taken from TNO estimates. National Totals from 2010-2017 are extrapolated data from TNO estimates (2003-2009). The sector distribution reported by Albania for the year 2008 was used to split the National Totals of the years 2009-2017. To avoid negative values for PM_{coarse}, all data for PM_{10}, which resulted in lower numbers than $PM_{2.5}$, were equaled to $PM_{2.5}$ and the National Total of PM_{10} subsequently adjusted by the sum of the sector data.

For CO, data for sector "B – Industry combustion" for the year 1996 were missing. This data was gap-filled by the difference of the sum of the remaining sectors to the National Total of this year.

NH_3

National total and sector distribution from previous submissions seem to be plausible up to 2015. Data for 2016 and 2017 are estimated by extrapolation of the last ten years (2005-2015) and using the sector distribution of the year 2015.

6.2. Armenia (AM)

Armenia provided with its 2019 submission data for National Total and sectors for the year 2017. From previous submissions, National Total data for the years 1990-2003, 2007 and 2014 and 2016, and sectoral data for 2007, 2014 and 2016 are available. For $PM_{2.5}$ and PM_{10}, only data for the years 2007, 2014 and 2016 are available.

NOx, NMVOC

National Totals of missing years were interpolated, and sectoral data of the years 2008 to 2013 were interpolated. For NO_x, the sector distribution of the year 2014 was used to split the National Totals of the year 2015 into sectors, and the sector distribution of the year 2007 for the years 1990 to 2006. NMVOC sector distribution for the year 2016 differ to the other years. Thus, for NMVOC the sector distribution of the year 2017 was used to split the National Totals of the year 2015 and 2016 into sectors, and the sector distribution of the year 2007 for the years 1990 to 2006.

SO_x

National Total data of missing years were interpolated. Concerning the sector distribution, one single sector (Industry) contributed to a very huge amount of the emissions (2017: 99.9 %). Further, the sector distribution differs strongly to expert estimates, and to the mean sector distribution from the 2018 gap-filled data set of all countries. Therefore, the sector distribution from TNO for the year 2008 is used to split the National Totals of all years, as this distribution is from all expert estimates most similar to the originally reported data.

NH_3

National Total data of the years 1991 to 2001 are very low. Therefore, National Total data for these years were extrapolated (2000-2002). National Total data of all other missing years were also interpolated. As only a few sectors were reported and the contribution of one single sector (Agriculture Livestock) was very huge (2017: 100 %), the extrapolated GAINS (IIASA 2014) sector distribution for 2017 is used to split the National Totals of all years, as this distribution is from all expert estimates most similar to the originally reported data.

$PM_{2.5}$, PM_{10}

National Totals seem to be far too low compared with expert estimates. Therefore, National Total data of all years are replaced with (inter-, extrapolated) data from the GAINS model (IIASA 2014). The sector distributions reported for the year 2016 and 2017 differ strongly to expert estimates and to the mean sectoral distribution. The sector distribution for the years 2014 is plausible. Thus, this distribution was used to split the distribution of all years.

CO

National Total data of missing years were interpolated. Concerning the sector distribution, one single sector (Road transport) contributed to a very huge amount of the emissions (2017: 97 %). Further, the sector distribution differs strongly to expert estimates and to the mean sector distribution from the 2018 gap-filled data set of all countries. Therefore, the sector distribution from the GAINS model (IIASA 2014), extrapolated for the year 2017, is used to split the National Totals of all years, as this distribution is from all expert estimates most similar to the originally reported data.

6.3. Austria (AT)

The data of Austria for the years 1990 to 2017 reported in 2019 seemed to be complete and plausible. Therefore no gap-filling was performed.

6.4. Azerbaijan (AZ)

The data of Azerbaijan reported for the years 1990 to 2017 seemed to be plausible, but for several years and pollutants, sector data were missing. National Totals were reported for all pollutants but SO_x and CO from 1990 to 2017. National Totals for SO_x and CO were reported from 1995 to 2017 only.

NO_x

Data for some sectors (1990-1994: Sectors A, D, F; 1990-1994, 1996-1998: Sector L; 1990-2004: Sector B; 1990-2006: Sectors C, G, I) were missing and thus were inter-/extrapolated. Data for the Sector “B – Industry” seemed too low for the years 2005 to 2006 and have been replaced.

Sector data for Sectors B, C, G, I were extrapolated by using 2004 to 2017 data, sector data for the Sectors A, D, F, L were extrapolated using 1995 to 2000 data, and sector data for Sector L for the years 1996 to 1998 were interpolated. As only the National Totals of the years 2015 to 2017 equal to the sum of the sectors, the National Totals of all other years were replaced by the sum of the sectors.

NMVOC

Data for some sectors (1990-1994: Sectors A, B, D; 1990-1999: Sector L; 2000: Sector B; 1990-2004: Sector J; 1990-2006: Sectors C, G, I; 2013-2017: Sector L) were missing and thus were extrapolated. Data for the Sector "B – Industry" seemed too low for the years up to 2004 and have been replaced.

Sector data for the Sector A, D were extrapolated using 1995 to 2000 data, sector data for the Sector B were extrapolated using 2005 to 2017 data, sector data for the Sectors C, G, I were extrapolated using 2007 to 2017 data, sector data for the Sector J were extrapolated using 2005 to 2010 data, sector data for the Sector L were extrapolated using 2000 to 2012 data. As the National Totals of no single year equal to the sum of the sectors, the National Totals of all years were replaced by the sum of the sectors.

