CEIP umweltbundesamt

UPDATED DOCUMENTATION OF THE EMEP GRIDDING SYSTEM V.2019

FOR THE SPATIAL DISAGGREGATION OF EMISSION DATA WITH A RESOLUTION OF 0.1°X0.1° (LONG-LAT)

Technical report CEIP 06/2019

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1 HISTORY OF THE EMEP GRID AND CHANGES FOR THE 0.1X0.1 LONG/LAT EMEP GRID

The geographical scope of EMEP is defined as “the area within which, coordinated by the international centres of EMEP, monitoring is carried out." Since its adoption in 1984, this definition has been referred to in all protocols to the LRTAP Convention. As Parties have ratified or acceded to the EMEP Protocol, the geographical scope of EMEP has become larger and the EMEP grid has been modified in the late 1990s, in 2008 and in 2013.

From 1984 to 1998 a 150 x 150 km² polar-stereographic grid was used for EMEP reporting. From 1999 on, the grid resolution was changed to 50 x 50 km², but the area covered by the higher resolution grid remained unchanged.

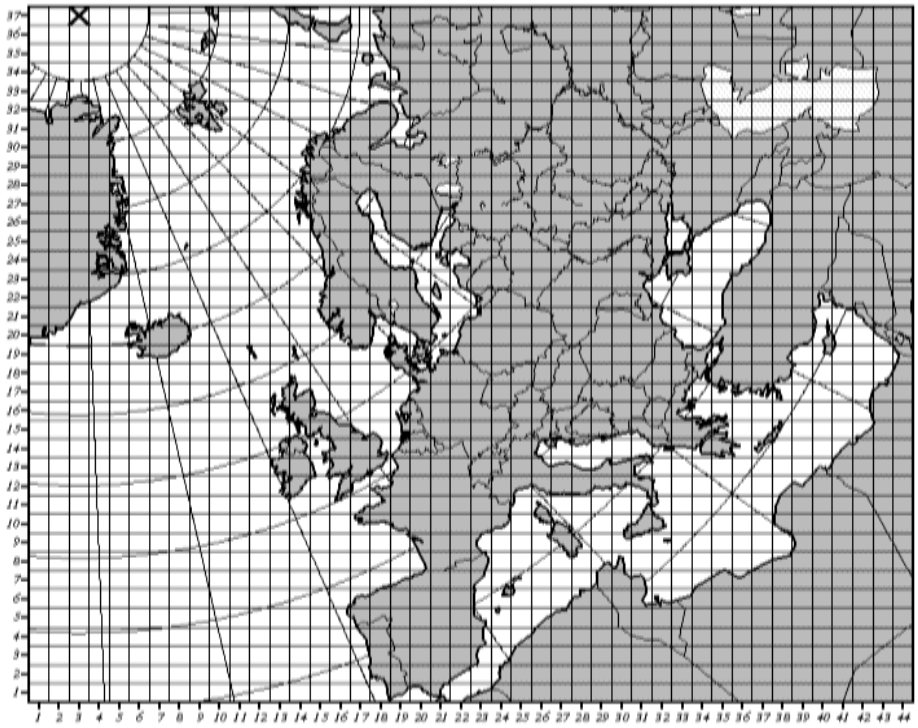


Figure 1 Map of the 150 x 150 km^2 grid

In 2008, the domain covered by the EMEP grid was extended to its current expansion to also include EECCA countries and a larger part of the Russian Federation, while keeping the resolution unchanged.

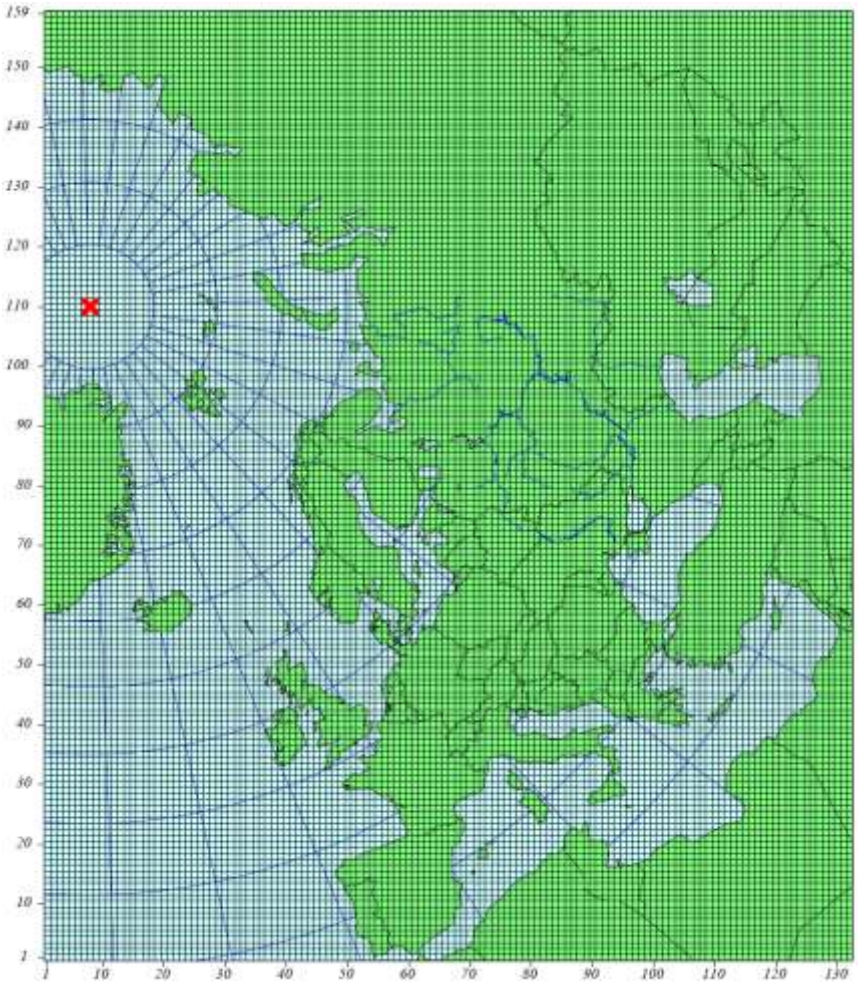


Figure 2 Map of the extended 50 x 50 km^2 grid

New directions of air pollution assessment imply new demands in regard to the geographical scope and model grid resolution. In particular, atmospheric dispersion of a number of pollutants under CLRTAP (including ozone, PM, mercury and some POPs) has been proved to have global character and this requires assessments on a global or hemispheric scale (HTAP 2010 Assessment Report). Besides, a number of tasks related to climate change and its effect on air pollution also require consideration on wider spatial scales. Furthermore, there is increasing interest among Parties to the Convention in more detailed information on pollution levels within their territories that require assessments with higher spatial resolution on national and local scales. Given the increasing resolution in state-of-the-art atmospheric models there has been an ongoing discussion about a further modification of the EMEP grid during the last few years, which resulted in a completely new grid with respect to the domain borders, the grid cell resolution and the projection.

At the 36th session of the EMEP Steering Body the EMEP Centers suggested to increase spatial resolution of reported emissions from 50x 50 km EMEP grid to 0.1° × 0.1° long-lat in a geographic coordinate system (WGS84) to improve quality of monitoring. The new EMEP domain will cover the geographic area between 30°N-82°N latitude and 30°W-90°E longitude. This suggestion represents a balance between political needs, scientific needs and technical feasibility as of 2012 and for the next years.

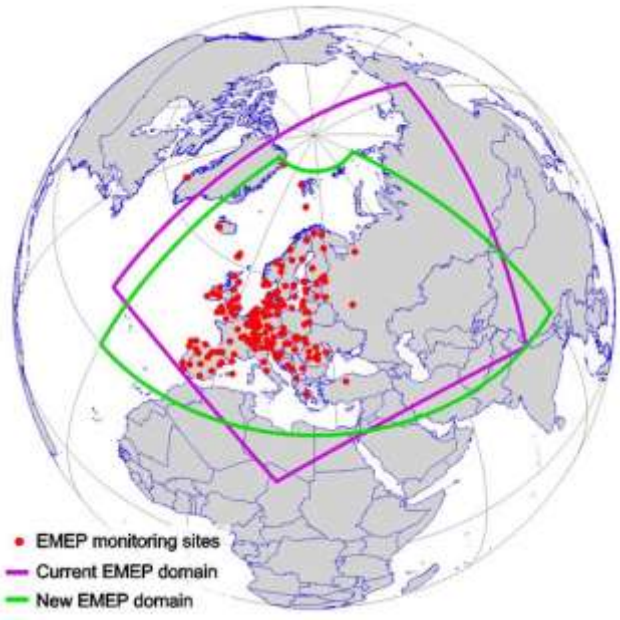


Figure 3 The old (magenta) and new (green) EMEP domain borders (Source: MSC-E)

2 DEFINITION OF THE EMEP GRID

The official EMEP grid was changed from a polar-stereographic projection to a latitude-longitude projection, covering the geographic domain from 30°N-82°N latitude to 30°W-90°E longitude:

Figure 4 The new geographic EMEP domain

For this domain a 0.1°x 0.1° (long-lat) grid definition was created, which is available in different formats for all countries/areas within the new EMEP domain (see http://www.ceip.at/new_emep-grid/grid_definition).

Available formats are:

- Excel tables
- CSV files
- ESRI shape files

Each format can be downloaded for the following countries:

Party	Country Code	Grid definition tables for 0.1°x0.1° (long-lat) grid	ESRI shape files with 0.1°x0.1° (long-lat) grid definition	Number of grid cells
Albania	AL	Excel / CSV	Shapefile	374
Armenia	AM	Excel / CSV	Shapefile	392
Austria	AT	Excel / CSV	Shapefile	1144
Azerbaijan	AZ	Excel / CSV	Shapefile	1094
Belarus	BY	Excel / CSV	Shapefile	3004
Belgium	BE	Excel / CSV	Shapefile	465
Bosnia & Herzegovina	BA	Excel / CSV	Shapefile	661
Bulgaria	BG	Excel / CSV	Shapefile	1365
Croatia	HR	Excel / CSV	Shapefile	924
Cyprus	CY	Excel / CSV	Shapefile	130

Party	Country Code	Grid definition tables for 0.1°x0.1° (long-lat) grid	ESRI shape files with 0.1°x0.1° (long-lat) grid definition	Number of grid cells
Czech Republic	CZ	Excel / CSV	Shapefile	1103
Denmark	DK	Excel / CSV	Shapefile	893
Estonia	EE	Excel / CSV	Shapefile	890
Finland	FI	Excel / CSV	Shapefile	6808
France	FR	Excel / CSV	Shapefile	6884
Georgia	GE	Excel / CSV	Shapefile	876
Germany	DE	Excel / CSV	Shapefile	4943
Greece	GR	Excel / CSV	Shapefile	2125
Hungary	HU	Excel / CSV	Shapefile	1218
Iceland	IS	Excel / CSV	Shapefile	2273
Ireland	IE	Excel / CSV	Shapefile	1171
Italy	IT	Excel / CSV	Shapefile	3834
Kazakhstan	KZ	Excel / CSV	Shapefile	7750
Kyrgyzstan	KG	Excel / CSV	Shapefile	2391
Latvia	LV	Excel / CSV	Shapefile	1074
Liechtenstein	LI	Excel / CSV	Shapefile	8
Lithuania	LT	Excel / CSV	Shapefile	1033
Luxembourg	LU	Excel / CSV	Shapefile	51
FYR of Macedonia	MK	Excel / CSV	Shapefile	315
Malta	MT	Excel / CSV	Shapefile	10
Republic of Moldova	MD	Excel / CSV	Shapefile	489
Monaco	MC	Excel / CSV	Shapefile	1
Montenegro	ME	Excel / CSV	Shapefile	192
Netherlands	NL	Excel / CSV	Shapefile	617
Norway	NO	Excel / CSV	Shapefile	10825
Poland	PL	Excel / CSV	Shapefile	4329
Portugal	PT	Excel / CSV	Shapefile	1151
Romania	RO	Excel / CSV	Shapefile	2931
Russian Federation	RU	Excel / CSV	Shapefile	62883
Serbia	RS	Excel / CSV	Shapefile	1127
Slovakia	SK	Excel / CSV	Shapefile	698
Slovenia	SI	Excel / CSV	Shapefile	297

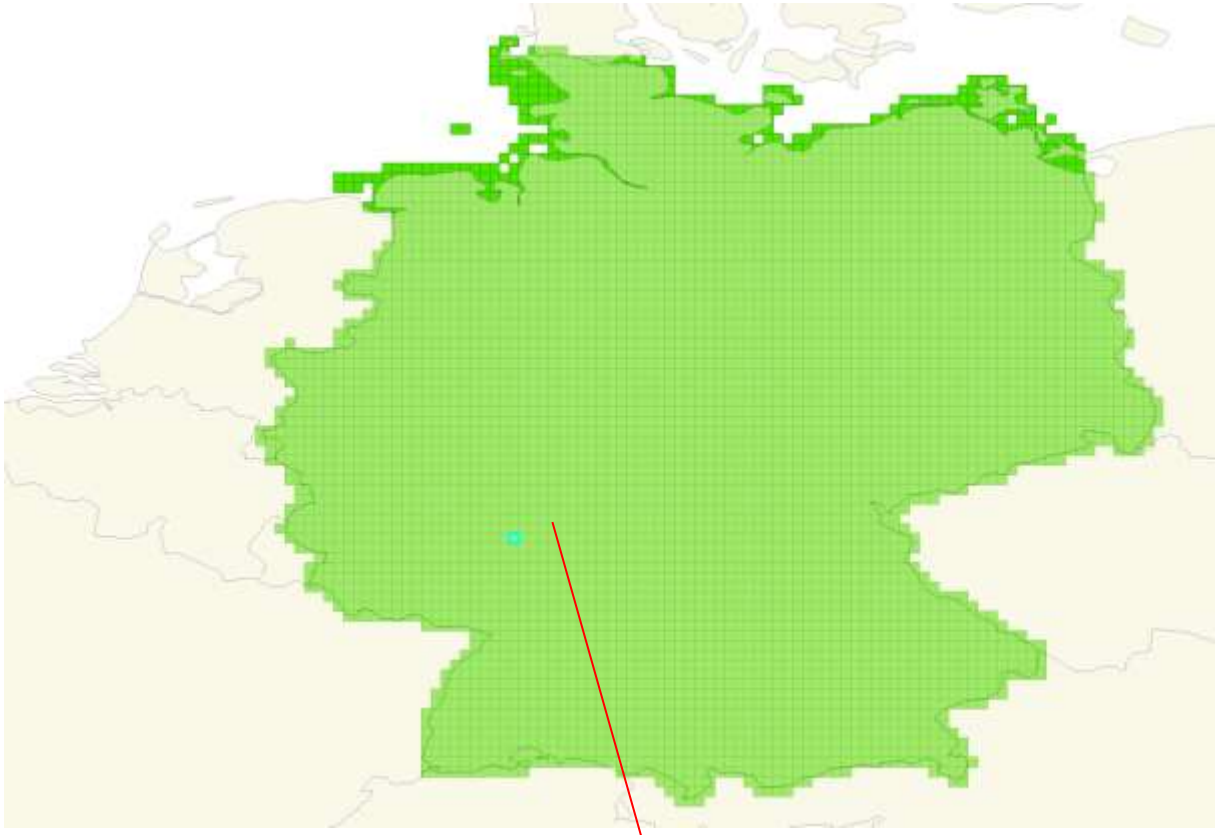
Party	Country Code	Grid definition tables for 0.1°x0.1° (long-lat) grid	ESRI shape files with 0.1°x0.1° (long-lat) grid definition	Number of grid cells
Spain	ES	Excel / CSV	Shapefile	5644
Sweden	SE	Excel / CSV	Shapefile	8573
Switzerland	CH	Excel / CSV	Shapefile	590
Turkey	TR	Excel / CSV	Shapefile	8626
Ukraine	UA	Excel / CSV	Shapefile	7861
United Kingdom	GB	Excel / CSV	Shapefile	4139

Other areas are available only as ESRI shapefiles:

Area	Area Code	ESRI shape files with 0.1°x0.1° (long-lat) grid definition	Number of grid cells
Aral Lake in the former official EMEP domain	ARO	Shapefile	89
Baltic Sea	BAS	Shapefile	7591
Black Sea	BLS	Shapefile	5567
Caspian Sea	CS	Shapefile	4335
EMEP-external part of Russian Federation	RUX	Shapefile	20744
Greenland	GL	Shapefile	13579
Mediterranean Sea	MED	Shapefile	27292
Modified Remaining Asian Areas in the former official EMEP domain	ASM	Shapefile	17951
North Africa	NOA	Shapefile	16422
North Sea	NOS	Shapefile	12911
Remaining Asian Areas in the extended EMEP domain	ASE	Shapefile	34542
Remaining North-East Atlantic Ocean	ATL	Shapefile	239852
Rest of Aral Lake in the extended EMEP domain	ARE	Shapefile	312
Rest of Kazakhstan in the extended EMEP domain	KZE	Shapefile	26146
Rest of Russian Federation in the extended EMEP domain	RFE	Shapefile	39599
Rest of Uzbekistan in the extended EMEP domain	UZE	Shapefile	4122
Tajikistan	TJ	Shapefile	1688
Turkmenistan	TM	Shapefile	5388
Uzbekistan in the former official EMEP domain	UZO	Shapefile	1021

Grid for the whole new EMEP domain (geographic area between 30°N-82°N latitude and 30°W-90°E longitude)		Shapefile	623480

Example:



FID	Shape *	Number	ISO	Name	long_min	long_max	lat_min	lat_max	long	lat	area	frac_area	fraction
1467	Polygon	60	DE	Germany	8,1	8,2	49,9	50	8,15	49,95	88,850565	88,850566	1
1468	Polygon	60	DE	Germany	8,2	8,3	49,9	50	8,25	49,95	88,850565	88,850565	1
1469	Polygon	60	DE	Germany	8,3	8,4	49,9	50	8,35	49,95	88,850565	88,850565	1
1470	Polygon	60	DE	Germany	8,4	8,5	49,9	50	8,45	49,95	88,850565	88,850565	1
1471	Polygon	60	DE	Germany	8,5	8,6	49,9	50	8,55	49,95	88,850565	88,850565	1
1472	Polygon	60	DE	Germany	8,6	8,7	49,9	50	8,65	49,95	88,850565	88,850566	1

Figure 5 0.1°x 0.1° grid definition for Germany

The grid definition for a country/area contains a dataset for each grid cell with information about

- the country or area (ISO2 or a three digits abbreviation for countries and other areas which you can see in the column „Country code“ in the grid definition table above)
- the country- or area name
- the longitude position of the grid cell (centre of the cell)
- the latitude position of the grid cell (centre of the cell)
- and fraction of the grid cell (share of the cell area which belongs to the country/area, e.g. 1 for cells which are completely inside the country/area borders and e.g. 0.5 for cells where half of the area belongs to the country/area and the rest is outside the boundary)

The attribute table of the available ESRI shape files contains additional information, like spatial information for the GIS application and information about the area of the whole grid cell in km² (area) as well as the area of the relevant fraction for the country/area in km² (frac_area). In addition, not only the centre of the cells as long-lat position is given, but also the position of the 4 edges of the grid cell square.