SO_x

Data for some sectors (1990-1994: Sectors A, D; 1990-2004: Sector B; 1990-2006: Sectors C, G) were missing and thus were inter-/extrapolated. Data of the Sector "A - Public electricity and heat production" of the years 2000 to 2006 and 2009 to 2014 seemed to be far too low, same as data for the Sector "B – Industry" for the years 2005 and 2006. Data of the Sector "A - Public electricity and heat production" of the year 2007 seemed to be far too high. These data were replaced. The National Totals of the years 1990 to 1994 were missing.

Sector data for the Sector A were inter-/extrapolated using 2008 to 2015 data, sector data for the Sector B, C, G were extrapolated using 2007 to 2017 data, sector data for the Sector D were extrapolated using 1995 to 2017 data. As only the National Totals of the years 2015 to 2017 equal to the sum of the sectors, the National Totals of all other years were gap-filled/replaced by the sum of the sectors.

NH3

Data for the sector "L - Other emissions from agriculture" for the years 2013 to 2017 seemed to be far too high compared with expert estimates and data of previous years, and thus were replaced by extrapolated data (1999-2012). Sector data of the Sector L were missing for the years 1990 to 1994 and 1996 to 1998 and thus extrapolated (1995-1999). The National Totals of the years 1990 to 1994, 1996 to 1999 and 2000 to 2017 were replaced by the sum of the sectors, as they did not equal to the sum of the sectors.

PM2.5, PM10

Data for some sectors (1990-1994: Sectors A, B, D, F; 1990-1999: Sector L; 1990-2006: Sector C, G, I; 1990-2007: Sector J) were missing and thus were extrapolated. Data of the Sector "F – Road Transport" were missing for PM10 up to the year 2012.

Sector data for the Sector A, B, D, F (F only for PM2.5) were extrapolated using 1995 to 2000 data, sector data for the Sector C were extrapolated using 2007 to 2015 data, sector data for the Sector G, I were extrapolated using 2007 to 2017 data, sector data for the Sector J were extrapolated using 2008 to 2017 data, and sector data for the Sector L were extrapolated using 2000 to 2017 data. Sector data for the Sector F (PM10) were extrapolated using 2013 to 2017 data, and data of the year 2012 were subsequently changed by data from PM2.5, as the extrapolation resulted in lower values for PM10 for this year.

The National Totals of the years 1990 to 2008 and 2010 to 2014 for PM2.5, and 1990 to 2014 for PM10, were replaced by the sum of the sectors, as they did not equal to the sum of the sectors.

CO

Data for some sectors (1990-1994: Sectors A, D, F; 1990-2004: Sector B; 1990-2006: Sectors C, G, I) were missing and thus were inter-/extrapolated. Data for the Sector "B – Industry" seemed too low for the years 2005 to 2011 and have been replaced.

Sector data for Sectors C, G, I were extrapolated by using 2004 to 2017 data, sector data for the Sector B were extrapolated using 2012 to 2017 data, and sector data for the Sectors A, D, F were extrapolated using 1995 to 2000 data. As only the National Totals of the years 2012, 2015 to 2017 equal to the sum of the sectors, the National Totals of all other years were replaced by the sum of the sectors.

6.5. Bosnia and Herzegovina (BA)

No reported data were available, except one value for the National Total of SO_x of the year 1990.

NO_x, NMVOC, NH_3, $PM_{2.5}$ and PM_{10}

The estimates used to calculate NO_x, NMVOC, NH_3, $PM_{2.5}$ and PM_{10} National Total data were (inter-, extrapolated) estimates from the GAINS models from spring and October 2014 (IIASA 2014). National Totals of NO_x and NMVOC for the years 1991 to 1994, 1996 to 1999 and 2001 to 2004 were calculated by the sum of the sectors. For NO_x, NMVOC and NH_3, also the (inter-, extrapolated) sector distribution from the GAINS model was used. For $PM_{2.5}$ and PM_{10}, the mean sector distribution from the 2018 gap-filled data set of all countries was used to split the National Totals of all years.

CO

National Totals of CO were gap-filled using (extrapolation of) TNO data for the years 2003 to 2017, and (interpolated) estimates from the GAINS model from spring 2014 (IIASA 2014) for the years 1990 to 2002. Also the (extra-/interpolated) sector distribution from TNO and GAINS was used. National Totals for the years 1991 to 1994, 1996 to 1999 and 2001 to 2002 were calculated by the sum of the sectors.

SO_x

National Totals of SO_x were gap-filled using EDGAR data up to 2010, and extrapolation of EDGAR data using population data for the years 2011 to 2017. The reported single value for the year 1990 was replaced. The mean sector distribution from the 2018 gap-filled data set of all countries was used to split the National Totals of all years.

6.6. Belgium (BE)

The data of Belgium reported for the years 1990 to 2017 reported in 2019 seemed to be complete and plausible. Therefore no gap-filling was performed.

6.7. Bulgaria (BG)

The data of Bulgaria reported for the years 2000 to 2017 reported in 2019 seemed to be complete and plausible. Only for the sector “H – Aviation”, data for $PM_{2.5}$ were reported but for PM_{10} were missing. Thus, $PM_{2.5}$ data were copied for PM_{10} for the whole time series, and the National Total of PM_{10} was replaced by a new National total including the sector H.