3 THE 0.1X0.1 LONG/LAT GRIDDING SYSTEM

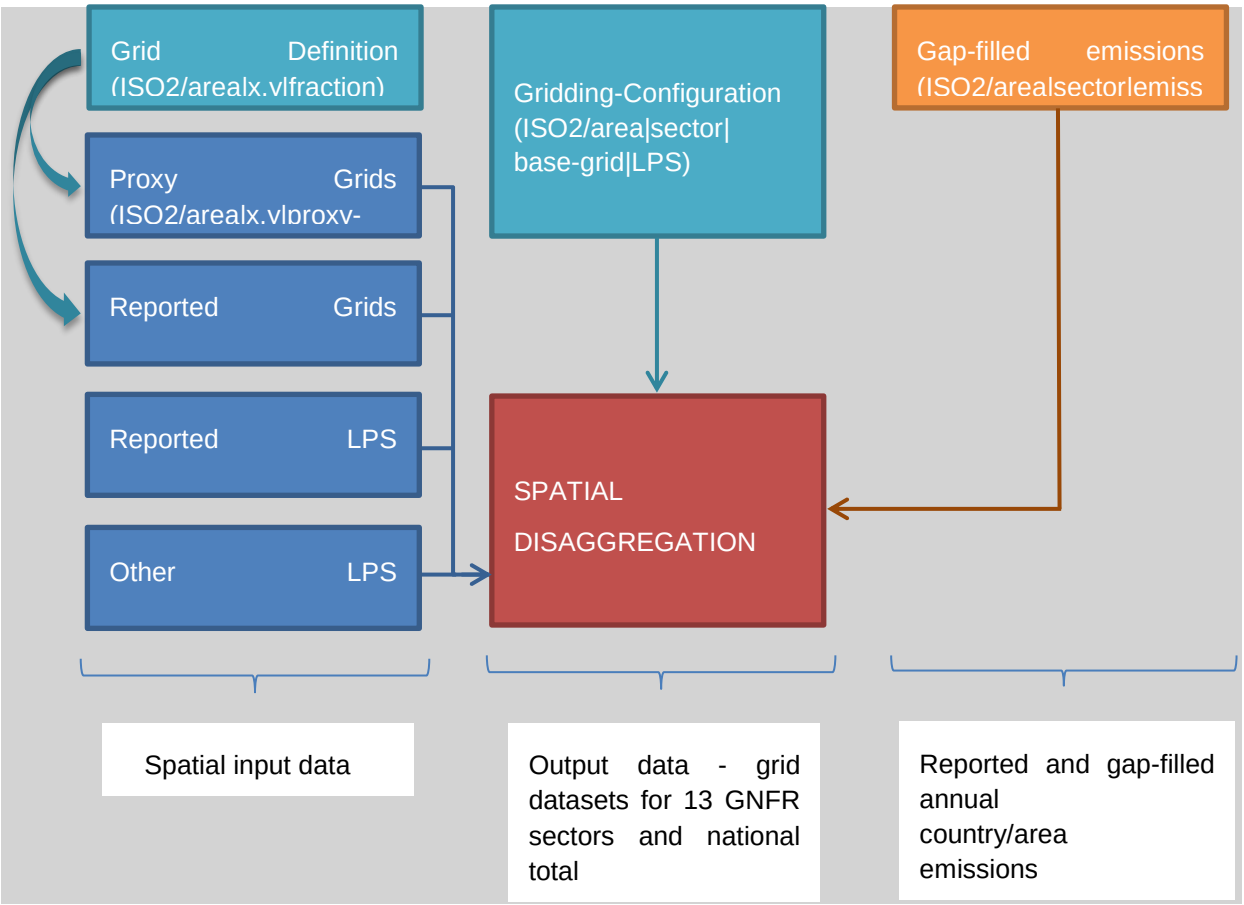


Figure 6 Structure of the 0.1x0.1 lon/lat gridding system

There is a defined folder structure for all templates, tools and data the gridding system is working with:

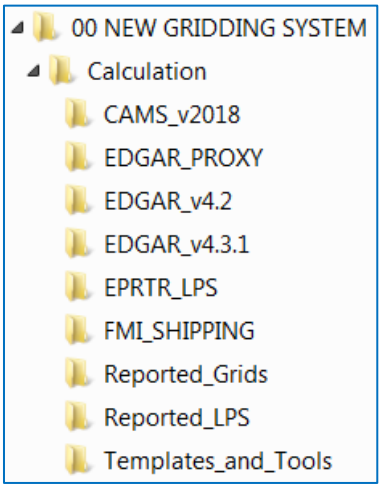


Figure 7 Folder structure of the new gridding system

The individual folders and their content will be explained in detail in the following chapters.

The top folder with the name “Calculation” contains the actual grid calculation tool and all the subfolders which contain data for the calculation tool. At the moment this subfolders are defined:

- **CAMS_v2018**
  with proxy data derived from CAMS regional emission datasets released in 2018
- **EDGAR_PROXY**
  with proxy data from JRC, which is used also for the EDGAR global emission inventory
- **EDGAR_v4.2**
  with proxy data derived directly from EDGAR v4.2 global emission inventory datasets
- **EDGAR_v4.3.1**
  with proxy data derived directly from EDGAR v4.3.1 global emission inventory datasets
- **EPRTR_LPS**
  with LPS data from E-PRTR reporting
- **FMI_SHIPPING**
  with proxy data for international shipping, derived from FMI data, which is based on AIS tracking data
- **Reported_Grids**
  with grid data reported to the CLRTAP
- **Reported_LPS**
  with LPS data reported to the CLRTAP
- **Templates_and_Tools**
  contains database templates for the reported data and the proxies as well as tools for transferring data from the original format to the template structure

3.1 Structure and configuration of the grid calculation tool

The gridding tool is implemented in VBA code within MS Access. Each pollutant and year is separated in an individual Access database file, which contains the gap-filled emission data, the gridding configuration and the gridding results. The folder „Template_and_Tools“ contains a template of this griddind database file with the name „pollutant_year_GRID_gridyear.accdb“, which can be copied and renamed for the gridding of a certain pollutant and year. After copying the template, “year” should be replaced with the current year, “gridyear” with the year of the included gridded emissions and “pollutant” with the appropriate pollutant. To run a grid calculation the relevant database file must be copied to the folder „Calculation“ (see chapter 3.3 to learn more about usage and functionality of the grid calculation tool).

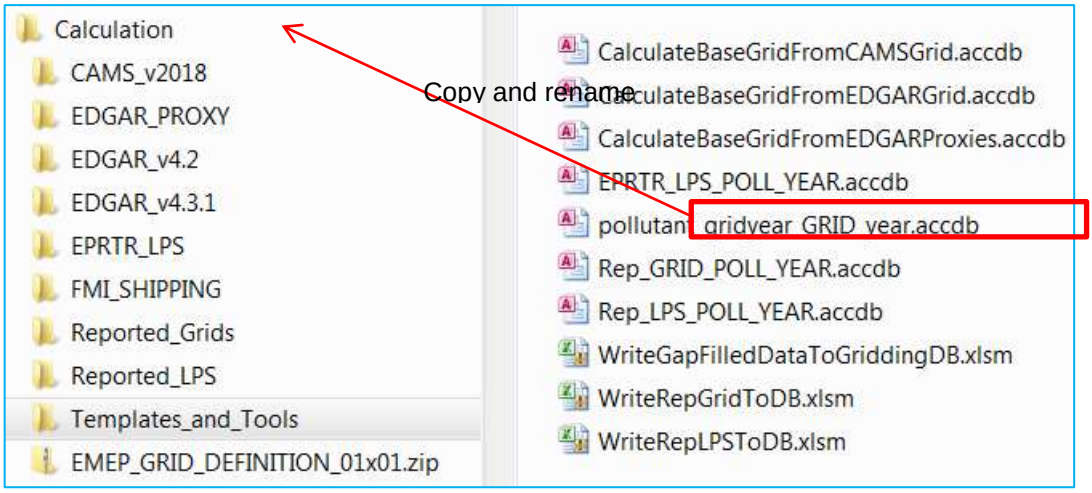


Figure 8 Preparation of a grid calculation

This Access template contains the following tables:

- SECTOR_EMISSIONS
- BASE_GRID_ALLOCATION
- A_PublicPower
- B_Industry
- C_OtherStationaryComb
- D_Fugitive
- E_Solvents
- F_RoadTransport
- G_Shipping
- H_Aviation
- I_Offroad
- J_Waste
- K_AgriLivestock
- L_AgriOther
- M_Other
- National_Total

3.1.1 Table „SECTOR_EMISSIONS“

The table “SECTOR_EMISSIONS” contains the gap-filled emissions for the specific pollutant and year to be spacially disaggregated.

The following fields are defined in this table:

- ISO2 (Type: Text, Field size: 3, PRIMARY KEY)
- emission_year (Type: Number, Field size: Integer)
- sector (Type: Text, Field size: 25, PRIMARY KEY)
- pollutant (Type: Text, Field size: 10)
- unit (Type: Text, Field size: 2)
- emission (Type: Number, Field size: Double)
- distributed (Type: Boolean)
- comment (Type: Text, Field size: 255)
- diff (Type: Number, Field size: Double)