6.8. Belarus (BY)

Belarus reported data up to the year 2017. National Total data are complete (except one single SO_x value for the year 2000) and seem to be plausible. However, of the sector data, only data for the years 2007-2012 and 2014-2017 seem to be complete.

Therefore, emissions data for the year 2013 were replaced by interpolated data from the years 2012 and 2014, National Totals of the years 1990 to 2006 were split up by using the sector distribution of

the year 2007. Further, SO_x data of the year 2009 for the sector "A – Public electricity and heat production" were divided by 10 as these data were extraordinary high and seemed to be a decimal error. The National Total data for SO_x of the year 2009 were adjusted.

National Totals of 2013 were replaced by the sum of the sectors, as well as the National Total of NMVOC for the year 2012, of of SO_x for the year 2009, for PM_{10} for the year 2015, and for CO for the year 2007 – as these did not equal to the sum of the sectors.

To avoid negative values for PM_{coarse}, missing data for $PM_{2.5}$ were filled by copy of PM_{10} data, and PM_{10} were filled by copy of $PM_{2.5}$ data, and correction of gap-filled data was made. Subsequently the National Totals of $PM_{2.5}$ (years 2000-2016) and PM_{10} (years 2005, 2006, 2016) had to be changed by the sum of sectors.

6.9. Switzerland (CH)

The data of Switzerland for the years 1990 to 2017 reported in 2019 seemed to be complete and plausible. Therefore no gap-filling was performed.

6.10. Cyprus (CY)

The data of Cyprus for the years 1990 to 2017 reported in 2019 seemed to be complete and plausible. Therefore no gap-filling was performed.

The sector distribution of SO_x is rather unusual, with a large contribution of the sector "A – Public electricity and heat production". Cyprus explained, that this is very reasonable since Sector "A – Public electricity" is using fuel with Sulfur content almost 1% and there are no large industries except one cement factory. The Sulfur content used in other main sectors like transport is 0,001%. For further information please see the IIR of Cyprus pages 68-69 (Cyprus 2019).

6.11. Czechia (CZ)

The data of Czechia for the years 1990 to 2017 reported in 2019 seemed to be complete and plausible. Therefore no gap-filling was performed.

6.12. Germany (DE)

The data of Germany for the years 1990 to 2017 reported in 2019 seemed to be complete and plausible. Therefore no gap-filling was performed.

6.13. Denmark (DK)

The data of Denmark for the years 1990 to 2017 reported in 2019 seemed to be complete and plausible. Therefore no gap-filling was performed.

6.14. Estonia (EE)

The data of Estonia for the years 1990 to 2017 reported in 2019 seemed to be complete and plausible. Therefore no gap-filling was performed.

The sector distribution of SO_x is rather unusual, with a large contribution of the sector "A – Public electricity and heat production". Further review is recommended here.

6.15. Spain (ES)

The data of Spain for the years 1990 to 2017 reported in 2019 seemed to be complete and plausible. Therefore no gap-filling was performed.

6.16. Finland (FI)

The data of Finland for the years 1990 to 2017 reported in 2019 seemed to be complete and plausible. Therefore no gap-filling was performed.

6.17. France (FR)

The data of France for the years 1990 to 2017 reported in 2019 seemed to be complete and plausible. Therefore no gap-filling was performed.

6.18. The United Kingdom (GB)

The data of the United Kingdom for the years 1990 to 2017 reported in 2019 seemed to be complete and plausible. Therefore no gap-filling was performed.

6.19. Georgia (GE)

Georgia reported in 2019 data from 2007 to 2017. Further, National Total data for the years 1990 to 2006 are available for NO_x, NMVOC, SO_x and CO, and data for the years 2000 to 2006 for NH_3.

The gap-filling of Georgia was investigated in more detail in spring 2019. The inventory of Georgia seems to be underestimated. There are several sources not estimated ("NE"), see Table 1.14, IIR of Georgia 2018 (Georgia 2019). One of the main conclusions was that there is a need to improve the gap-filling of the sector distribution of NO_x, SO_x, $PM_{2.5}$ and PM_{10}.

NO_x

For NO_x, all reported data seemed to be plausible. As a consequence of the review of the gap-filling 2018 and as still no sector data are available for the years before 2007, the sector distribution of the year 2007 was used to gap-fill the years 1990 to 2006.

NMVOC

Data seemed to be complete and plausible for the years 2007 to 2016. Data for the years 2000 to 2006 seemed to be far too high. The sector distributions of the years 2007 to 2012 differ to the sector distributions of the years 2013 to 2016, and extrapolation would result in a sector distribution that differs continuously and underrepresent some sectors. Therefore, copy of the year 2007 were used for the sector distribution of the years 1990 to 2006, and the National Totals were replaced by EDGAR data, as those data turned out to be the most fitting expert data.

SO_x

Within the reported sector distribution, the sector "Industry" is dominating with 87 % for the year 2017, and up to 97 % in some other years. This distribution differs strongly to expert estimates and to the mean sector distribution from the 2018 gap-filled data set of all countries. For this reason, data were replaced by sector data from EDGAR for the years 1990 to 2006, as this turn out as the most appropriate estimates. National Totals were calculated by the sum of the sectors for these years. The reported National Totals of the years 2007 to 2017 were split up into sectors using the EDGAR sector distribution of the year 2006.

NH_3

For NH_3, the data seemed to be complete and plausible. The missing sector distribution for the years 2000 to 2006 was made by extrapolation of the sector distribution 2007 to 2017 (In cases when the extrapolation resulted in negative values, this was corrected to 0). Sector data for the years 1990-1999 were extrapolated from 2000-2017, and the National Totals were gap-filled as sum of the sectors.

$PM_{2.5}$, PM_{10}

National Total data and sector distribution for the years 2013 to 2017 seemed to be complete and plausible. Data for the years 2007 to 2012 differs strongly to the National Totals and sector distributions of the years 2013 to 2017, to expert estimates and to the mean sector distribution from the 2018 gap-filled data set of all countries and extrapolation would result in a sector distribution that differs continuously and underrepresent some sectors. Therefore, the National Totals were replaced by GAINS data and for the sectoral distribution, copy of the year 2017 were used for the years 1990 to 2012.

To avoid negative values for PM_{coarse}, all data for PM_{10}, which resulted in lower numbers than $PM_{2.5}$, were equaled to $PM_{2.5}$. The National Totals of PM_{10} for 2000 to 2012 were then corrected by the sum of the sectors.

CO

For CO, only the sector distribution 2013 to 2017 seemed to be complete and plausible. The sector distribution for the years 2007 to 2012 differs strongly to expert estimates from IIASA, TNO and EDGAR, to the mean sector distribution from the 2018 gap-filled data set of all countries and to the reported sector distribution of the years 2013 to 2017. Thus, the sector distribution of the year 2017 was used to split the National Totals of the years 1990 to 2012.

6.20. Greece (GR)

Greece provided no submission in 2019. From previous submissions, data up to the year 2016 are available. The data seemed to be complete and plausible. The year 2017 was gap-filled by extrapolation of reported data (1990-2016), whereas negative data were avoided by the copy of data of the previous year. For that reason, the National Total for SO_x then was calculated by the sum of the sectors.

6.21. Croatia (HR)

The data of Croatia reported for the years 1990 to 2017 reported in 2019 seemed to be complete and plausible. Therefore no gap-filling was performed.

6.22. Hungary (HU)

The data of Hungary reported for the years 1990 to 2017 reported in 2019 seemed to be complete and plausible. Therefore no gap-filling was performed.

6.23. Ireland (IE)

The data of Ireland reported for the years 1990 to 2017 reported in 2019 seemed to be complete and plausible. Therefore no gap-filling was performed.

6.24. Iceland (IS)

The data of Iceland reported for the years 1990 to 2017 reported in 2019 seemed to be complete and plausible. Therefore no gap-filling was performed.

The sector distribution of CO is rather unusual, with a large contribution of the sector "B – Industry combustion". Further review is recommended here.

6.25. Italy (IT)

The data of Italy reported for the years 1990 to 2017 reported in 2019 seemed to be complete and plausible. Therefore no gap-filling was performed.

6.26. Kyrgyzstan (KG)

Kyrgyzstan provided no submission in 2019. From previous submissions, sectoral data for the years 2010 to 2012, and 2014 to 2016 are available. National Total data are available for NO_x, NMVOC, SO_x and CO for the years 1990 to 2005, 2010 to 2012 and 2014 to 2016. For NH_3, National Totals are available for 1999, 2010 to 2012 and 2014 to 2016. For PM_{10}, National Totals are available for 2010 to 2012 and 2014 to 2016, and for $PM_{2.5}$ National Totals are given for 2014 to 2016 only.

Previous reported data differ in National Totals and sector distribution strongly to expert estimates, except data reported for the year 2016. Thus, for the National Total data, inter-/extrapolation of GAINS estimates were used up to the year 2010, interpolation between 2010 and the reported year 2016 and extrapolation for the year 2017 were made. The reported sector distribution of the year 2016 was used to split the sectors of all years.

To avoid negative values for PM_{coarse}, data of the year 2017 for PM_{10}, which resulted in lower numbers than $PM_{2.5}$, were equaled to $PM_{2.5}$. The National Total of PM_{10} for 2017 were then corrected by the sum of the sectors.

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

Kazakhstan provided no submission in 2019 but reported with its 2018 submission data for the whole time series.

Data between KZ and KZE are splitted up by 15 % vs. 85 %.

NO_x, NMVOC, SO_x, CO

For the years 2001 to 2004 and 2006 to 2008, no National Totals were reported and for the same years plus 1991 to 1994, 1996 to 1999 and 2009 the data for the sectors "A - Public electricity and heat production", "B - Industry combustion" and "C - Other stationary combustion" were missing. Further, data from "G – International and national inland shipping" are missing for the years 1999 and 2005 to 2007, and seemed to be far too high for NO_x, NMVOC and CO for the years 1993 to 1998. The National Totals of several years do not equal to the respective sum of the sectors.

For SO_x, Kazakhstan reported a very huge amount on road transport emissions, especially for the categories "Light duty vehicles" and "Heavy duty vehicles and buses". It is assumed, that this is due to a decimal error: For NO_x, which is an important pollutant for road transport, road transport emissions are not extraordinary high within these categories compared to other sectors or categories.