ISO2	emission	sector	pollutant	unit	emission	distributed	comment
AT	2015	A_PublicPower	NOx	Gg	9,663981306	✓	#Reported grid used
AT	2015	B_Industry	NOx	Gg	26,87039322	✓	#Reported grid used
AT	2015	C_OtherStationaryComb	NOx	Gg	11,82586636	✓	#Reported grid used
AT	2015	F_RoadTransport	NOx	Gg	73,16141882	✓	#Reported grid used
AT	2015	G_Shipping	NOx	Gg	0,566146133	✓	#Reported grid used
AT	2015	H_Aviation	NOx	Gg	1,366040672	✓	#Reported grid used
AT	2015	I_Offroad	NOx	Gg	14,74622901	✓	#Reported grid used
AT	2015	J_Waste	NOx	Gg	0,01347	✓	#Reported grid used
AT	2015	K_AgriLivestock	NOx	Gg	0,370733668	✓	#Reported grid used
AT	2015	L_AgriOther	NOx	Gg	10,53879753	✓	#Reported grid used
AT	2015	NATIONAL_TOTAL	NOx	Gg	149,1230767	✓	
ATL	2015	G_Shipping	NOx	Gg	695,46674	✓	#EDGAR proxy used
ATL	2015	NATIONAL_TOTAL	NOx	Gg	695,46674	✓	
AZ	2015	A_PublicPower	NOx	Gg	21,9550141	✓	#EDGAR grid used
AZ	2015	B_Industry	NOx	Gg	3,0363385	✓	#Reported LPS used
AZ	2015	C_OtherStationaryComb	NOx	Gg	6,6409681	✓	#EDGAR grid used
AZ	2015	D_Fugitive	NOx	Gg	1,556352	✓	#EDGAR grid used
AZ	2015	F_RoadTransport	NOx	Gg	36,078195	✓	#EDGAR grid used
AZ	2015	G_Shipping	NOx	Gg	5,87965	✓	#EDGAR proxy used #Reported LPS used
AZ	2015	I_Offroad	NOx	Gg	10,1775243	✓	#EDGAR proxy used
AZ	2015	J_Waste	NOx	Gg	0,8546593	✓	#EDGAR proxy used
AZ	2015	K_AgriLivestock	NOx	Gg	0,234327104	✓	#EDGAR grid used
AZ	2015	NATIONAL_TOTAL	NOx	Gg	86,4130284	✓	
BA	2015	A_PublicPower	NOx	Gg	15,27698491	✓	#EDGAR grid used
BA	2015	B_Industry	NOx	Gg	3,166401018	✓	#EDGAR grid used
BA	2015	C_OtherStationaryComb	NOx	Gg	1,21487039	✓	#EDGAR grid used
BA	2015	D_Fugitive	NOx	Gg	0,614700198	✓	#EDGAR grid used
BA	2015	F_RoadTransport	NOx	Gg	8,93108287	✓	#EDGAR grid used
BA	2015	H_Aviation	NOx	Gg	0,001720001	✓	#EDGAR proxy used
BA	2015	I_Offroad	NOx	Gg	0,46826015	✓	#EDGAR proxy used
BA	2015	J_Waste	NOx	Gg	0,015330005	✓	#EDGAR proxy used

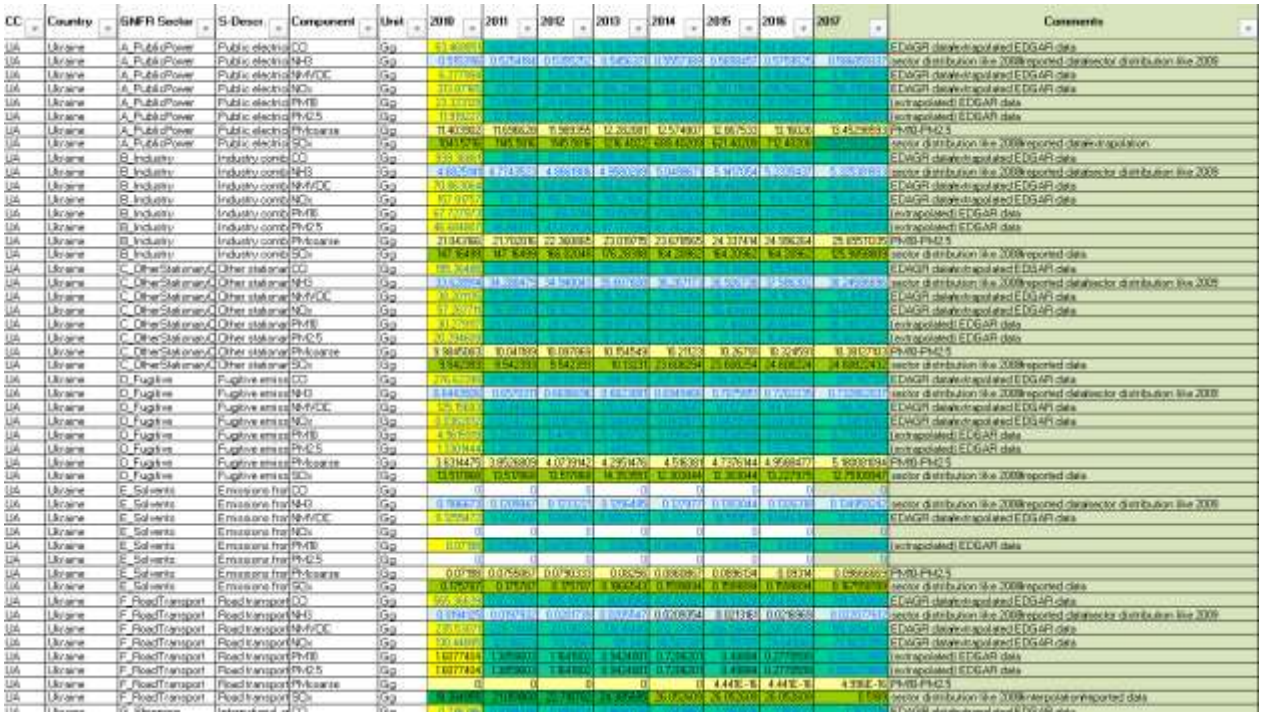
Figure 9 Example of a "SECTOR_EMISSIONS" table after gridding

Before the grid calculation run, only the columns "ISO2", "emission", "sector", "pollutant", "unit" and "emission" are filled with the gap-filled emissions. During the calculation the checkbox "distributed" is set as soon as the grid calculation for a certain country/area and sector is completed. In addition detailed information about proxy data which was used for the distribution is written to the column "comment". The final step in the grid calculation is a comparison of the gap-filled emissions with the aggregated sum of the related grid cells. The difference in percent is written to the column "diff" and must always be zero, otherwise it indicates an error.

3.1.1.1 Preparation of emissions as input data for the new gridding system

Non-spatial emission data is reported annually in NFR sector tables to CLRTAP/CEIP or the EIONET central data repository at the EEA. This reported emission data is converted to GNFR sectors and gap-filled for countries and areas where no reported emission data is available. Afterwards it can be used as input data for the gridding system.

For preparing the gap-filling table, data is exported from the WebDab database as CSV files and afterwards imported to the gap-filling table:



CC	Country	GNFR Sector	S-Descr	Component	Unit	2010	2011	2012	2013	2014	2015	2016	2017	Comments
UA	Ukraine	A_PublicPower	Public electric	CO	Gg									EDAGR data/extrapolated EDGAR data
UA	Ukraine	A_PublicPower	Public electric	NH3	Gg									sector distribution like 2009/reported data/sector distribution like 2009
UA	Ukraine	A_PublicPower	Public electric	NMVOC	Gg									EDAGR data/extrapolated EDGAR data
UA	Ukraine	A_PublicPower	Public electric	NOx	Gg									EDAGR data/extrapolated EDGAR data
UA	Ukraine	A_PublicPower	Public electric	PM10	Gg									(extrapolated) EDGAR data
UA	Ukraine	A_PublicPower	Public electric	PM2.5	Gg									(extrapolated) EDGAR data
UA	Ukraine	A_PublicPower	Public electric	PMcoarse	Gg									PM10-PM2.5
UA	Ukraine	A_PublicPower	Public electric	SOx	Tg									sector distribution like 2009/reported data/extrapolation
UA	Ukraine	B_Industry	Industry comb	CO	Gg									EDAGR data/extrapolated EDGAR data
UA	Ukraine	B_Industry	Industry comb	NH3	Gg									sector distribution like 2009/reported data/sector distribution like 2009
UA	Ukraine	B_Industry	Industry comb	NMVOC	Gg									EDAGR data/extrapolated EDGAR data
UA	Ukraine	B_Industry	Industry comb	NOx	Gg									EDAGR data/extrapolated EDGAR data
UA	Ukraine	B_Industry	Industry comb	PM10	Gg									(extrapolated) EDGAR data
UA	Ukraine	B_Industry	Industry comb	PM2.5	Gg									(extrapolated) EDGAR data
UA	Ukraine	B_Industry	Industry comb	PMcoarse	Gg									PM10-PM2.5
UA	Ukraine	B_Industry	Industry comb	SOx	Gg									sector distribution like 2009/reported data
UA	Ukraine	C_OtherStationaryC	Other stationar	CO	Gg									EDAGR data/extrapolated EDGAR data
UA	Ukraine	C_OtherStationaryC	Other stationar	NH3	Gg									sector distribution like 2009/reported data/sector distribution like 2009
UA	Ukraine	C_OtherStationaryC	Other stationar	NMVOC	Gg									EDAGR data/extrapolated EDGAR data
UA	Ukraine	C_OtherStationaryC	Other stationar	NOx	Gg									EDAGR data/extrapolated EDGAR data
UA	Ukraine	C_OtherStationaryC	Other stationar	PM10	Gg									(extrapolated) EDGAR data
UA	Ukraine	C_OtherStationaryC	Other stationar	PM2.5	Gg									(extrapolated) EDGAR data
UA	Ukraine	C_OtherStationaryC	Other stationar	PMcoarse	Gg									PM10-PM2.5
UA	Ukraine	C_OtherStationaryC	Other stationar	SOx	Gg									sector distribution like 2009/reported data
UA	Ukraine	D_Fugitive	Fugitive emiss	CO	Gg									EDAGR data/extrapolated EDGAR data
UA	Ukraine	D_Fugitive	Fugitive emiss	NH3	Gg									sector distribution like 2009/reported data/sector distribution like 2009
UA	Ukraine	D_Fugitive	Fugitive emiss	NMVOC	Gg									EDAGR data/extrapolated EDGAR data
UA	Ukraine	D_Fugitive	Fugitive emiss	NOx	Gg									EDAGR data/extrapolated EDGAR data
UA	Ukraine	D_Fugitive	Fugitive emiss	PM10	Gg									(extrapolated) EDGAR data
UA	Ukraine	D_Fugitive	Fugitive emiss	PM2.5	Gg									(extrapolated) EDGAR data
UA	Ukraine	D_Fugitive	Fugitive emiss	PMcoarse	Gg									PM10-PM2.5
UA	Ukraine	D_Fugitive	Fugitive emiss	SOx	Gg									sector distribution like 2009/reported data
UA	Ukraine	E_Solvents	Emissions fron	CO	Gg	0	0	0	0	0	0	0	0	
UA	Ukraine	E_Solvents	Emissions fron	NH3	Gg									sector distribution like 2009/reported data/sector distribution like 2009
UA	Ukraine	E_Solvents	Emissions fron	NMVOC	Gg									EDAGR data/extrapolated EDGAR data
UA	Ukraine	E_Solvents	Emissions fron	NOx	Gg	0	0	0	0	0	0	0	0	
UA	Ukraine	E_Solvents	Emissions fron	PM10	Gg									(extrapolated) EDGAR data
UA	Ukraine	E_Solvents	Emissions fron	PM2.5	Gg	0	0	0	0	0	0	0	0	
UA	Ukraine	E_Solvents	Emissions fron	PMcoarse	Gg									PM10-PM2.5
UA	Ukraine	E_Solvents	Emissions fron	SOx	Gg									sector distribution like 2009/reported data
UA	Ukraine	F_RoadTransport	Road transport	CO	Gg									EDAGR data/extrapolated EDGAR data
UA	Ukraine	F_RoadTransport	Road transport	NH3	Gg									sector distribution like 2009/reported data/sector distribution like 2009
UA	Ukraine	F_RoadTransport	Road transport	NMVOC	Gg									EDAGR data/extrapolated EDGAR data
UA	Ukraine	F_RoadTransport	Road transport	NOx	Gg									EDAGR data/extrapolated EDGAR data
UA	Ukraine	F_RoadTransport	Road transport	PM10	Gg									(extrapolated) EDGAR data
UA	Ukraine	F_RoadTransport	Road transport	PM2.5	Gg									(extrapolated) EDGAR data
UA	Ukraine	F_RoadTransport	Road transport	PMcoarse	Gg	0	0	0	0	0	4.44E-16	4.44E-16	4.33E-16	PM10-PM2.5
UA	Ukraine	F_RoadTransport	Road transport	SOx	Gg									sector distribution like 2009/interpolation/reported data