Therefore, missing sector data were interpolated and National Totals were calculated by the sum of sectors (years 2001 to 2004 and 2006 to 2008). Data of the sector "G – International and national inland shipping" of the years 1992 to 1998 were gap-filled and replaced (replaced only for NO_x,

NMVOC and CO) by extrapolations of shipping data from 1991-1999. The SO_x emission data of the road transport sector have been divided by factor 10. Sector data for the year 2017 were extrapolated (1990-2016), and in cases were the extrapolation resulted into negative values, copy of data from 2016 was used.

To avoid differences between sum of sectors and National Total data, the NO_x National Totals of the years 1990 to 2000, 2005, 2009 to 2015 were replaced by the sum of the sectors. For NMVOC, the National Totals of 1991 to 1999, 2005, 2009, 2011 and 2015 to 2016 were replaced. For CO, the National Totals of the years 1990 to 1999, 2005, 2009 to 2015 were replaced, and for SO_x, National Totals of the whole time series were replaced/gap-filled by the sum of the sectors.

NH_3

National Total data are reported for all years and equal to the sum of sectors of all years but the year 2010. Sector data of the sector "Industry combustion" are missing for the years 1991 to 1994, 1996 to 1999, 2001 to 2004 and 2006 to 2009 and seem to be erroneous in the year 2010, as data for this year are extraordinary high, and subtraction of these data would effect that the sum of the sectors equal to the reported National Total for this year.

Thus, data of the category "B – Industry combustion" were interpolated for the years 1991 to 1994, 1996 to 1999, 2001 to 2004 and 2006 to 2010, whereas data for the year 2010 were replaced. National Totals for these years were replaced by the sum of sectors.

$PM_{2.5}$, PM_{10}

Reported $PM_{2.5}$ and PM_{10} emissions were very low, and the National Total differed strongly to expert estimates. Thus, the reported National Total data have been replaced. Estimates from EDGAR were used. Sectoral distribution was gapfilled (by interpolation) for category "B – Industry combustion" for the years 1991 to 1994, 1996 to 1999, 2001 to 2004 and 2006 to 2009, and "G - International and national inland shipping" for the years 1992, 2005-2007, as these years were missing. Further, data from the shipping sector seemed to be far too high for the years 1993 to 1998 and thus were replaced by extrapolated data (1991 to 1999).

The sectors "F – Road Transport" and "H – Aviation" were copied from $PM_{2.5}$ to PM_{10}, as no emissions for these sectors were reported for PM_{10}. Then, the sector distribution of the $PM_{2.5}$ time series was used to split the new National Totals of $PM_{2.5}$ and PM_{10} of the respective year.

6.28. Liechtenstein (LI)

Liechtenstein provided no submission in 2019. From previous submissions, data up to the year 2016 are available. The data seemed to be complete and plausible. The year 2017 was gap-filled by extrapolation of reported data (2000-20165), whereas negative data were avoided by the copy of data of the previous year. The National Totals of the year 2017 then were calculated by the sum of the sectors.

6.29. Lithuania (LT)

The data of Lithuania reported for the years 2000 to 2016 seemed to be plausible for most of the sectors. Of the sector "L – Other emissions from agriculture" data for the years 1990 to 2004 for NMVOC and PMs were missing. These were extrapolated. Data of the sector "B – Industry combustion" are very low for NMVOC before the year 2005 and far too high for $PM_{2.5}$ from 2005 to 2017, especially if compared with data reported in 2018. As industry data of other pollutants did not show such a trend, NMVOC data were replaced by extrapolated data and $PM_{2.5}$ data were replaced

by data reported in 2018 up to the year 2016, and inter-/extrapolation of the years 2012 (which was not reported in 2018) and 2017.

PM_{10} emissions of the sectors "G – Shipping" were smaller than $PM_{2.5}$, thus PM_{10} data were replaced by $PM_{2.5}$ data. For the sector "H – Aviation", PM_{10} data were missing at all. Thus PM_{10} data were gap-filled by data from $PM_{2.5}$ and the National Total adjusted by the sum of the sectors.

The National Totals of the years 1990 to 2004 (NMVOC), and 1990-2017 ($PM_{2.5}$, PM_{10}) were replaced by the sum of the sectors.

6.30. Luxembourg (LU)

The data of Luxembourg reported for the years 1990 to 2017 reported in 2019 seemed to be complete and plausible. Therefore no gap-filling was performed.

6.31. Latvia (LV)

The data of Latvia reported for the years 1990 to 2017 reported in 2019 seemed to be complete and plausible. Therefore no gap-filling was performed.

6.32. Monaco (MC)

The data of Monaco reported for the years 1990 to 2017 reported in 2019 seemed to be complete. Therefore no gap-filling was performed.

The NH_3 emissions of Monaco are rather unusual, with up to 88 % of the emissions occurring in the sector "F - Road transport emissions". In contrast, within the 2018 submission, the bigger part of the emissions with up to 97 % of the NH_3 emissions occurred from "G - International and national inland shipping". Further review is recommended here.

The CO emissions of Monaco are rather unusual, with up to 80 % of the emissions occurring in the sector "H - International and domestic LTO emissions". In contrast, within the 2018 submission, the bigger part of the emissions of the CO emissions occurred from "F - Road transport emissions". Further review is recommended here.

PM_{10} emissions of the sectors "I – Off-road" were smaller than $PM_{2.5}$, thus PM_{10} data were replaced by $PM_{2.5}$ data for this sector and the National Total adjusted by the sum of the sectors.

6.33. Republic of Moldova (MD)

The Republic of Moldova provided no submission in 2019. From previous submissions, data up to the year 2015 are available. Sectoral data seemed to be complete and plausible, same as for the National Total data of NH_3 and SO_x. Only data of the sector "H - International and domestic LTO emissions" for the years 1991 to 2000 were missing. The National Totals of NO_x, NMVOC, $PM_{2.5}$, PM_{10} and CO did not equal to the sum of the sectors.

The years 2016 and 2017 were gap-filled by extrapolation of reported data (2000-2015), or copy of the year 2015 – if extrapolation resulted in negative values. The years 1991 to 2000 of sector H were interpolated. The National Totals of NO_x, NMVOC, $PM_{2.5}$, PM_{10} and CO have been replaced by the sum of the sectors.

6.34. Montenegro (ME)

Montenegro provided no submission in 2019. From previous submissions, data up to the year 2011 are available. These data seemed to be complete.

The SO_x emissions of Montenegro are rather unusual, with up to 96 % of the emissions occurring in the sector "A - Public electricity and heat production". Montenegro explained that there is only one Thermo Power plant in Montenegro (TPP Pljevlja) which is using lignite (with about 1% of sulfur) for electricity production and that this is the majority of lignite consumption in the country. TPP Pljevlja is the main SO_x emitter in Montenegro with a big share in total emissions.

The NH_3 emissions of Montenegro are rather unusual, as the share of sector "L - Other emissions from agriculture" is very low. Further review is recommended here.

The National Totals of the years 2012 to 2017 thus were gap-filled by extrapolation of reported data (2000-2011). The sector distribution for the years 2012 to 2017 were split up according to the sector distribution of the year 2011.

6.35. North Macedonia (MK)

The data of North Macedonia reported for the years 1990 to 2017 seemed to be complete. Therefore no gap-filling was performed.

PM_{10} values of the sector "H – Aviation" were missing. Thus, $PM_{2.5}$ data of the whole time series were copied for PM_{10}, and the PM_{10} National Totals from 1990 to 2017 were replaced by the sum of the sectors.

The sector distribution of SO_x is rather unusual, with a large contribution of the sector "A – Public electricity and heat production". North Macedonia explained that there are large contributions of this sector since the electricity production is made by power plants using low caloric domestic coal. There were recommendations in the stage 3 review carried out in 2016 to calculate sulphur emissions from the NFR sectors 1A3c and 1Afvii. Thus, North Macedonia has calculated emissions from this NFRs, but emissions are minor. The largest contributor still remains "A – Public electricity and heat production". North Macedonia hopes that with installation of a de-sulfurization unit in the major power plant and increased production of electricity from other renewable sources which is visible in the last few years the emissions from NFR 1A1a in total SO_x emissions will be reduced.

6.36. Malta (MT)

For Malta, data are available from 2000 to 2017. These data seemed to be plausible, but some sector data for some years are missing. Data for the years 1990 to 1999 were gap-filled.

NO_x

National Totals for the years 1990 to 1999 were copied from the CRF submission of Malta, and the reported sector distribution of the year 2000 was used to split the sectors of the years 1990 to 1999.

NMVOC

Some sector data of the years 2000 to 2004 have been gap-filled (extrapolation) and for the Sector "J - Emissions from waste" data of these years were replaced as the data seem to be far too low. The National Totals of these years have been replaced by the sum of the sectors. Sectors were

extrapolated for the years 1990 to 1999 and the National Total was calculated by the sum of the sectors.

SO_x

Data of the sector “A - Public electricity and heat production” seem to be far too low for the year 2017 and thus have been replaced by extrapolation (2010 to 2016), and the National Total has been replaced by the sum of the sectors. National Totals of the years 2000 to 2003 seem to be far too high, especially when compared with CRF data. These data were thus replaced by CRF data, and sectors were split up according to the reported distribution. National Totals for the years 1990 to 1999 were copied from the CRF submission of Malta, and the reported sector distribution of the year 2000 was used to split the sectors of the years 1990 to 1999.

NH_3

Sectors were extrapolated (using data of the years 2000 to 2004) for the years 1990 to 1999 and the National Total was calculated by the sum of the sectors.

$PM_{2.5}$, PM_{10}

Some sector data of the years 2000 to 2004 have been gap-filled, and data of the sector “F- Road transport emissions” have been replaced as they seemed far too high compared with other years. National Total data of these years have been replaced by the sum of the sectors.

For the years 1990 to 1999, sectors were extrapolated (2000 to 2017) and negative values corrected to 0. Afterwards, some gap-filled PM_{10} values of the sectors B, E, F were replaced by data of $PM_{2.5}$, as these were higher. The National Totals were then calculated by the sum of the sectors.

CO

Some sector data of the years 2000 to 2004 have been gap-filled (extrapolation). The National Totals of these years have been replaced by the sum of the sectors. Sectors were extrapolated for the years 1990 to 1999 and the National Total was calculated by the sum of the sectors.

6.37. The Netherlands (NL)

The data of the Netherlands for the years 1990 to 2017 reported in 2019 seemed to be complete and plausible. Therefore no gap-filling was performed.

6.38. Norway (NO)

The data of Norway for the years 1990 to 2017 reported in 2019 seemed to be complete and plausible. Therefore no gap-filling was performed.