Figure 10 Excerpt from the 2019 gap-filling table

The gaps are filled with emissions from different sources, like reported data for previous years, EDGAR, IIASA, ENTEC, etc. The comments column contains detailed documentation of the gap-filling for each country/area, sector and pollutant.

Afterwards the gap-filled emissions are prepared in tables per pollutant, which can be imported directly to the gridding tool:

AL	2011	A_PublicPower	NOx	Gg	0.417112
AL	2011	B_Industry	NOx	Gg	3.777
AL	2011	C_OtherStationaryComb	NOx	Gg	1.155
AL	2011	D_Fugitive	NOx	Gg	0.0177
AL	2011	F_RoadTransport	NOx	Gg	17.002
AL	2011	G_Shipping	NOx	Gg	0.445
AL	2011	H_Aviation	NOx	Gg	0.087
AL	2011	I_Offroad	NOx	Gg	1.621
AL	2011	J_Waste	NOx	Gg	0.0157495
AL	2011	K_AgriLivestock	NOx	Gg	0.567961
AL	2011	L_AgriOther	NOx	Gg	0.036
AL	2011	NATIONAL_TOTAL	NOx	Gg	25.1415225
AM	2011	A_PublicPower	NOx	Gg	2.07074
AM	2011	B_Industry	NOx	Gg	3.12497
AM	2011	C_OtherStationaryComb	NOx	Gg	1.40256
AM	2011	F_RoadTransport	NOx	Gg	10.6638
AM	2011	K_AgriLivestock	NOx	Gg	0.350769
AM	2011	L_AgriOther	NOx	Gg	1.429192
AM	2011	NATIONAL_TOTAL	NOx	Gg	19.042031

Figure 11 Part of the gap-filled list of NOx emissions for 2011

The import of gap-filled emissions from the gap-filling tables to the individual gridding tool database files can be done automatically by using a macro located in the Excel file “WriteGapFilledDataToGriddingDB.xlsm”.

3.1.2 Table „BASE_GRID_ALLOCATION“

The table “BASE_GRID_ALLOCATION” contains the gridding configuration for the specific pollutant and year.

The following fields are defined in this table:

- ISO2 (Type: Text, Field size: 3, PRIMARY KEY, INDEXED)
- area (Type: Number, Field size: Integer)
- sector (Type: Text, Field size: 25, PRIMARY KEY, INDEXED)
- pollutant (Type: Text, Field size: 10, INDEXED)
- base_grid (Type: Text, Field size: 60)
- lps (Type: Text, Field size: 50)

ISO2	a	sector	pollutant	base_grid	lps
AT	2	A_PublicPower	NOx	Reported_Grids\Rep_GRID_NOx_2015	
AT	2	B_Industry	NOx	Reported_Grids\Rep_GRID_NOx_2015	
AT	2	C_OtherStationaryComb	NOx	Reported_Grids\Rep_GRID_NOx_2015	
AT	2	D_Fugitive	NOx	EDGAR_v4.2\v42_NOx_2008_D_Fugitive	
AT	2	E_Solvents	NOx	EDGAR_v4.2\v42_NMVOC_2008_E_Solvents	
AT	2	F_RoadTransport	NOx	Reported_Grids\Rep_GRID_NOx_2015	
AT	2	G_Shipping	NOx	Reported_Grids\Rep_GRID_NOx_2015	
AT	2	H_Aviation	NOx	Reported_Grids\Rep_GRID_NOx_2015	
AT	2	I_Offroad	NOx	Reported_Grids\Rep_GRID_NOx_2015	
AT	2	J_Waste	NOx	Reported_Grids\Rep_GRID_NOx_2015	
AT	2	K_AgriLivestock	NOx	Reported_Grids\Rep_GRID_NOx_2015	
AT	2	L_AgriOther	NOx	Reported_Grids\Rep_GRID_NOx_2015	
AT	2	M_Other	NOx	EDGAR_PROXY\edgar_proxy_population_2010	
AT	2	NATIONAL_TOTAL	NOx		
ATL	32	G_Shipping	NOx	EDGAR_PROXY\edgar_proxy_Ships_2007	
ATL	32	NATIONAL_TOTAL	NOx		
AZ	69	A_PublicPower	NOx	EDGAR_v4.2\v42_NOx_2008_A_PublicPower	
AZ	69	B_Industry	NOx		Reported_LPS\Rep_LPS_NOx_2013
AZ	69	C_OtherStationaryComb	NOx	EDGAR_v4.2\v42_NOx_2008_C_OtherStationaryComb	
AZ	69	D_Fugitive	NOx	EDGAR_v4.2\v42_NOx_2008_D_Fugitive	
AZ	69	E_Solvents	NOx	EDGAR_v4.2\v42_NMVOC_2008_E_Solvents	
AZ	69	F_RoadTransport	NOx	EDGAR_v4.2\v42_NOx_2008_F_RoadTransport	
AZ	69	G_Shipping	NOx	EDGAR_PROXY\edgar_proxy_fishing_2010	Reported_LPS\Rep_LPS_NOx_2013
AZ	69	H_Aviation	NOx	EDGAR_PROXY\edgar_proxy_Takeoff_Landing_2010	
AZ	69	I_Offroad	NOx	EDGAR_PROXY\edgar_proxy_railways_rural_population	
AZ	69	J_Waste	NOx	EDGAR_PROXY\edgar_proxy_population_2010	
AZ	69	K_AgriLivestock	NOx	EDGAR_v4.2\v42_NOx_2008_K_AgriLivestock	
AZ	69	L_AgriOther	NOx	EDGAR_v4.2\v42_NOx_2008_L_AgriOther	
AZ	69	M_Other	NOx	EDGAR_PROXY\edgar_proxy_population_2010	Reported_LPS\Rep_LPS_NOx_2013
AZ	69	NATIONAL_TOTAL	NOx		
BA	50	A_PublicPower	NOx	EDGAR_v4.2\v42_NOx_2008_A_PublicPower	

Figure 12 Part of the configuration table for the NOx base grid allocation

For each country/area and GNFR sector combination the base grid and/or the LPS which is used for the spatial distribution must be defined. Within the gridding tool the pollutant is always the same, because each pollutant is gridded separately. In the figure above a part of the configuration table for NOx base grid allocation can be seen as an example. It is important, that the relative path to the base grid information – depending on where the gridding tool is located – must be used. In case of the configuration of a base grid and a LPS for a certain country/area and sector, both are weighted equally for the spatial emission distribution.

Because manual configuration of the base grid allocation is very time consuming, and also error-prone, it is now possible to do this allocation automatically, based on the available reported grid- and LPS data as well as other proxy data (see chapter 3.2 Preparation of spatial input data)

3.1.2.1 Ruleset definition of the automatized base grid allocation

With the button “Config BASE_GRID_ALLOCATION” in the grid calculation tool (see chapter 3.3 Usage and functionality of the grid calculation tool) an initial automatic configuration of the used proxy data can be performed. For each country/sector combination the tool is searching for available reported grid- and LPS data and for other available proxy data (CAMS, EDGAR, E-PRTR) and is automatically setting the best proxy information for a certain country/sector combination based on the following ruleset:

- Between a configured timeframe (min and max year) the system is always searching for the most current reported grid and LPS data for each pollutant/area/sector combination
- For CAMS, EDGAR and E-PRTR proxy data a certain year must be defined
- For each pollutant/area/sector:
    - Search for reported grid data within the configured timeframe and use it if available
        - For each country were reported grid data is available and it is configured that LPS information is not included in reported gridded emissions (e.g. GB), search for LPS data and use it in addition
        - If reported grid data is not available and the pollutant is a HM or POP, search for reported gridded PM10 data and use it if available
        - If reported grid data is not available and the pollutant is BC, search for reported gridded PM2.5 data and use it if available
    - If reported grid data is not available
        - If the pollutant is a HM or POP, search for PM10 proxy data in the following steps
        - If the pollutant is BC, search for PM2.5 proxy data in the following steps
        - If sector is G_Shipping, search for proxy data derived from FMI shipping emissions and use it if available
        - Otherwise search for proxy data derived from CAMS and use it if available
            - If the pollutant is not NMVOC, the sector is E_Solvents and reported grid data as well as proxy data derived from CAMS is not available, search for NMVOC proxy data derived from CAMS for E_Solvents and use it if available
            - If the pollutant is not CO, the sector is D_Fugitive and reported grid data as well as proxy data derived from CAMS is not available, search for CO proxy data derived from CAMS for D_Fugitive and use it if available
            - If the sector is K_AgriLivestock and reported grid data as well as proxy data derived from CAMS is not available, search for proxy data derived from CAMS for L_AgriOther and use it if available
        - Otherwise search for proxy data derived from EDGAR and use it if available
            - If the pollutant is not NMVOC, the sector is E_Solvents and reported grid data as well as proxy data derived from EDGAR is not available, search for NMVOC proxy data derived from EDGAR for E_Solvents and use it if available
            - If the pollutant is not CO, the sector is D_Fugitive and reported grid data as well as proxy data derived from EDGAR is not available, search for CO proxy data derived from EDGAR for D_Fugitive and use it if available
            - If the sector is K_AgriLivestock and reported grid data as well as proxy data derived from EDGAR is not available, search for proxy data derived from EDGAR for L_AgriOther and use it if available
    - Search for reported LPS data
        - If reported LPS data is available and the sector is A_PublicPower or B_Industry and proxy data derived from EDGAR is used, replace it with reported LPS data
        - If reported LPS data is available and the sector is not A_PublicPower or B_Industry and proxy data derived from EDGAR is used, use reported LPS data in addition

- If reported LPS data is not available search for LPS data from E-PRTR
  - If LPS data from E-PRTR is available and proxy data derived from EDGAR is used, use LPS data from E-PRTR in addition

This ruleset can be adjusted any time if new proxy data from other sources is included or if there are new insights, which makes changes necessary or usefull.