6.39. Poland (PL)

The data of Poland for the years 1990 to 2017 reported in 2019 seemed to be complete and plausible. Therefore no gap-filling was performed.

6.40. Portugal (PT)

The data of Portugal for the years 1990 to 2017 reported in 2019 seemed to be complete and plausible. Therefore no gap-filling was performed.

6.41. Romania (RO)

No sector data and no National Total data for NH_3 and PMs for the years 1990 to 1994 are available for Romania. All other data reported by Romania seemed to be complete and plausible.

National Totals of NH_3 and PMs were gap-filled by using EDGAR data and sector data of all pollutants for the years 1990 to 1994 were split up using the reported sector distribution from 1995.

6.42. Serbia (RS)

The data of Serbia for the years 1990 to 2017 reported in 2019 seemed to be complete and plausible. Therefore no gap-filling was performed.

The sector distribution of SO_x is rather unusual, with a large contribution of the sector "A – Public electricity and heat production". Further review is recommended here.

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

The Russian Federation reported National Total data of the years 1990 to 2000 and 2002 to 2017 ($PM_{2.5}$ and PM_{10}: only 2002-2017), and sectoral data for the years 2002 to 2016. Further, some data corrections for the years 2006 to 2009 were sent directly to CEIP (no official submission) in spring 2019.

However, for the years 2002 to 2008, sector data seemed to be not complete as several sectors were missing and the sum of the sectors did not equal to the National Total.

NO_x, NMVOC, SO_x, NH_3, CO

The corrected data sent from the Russian Federation to CEIP was used for the years 2006 to 2009 (National Totals), and for the sector data of the year 2009. The National Total of the year 2001 was interpolated. Sectoral distribution of the years 1990 to 2008 were distributed like the year 2009. In doing so, the sector distribution of the years 2002 to 2008 was replaced.

Within the sector distribution of CO of the Russian Federation, the sector "F – Road Transport" is rather large, whereas the sector "C – Other Stationary Combustion" is small. Further review is recommended here.

$PM_{2.5}$, PM_{10}

The corrected data sent from the Russian Federation to CEIP was used for the years 2006 to 2009 (National Totals), and for the sector data of the year 2009. Sectoral distribution of the years 2000 to 2008 were distributed like the year 2009. In doing so, the sector distribution of the years 2002 to 2008 was replaced. Afterwards, for the sectors "F – Road transport" (years 2000-2002 and 2006 to 2008) and "I – Offroad emissions" (year 2000), gap-filled PM_{10} data have been replaced by data from $PM_{2.5}$, as gap-filled $PM_{2.5}$ data were originally higher than those. The National Totals have been adjusted to the sum of sectors.

Within the sector distributions for $PM_{2.5}$ and PM_{10} of the Russian Federation, the sector "C – Other Stationary Combustion" is rather small. Further review is recommended here.

6.44. Sweden (SE)

The data of Sweden for the years 1990 to 2017 reported in 2019 seemed to be complete and plausible. Therefore no gap-filling was performed.

6.45. Slovenia (SI)

The data of Slovenia for the years 1990 to 2017 reported in 2019 seemed to be complete and plausible. Therefore no gap-filling was performed.

6.46. Slovakia (SK)

The data of Slovakia for the years 1990 to 2017 reported in 2019 seemed to be complete and plausible. Therefore no gap-filling was performed. PM_{10} of the sector "H – Aviation" was smaller than $PM_{2.5}$ in the year 1994, thus PM_{10} data were replaced by $PM_{2.5}$ data and the National Total adjusted (sum of sectors).

6.47. Tajikistan (TJ)

No reported data were available. Sector data and National Totals were gap-filled using EDGAR data for the years 1990 to 2010, and extrapolation for the years 2011 to 2017 (2000 to 2010).

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

No reported data were available. For NO_x, NMVOC, $PM_{2.5}$, PM_{10} and CO, sector data and National Totals were gap-filled using EDGAR data for the years 1990 to 2010, and extrapolation for the years 2011 to 2017 (2000 to 2010). For SO_x and NH_3, EDGAR data were used up to the year 1999, and data from 2000 to 2015 were gap-filled using CAMS data, as these data seem to be more sufficient (For the method used please see section 3.1). For the years 2016 and 2017, sector data were extrapolated and the National Total calculated by the sum of the sectors.

The parts "TME" and "TMO" were split up according to 80 % and 20 % of the emissions of Turkmenistan.

6.49. Turkey (TR)

Turkey reported data for all pollutants. The reported data of NO_x, NMVOC, SO_x and NH_3 seemed to be complete and plausible, except the National Totals of the year 2011 for NMVOC, NH_3 and SO_x, where the sum of sectors did not equal to the National Total and thus was replaced by the sum of the sectors.

$PM_{2.5}$, PM_{10}

Data reported for $PM_{2.5}$ seem to be far too low compared with expert estimates and data of the year 1994 is missing. The sector distribution shows an extraordinary high share of the sector "B – Industry", and the sector distribution differs strongly to expert estimates. Therefore, National Total and sector distributions were replaced by TNO data for the years 2003 to 2009, and by IIASA data for the years 1990 to 2000. The years 2001 to 2002 and 2010 to 2017 were inter- and extrapolated.