3.1.3 Result tables for individual GNFR sectors and „National_Total“

The rest of the tables (13 GNFR sector tables and a national totals table) are for the output data of the gridding process. After the gridding is done, these tables are filled with the spatial grids of the individual GNFR sectors and the national total.

The following fields are defined in this table:

- ISO2 (Type: Text, Field size: 3)
- area (Type: Number, Field size: Integer, PRIMARY KEY)
- emission_year (Type: Number, Field size: Integer)
- sector (Type: Text, Field size: 25)
- pollutant (Type: Text, Field size: 10)
- x (Type: Number, Field size: Double, PRIMARY KEY, INDEXED)
- y (Type: Number, Field size: Double, PRIMARY KEY, INDEXED)
- unit (Type: Text, Field size: 2)
- emission (Type: Number, Field size: Double)
- cellId (Type: Text, Field size: Text, INDEXED)

ISO2	area	emission_year	sector	pollutant	x	y	unit	emission	cellId
AL	1	2015	A_PublicPower	NOx	1945	4045	Mg	2,45691774752631E-02	x1945y4045
AL	1	2015	A_PublicPower	NOx	1955	4075	Mg	62,7606390639872	x1955y4075
AL	1	2015	A_PublicPower	NOx	1985	4135	Mg	24,7659673642986	x1985y4135
AL	1	2015	A_PublicPower	NOx	1995	4095	Mg	43,2426276975718	x1995y4095
AL	1	2015	A_PublicPower	NOx	1995	4105	Mg	5,59433727978461E-02	x1995y4105
AL	1	2015	A_PublicPower	NOx	2005	4115	Mg	36,8705756619347	x2005y4115
AL	1	2015	A_PublicPower	NOx	2075	4065	Mg	36,8705756619347	x2075y4065
AT	2	2015	A_PublicPower	NOx	955	4725	Mg	0,862138068688078	x955y4725
AT	2	2015	A_PublicPower	NOx	955	4735	Mg	0,726581678999663	x955y4735
AT	2	2015	A_PublicPower	NOx	965	4715	Mg	0,420456432352031	x965y4715
AT	2	2015	A_PublicPower	NOx	965	4725	Mg	2,29408151467724	x965y4725
AT	2	2015	A_PublicPower	NOx	965	4735	Mg	3,78346693680015	x965y4735
AT	2	2015	A_PublicPower	NOx	965	4745	Mg	0,802014317349462	x965y4745
AT	2	2015	A_PublicPower	NOx	965	4755	Mg	0,420416794563577	x965y4755
AT	2	2015	A_PublicPower	NOx	975	4705	Mg	1,70146979259929E-02	x975y4705
AT	2	2015	A_PublicPower	NOx	975	4715	Mg	19,0429077451404	x975y4715
AT	2	2015	A_PublicPower	NOx	975	4725	Mg	19,005830704276	x975y4725
AT	2	2015	A_PublicPower	NOx	975	4735	Mg	2,14815342819785	x975y4735
AT	2	2015	A_PublicPower	NOx	975	4745	Mg	85,060433790902	x975y4745
AT	2	2015	A_PublicPower	NOx	975	4755	Mg	86,898044102285	x975y4755
AT	2	2015	A_PublicPower	NOx	985	4705	Mg	3,71389001830172	x985y4705
AT	2	2015	A_PublicPower	NOx	985	4715	Mg	15,5860950801003	x985y4715
AT	2	2015	A_PublicPower	NOx	985	4725	Mg	0,473660657295925	x985y4725
AT	2	2015	A_PublicPower	NOx	985	4735	Mg	3,80136986810746	x985y4735
AT	2	2015	A_PublicPower	NOx	985	4745	Mg	11,3774987035528	x985y4745
AT	2	2015	A_PublicPower	NOx	985	4755	Mg	2,1072998201728	x985y4755
AT	2	2015	A_PublicPower	NOx	995	4705	Mg	3,69687532037573	x995y4705
AT	2	2015	A_PublicPower	NOx	995	4715	Mg	16,9466465867081	x995y4715
AT	2	2015	A_PublicPower	NOx	995	4725	Mg	0,133980772824203	x995y4725
AT	2	2015	A_PublicPower	NOx	995	4735	Mg	2,17080848178975	x995y4735
AT	2	2015	A_PublicPower	NOx	995	4745	Mg	11,5282075667832	x995y4745

Figure 13 Part of the calculated grid for 2015, NOx, A_PublicPower

The column “cellId” contains an identifier which is unique for each grid cell, independent from the country/area. This is important for the visualisation of the gridding results (see chapter 5.1 Visualizing the results of the gridding tool in ESRI ArcGIS).

3.2 Preparation of spatial input data

3.2.1 Reported grid data

If available, reported grids are used for the spatial distribution of emissions among a country/area (see chapter 3.1.2.1 Ruleset definition of the automatized base grid allocation).

To be able to use the submitted grids in the new gridding system, data must be transferred from the reporting templates to Access database files the gridding system is using. This can be done automatically via an Excel-Macro („WriteRepGridToDB.xlsm“), which has to be applied to the reported Excel files containing the reported grid data.

During this transfer, border checks are carried out, to ensure that all reported grid cells are within the country borders, and the database files are either updated (if grid data already exists for a certain pollutant and year) or created (if there is no file jet for the certain pollutant and year):

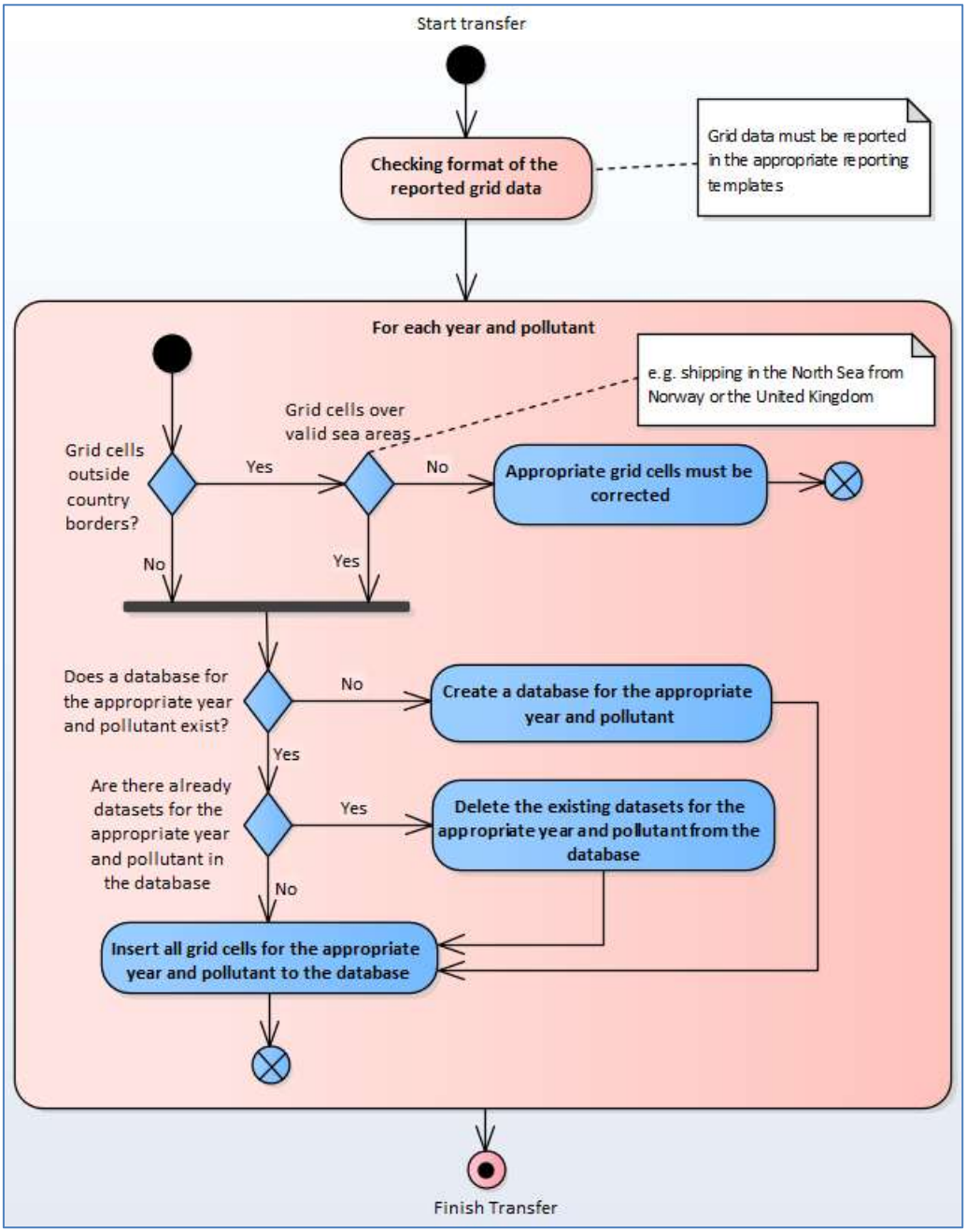


Figure 14 Database import of reported grid data

Each pollutant and year specific database contains a table with the name „REPORTED“. This table contains the following fields:

- ISO2 (Type: Text, Field size: 3, INDEXED)
- year (Type: Number, Field size: Integer)
- x (Type: Number, Field size: Double, INDEXED)
- y (Type: Number, Field size: Double, INDEXED)
- sector (Type: Text, Field size: 25, INDEXED)
- Pollutant (Type: Text, Field size: 10)
- unit (Type: Text, Field size: 2)
- emission (Type: Number, Field size: Double)

ISO2	year	x	y	sector	Pollutant	unit	emission
PT	2015	-2885	3855	B_Industry	NOx	Mg	0,1875200143
PT	2015	-2885	3865	B_Industry	NOx	Mg	0,0782771548
PT	2015	-2885	3855	C_OtherStationaryComb	NOx	Mg	0,6323051118
PT	2015	-2885	3865	C_OtherStationaryComb	NOx	Mg	0,2639453996
PT	2015	-2885	3855	F_RoadTransport	NOx	Mg	3,3590233524
PT	2015	-2885	3865	F_RoadTransport	NOx	Mg	1,4021692129
PT	2015	-2885	3855	I_Offroad	NOx	Mg	3,3808138588
PT	2015	-2885	3865	I_Offroad	NOx	Mg	1,4112653025
PT	2015	-2885	3855	J_Waste	NOx	Mg	0,0001131045
PT	2015	-2885	3865	J_Waste	NOx	Mg	4,721361E-05
PT	2015	-2885	3855	K_AgriLivestock	NOx	Mg	0,1600547974
PT	2015	-2885	3865	K_AgriLivestock	NOx	Mg	0,0668122504
PT	2015	-2885	3855	L_AgriOther	NOx	Mg	0,1714327275
PT	2015	-2885	3865	L_AgriOther	NOx	Mg	0,0715617807
PT	2015	-2875	3855	B_Industry	NOx	Mg	2,1249626299
PT	2015	-2875	3865	B_Industry	NOx	Mg	0,8221031525
PT	2015	-2875	3855	C_OtherStationaryComb	NOx	Mg	7,1652337384
PT	2015	-2875	3865	C_OtherStationaryComb	NOx	Mg	2,7720775706
PT	2015	-2875	3855	F_RoadTransport	NOx	Mg	38,06419876
PT	2015	-2875	3865	F_RoadTransport	NOx	Mg	14,726234409
PT	2015	-2875	3855	H_Aviation	NOx	Mg	55,651152134
PT	2015	-2875	3855	I_Offroad	NOx	Mg	54,715340794
PT	2015	-2875	3865	I_Offroad	NOx	Mg	14,821765779
PT	2015	-2875	3855	J_Waste	NOx	Mg	0,0012816913

Figure 15 Part of reported NOx grid data transferred to database

During the transformation, the decimal point character of the x and y coordinates is removed (e.g. the coordinate “-28.85” is converted to “-2885” and “38.65” is converted to “3865”), because the gridding system is using coordinates in this format.

3.2.2 Reported LPS data

In some cases also reported LPS data is used for the spatial distribution of emissions among a country/area (see chapter 3.1.2.1 Ruleset definition of the automatized base grid allocation).

To be able to use the submitted LPS data in the new gridding system, data must be transferred from the reporting templates to Access database files the gridding system is using. This can be done automatically via an Excel-Macro („WriteRepLPSToDB.xlsm“), which has to be applied to the reported Excel files containing the reported LPS data.

During this transfer, border checks are carried out, to ensure that all reported large point sources are located within the country borders, and the database files are either updated – if LPS data already exists for a certain pollutant and year - or created – if there is no file jet for the certain pollutant and year:

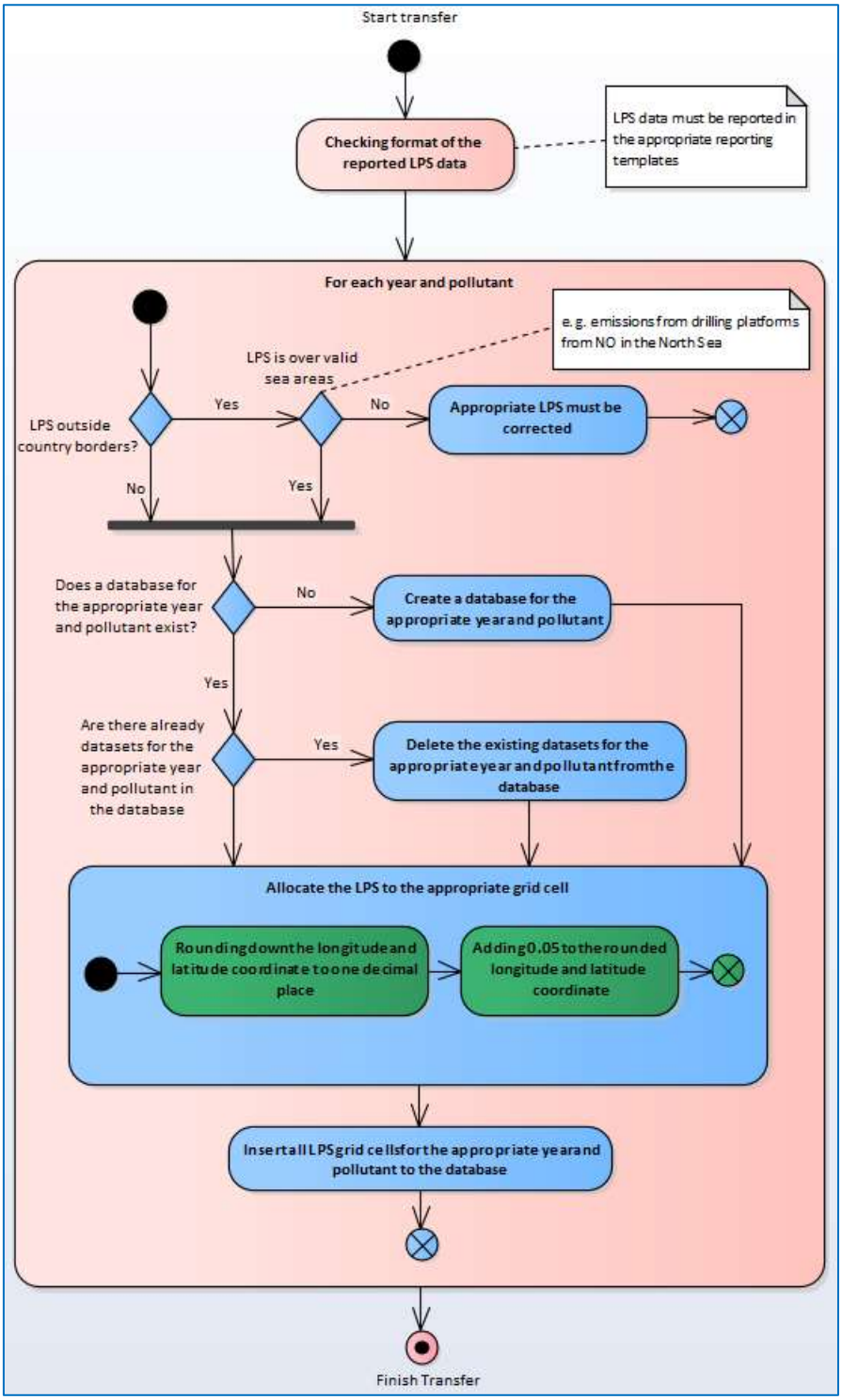


Figure 16 Database import of reported LPS data

Each pollutant and year specific database contains a table with the name „REPORTED“. This table contains the following fields:

- ISO2 (Type: Text, Field size: 3, INDEXED)
- year (Type: Number, Field size: Integer)
- lps (Type: Text, Field size: 255)
- sector (Type: Text, Field size: 25, INDEXED)
- heightclass (Type: Number, Field size: Integer)

- x (Type: Number, Field size: Double, INDEXED)
- y (Type: Number, Field size: Double, INDEXED)
- Pollutant (Type: Text, Field size: 10)
- unit (Type: Text, Field size: 2)
- emission (Type: Number, Field size: Double)

ISO2	year	x	y	sector	Poll	unit	emission
PL	2015	1445	5325	A_PublicPower	NOx	Gg	4,331503
PL	2015	1455	5335	A_PublicPower	NOx	Gg	1,465899
PL	2015	1455	5345	A_PublicPower	NOx	Gg	0,596647
PL	2015	1495	5095	A_PublicPower	NOx	Gg	7,151917
PL	2015	1525	5275	A_PublicPower	NOx	Gg	0,555085925
PL	2015	1545	5195	A_PublicPower	NOx	Gg	0,4676348
PL	2015	1575	5085	A_PublicPower	NOx	Gg	0,07218195
PL	2015	1605	5145	A_PublicPower	NOx	Gg	0,050823
PL	2015	1615	5115	A_PublicPower	NOx	Gg	0,005653
PL	2015	1615	5145	A_PublicPower	NOx	Gg	0,11822
PL	2015	1635	5085	A_PublicPower	NOx	Gg	0,0058418
PL	2015	1695	5245	A_PublicPower	NOx	Gg	2,086363791
PL	2015	1705	5115	A_PublicPower	NOx	Gg	1,5646478
PL	2015	1705	5205	A_PublicPower	NOx	Gg	0,0345428197
PL	2015	1715	5105	A_PublicPower	NOx	Gg	0,6968584
PL	2015	1785	5075	A_PublicPower	NOx	Gg	5,7759349
PL	2015	1795	5065	A_PublicPower	NOx	Gg	0,23629618
PL	2015	1795	5315	A_PublicPower	NOx	Gg	0,045263
PL	2015	1805	5305	A_PublicPower	NOx	Gg	1,80691
PL	2015	1815	5175	A_PublicPower	NOx	Gg	0,056913
PL	2015	1825	5235	A_PublicPower	NOx	Gg	8,374851
PL	2015	1825	5225	A_PublicPower	NOx	Gg	1,381853
PL	2015	1825	5035	A_PublicPower	NOx	Gg	0,5553943
PL	2015	1845	5445	A_PublicPower	NOx	Gg	0,0015624
PL	2015	1845	5455	A_PublicPower	NOx	Gg	1,115219
PL	2015	1845	5005	A_PublicPower	NOx	Gg	0,13841559
PL	2015	1855	5435	A_PublicPower	NOx	Gg	0,0157281
PL	2015	1855	5005	A_PublicPower	NOx	Gg	0,02005177
PL	2015	1855	5015	A_PublicPower	NOx	Gg	9,9937358
PL	2015	1855	5205	A_PublicPower	NOx	Gg	7,471183

Figure 17 Part of reported NOx LPS data transferred to database

During the transformation, longitude and latitude coordinates are rounded down to one decimal place and afterwards increased by 0.05. This represents the centre of the grid cell where the LPS is located. In addition the decimal point character is removed for the database entry (e.g. the coordinate “2.905” is converted to “295” and “54.72457” is converted to “5475”), because the gridding system is using coordinates in this format.