The sector distribution for PM_{10} shows an extraordinary high share of the sector "B – Industry", and the sector distribution differ strongly to expert estimates. Therefore, the sector distribution was replaced by the sector distribution from TNO to split the National Total of the years 2003 to 2009 into sector data. The years 2010 to 2017 were distributed like the sector split from TNO for the year 2009, and the years 1990 to 1999 were distributed like the sector split from TNO for the year 2003. In cases where $PM_{2.5}$ was higher than PM_{10}, data of $PM_{2.5}$ were copied for PM_{10} (Sector D 1990-2001,

Sector E 1990-2002, Sector H 2014, Sector 1994-2001) and the National Total corrected by the sum of the sectors.

CO

Data of the sector "F – Road transport" were missing for the years 1990 to 1993 and thus were gap-filled by extrapolation (1994-2016). The National Total of these years were corrected and replaced by the sum of sectors. Data for year 2017 were missing (Sectors and National Totals) and thus the sectors were gap-filled by extrapolation (1990-2016) or copy of the year 2016 (if extrapolation would have resulted in negative values), and the National Total calculated by the sum of the sectors.

6.50. Ukraine (UA)

The Ukraine provided National Totals for the years 1990 to 2017 (2000 missing for CO and NMVOC, and PMs only 2002, 2004, 2005, 2010-2017) and some sector data for the years 2002 to 2017.

NO_x, NMVOC, $PM_{2.5}$, PM_{10}, CO

National Totals seem to be too low for the most years compared with expert estimates. The reported sector distributions differ strongly to expert estimates and to the mean sectoral distribution. Further, the sum of the sectors of the years 2002 to 2007 was not equal to the National Totals. Therefore, National Total and sector data of all years are replaced or filled with EDGAR data for the years 1990 to 2010 and with extrapolated sectoral and National Total EDGAR data for the years 2011 to 2017.

SOx

Data seemed to be complete and plausible for the years 2008 to 2009 and 2014 to 2016. For the years 2010 to 2013, some sector data (Sectors F, G, H and I) are missing. Sector data of the years 2002 to 2007 are very incomplete and the sum of the sectors do not equal to the National Totals. Data for the year 2017 (especially of Sector A) seem to be far too low, especially when compared with expert estimates.

Therefore, missing sector data of the years 2010 to 2013 are interpolated and the National Total was corrected by the sum of sectors. Data of sector "A - Public electricity and heat production" for the year 2017 were replaced by extrapolation (2008-2016) and the National Total corrected by the sum of the sectors. Sector data of the years 1990 to 2007 were replaced or filled by using the sector distribution of the year 2008 to split the National Total.

NH3

National Totals seem to be too low for the years 2010 to 2017 compared with expert estimates. Further, the sum of the sectors of the years 2002 to 2007 did not equal to the National Totals. Only reported data of the years 2008 and 2009 seem to be plausible.

Therefore, National Totals of the years 2010 to 2017 were replaced by (inter-/extrapolated) IIASA estimates. Sector data of the years 1990 to 2007 were gap-filled and replaced using the reported National Total and the sector distribution of the year 2008. Sector data of the years 2010 to 2017 were gap-filled and replaced using the reported National Total and the sector distribution of the year 2009.

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

No reported data were available. Sector data and National Totals were gap-filled using EDGAR data for the years 1990 to 2010, and extrapolation for the years 2011 to 2017 (2000 to 2010), whereas negative data were avoided by the copy of data of the previous year.

The parts "UZE" and "UZO" were split up according to 97 % and 3 % of the emissions of Uzbekistan.

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

7.1. Sea regions: Atlantic Ocean (ATL), Baltic Sea (BAS), Black Sea (BLS), Caspian Sea (CAS), Mediterranean Sea (MED), North Sea (NOS)

Emissions from 2000 to 2017 for the sea regions were extracted from CAMS global ship datasets (Finish Meteorological Institute, FMI 2019), provided via ECCAD (https://eccad.aeris-data.fr - CAMS_GLOB_SHIP). Shipping emissions from 1990 to 1999 were calculated using CAMS global ship emissions for 2000 adjusted with trends for global shipping from EDGAR v.4.3.2 (https://edgar.jrc.ec.europa.eu).

Caspian Sea

For the Caspian Sea, FMI shipping data (FMI 2017) for 2015 were used and adjusted with the GDP trend of Kazakhstan.

7.2. Aral Lake: Rest of Aral Lake in the extended EMEP domain (ARE), Aral Lake in the former official EMEP domain (ARO)

For the Aral Lake, inter- and extrapolated data from EDGAR data for 2000, 2005 and 2010 was used. For shipping, FMI shipping data (FMI 2017) for 2015 were used and adjusted with the GDP trend of Kazakhstan.

7.3. 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)

To calculate emissions for the Russian Federation in the extended EMEP domain, aggregated and interpolated grid emissions from EDGAR for 2000, 2005 and 2010, extrapolated with the GDP trend for the Russian Federation, was used.

7.4. Remaining Asian Areas in the extended EMEP domain (ASE) and Modified Remaining Asian Areas in the former official EMEP domain (ASM)

To calculate emissions for the remaining Asian Areas in the extended EMEP domain, aggregated and interpolated grid emissions from EDGAR for 2000, 2005 and 2010, extrapolated with the GDP trend for China, was used.

7.5. North Africa (NOA)

To calculate emissions for North Africa, aggregated and interpolated grid emissions from EDGAR for 2000, 2005 and 2010, extrapolated with the GDP trend for Morocco, was used.

8. References

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9. 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 9.1 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