3.2.3 Proxy base grids derived from CAMS and EDGAR

To be able to distribute country/area emissions in areas where no reported gridded emission exists, the spatial information for the distribution has to be derived from other sources and converted to so called base grids.

Currently these gaps are filled with emission distribution maps from CAMS-81[1] as well as proxy data and emission distribution maps from the EDGAR project[2], which CEIP is allowed to use on the basis of a collabo-

[1] Copernicus Atmosphere Monitoring Service - Global and regional emissions (https://atmosphere.copernicus.eu/cams81-global-and-regional-emissions)

ration with JRC. With time and further development of the gridding methodology, this base grids may be replaced for certain areas and sectors with base grids derived from other sources. The gridding system is flexible enough to define the used base grid for each country/area, sector and pollutant.

3.2.3.1 Emission distribution maps from CAMS

To derive the base grid from CAMS-81 spatial distribution maps and convert it to the format where it can be used by the new gridding system, an Access tool has been developed, which can be found in the folder "Templates_and_Tools":

- "CalculateBaseGridFromCAMSGrid.accdb"

For each base grid year which should be derived from CAMS spatial distribution maps, the appropriate Access file must be copied from „Template_and_Tools" and renamed.

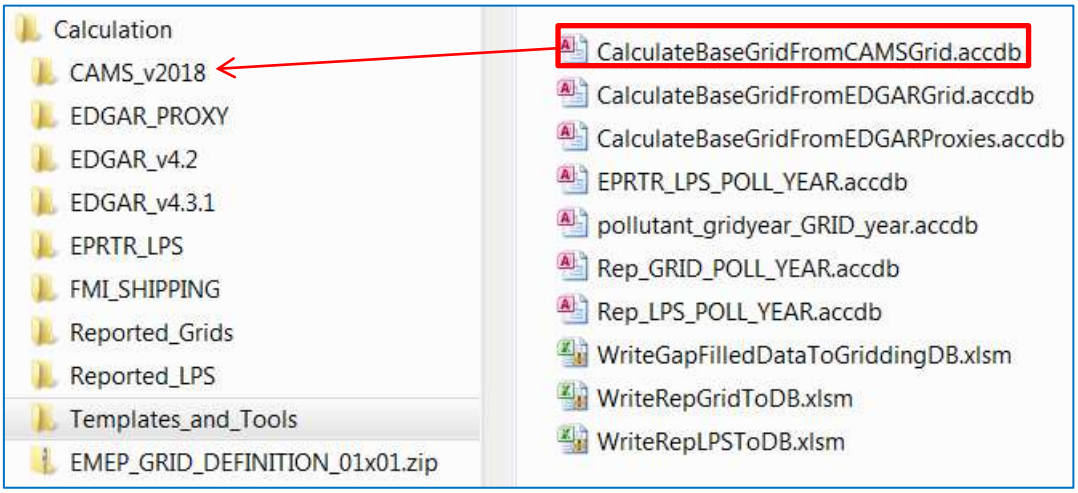


Figure 18 Derivation of base grids from CAMS data

The tool consist of a table where original data from CAMS, which is available as ASCII/CSV files, can be imported. It also contains tables for the output of the converted base grid.

[2] The Emissions Database for Global Atmospheric Research (https://edgar.jrc.ec.europa.eu)

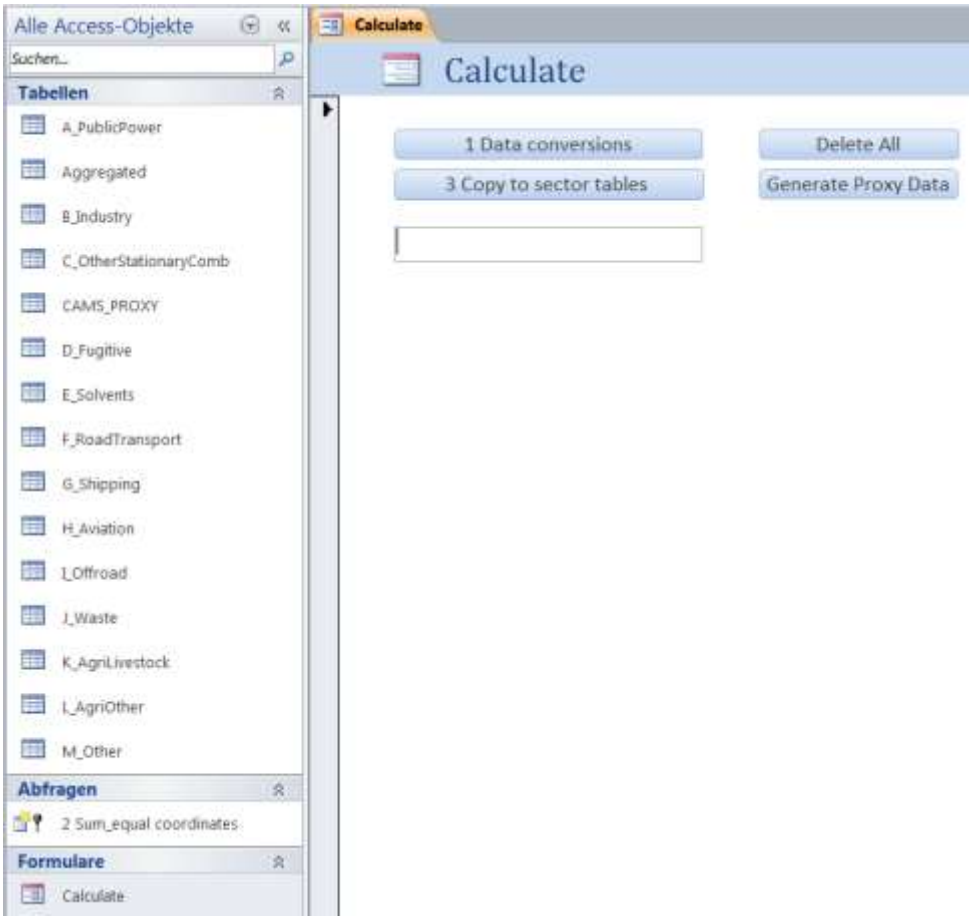


Figure 19 Tool for the preparation of base grids from CAMS proxy data

The figure above shows the MS-Access tool, with the table “CAMS_PROXY” for the original CAMS proxy data. After the proxy table is filled with the proxy data from CAMS, the button “1 Data conversions” starts the conversion process:

- Coordinates must be converted from 0.05° x 0.05° (long/lat) to 0.1° x 0.1° (long/lat).
- The sector “road transport”, which is divided in 4 subsectors in CAMS (F1/F2/F3/F4) must be aggregated to one sector “F_RoadTransport”.
- Country and area codes must be converted from “alpha-3 code” to “alpha-2 code”
- Some country codes in CAMS must be allocated to an overall area to which the country is assigned in EMEP

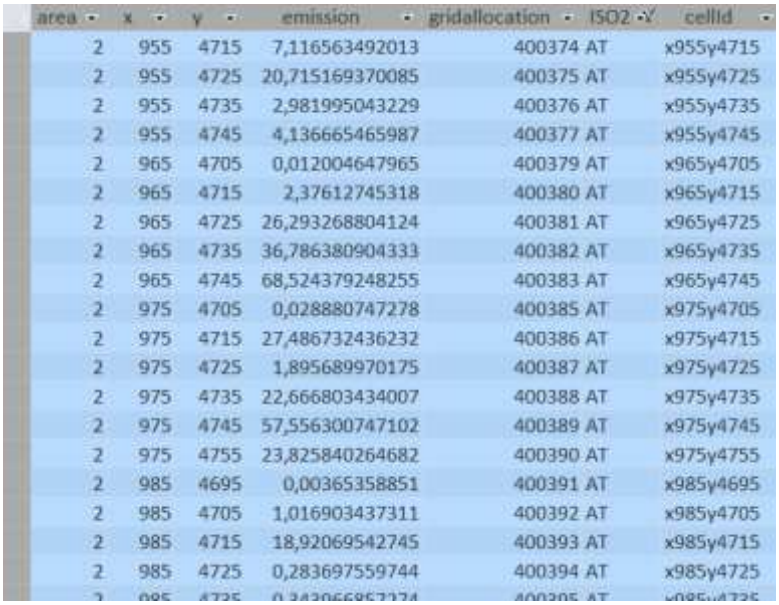
In addition also the query “2 Sum_equal_coordinates” must be executed, to sum up equal coordinates which arose in the previous conversion process.

Because the converted data includes gridded emissions from all pollutants (NOx, NMVOC, SOx, NH3, PM2.5, PM10, CO) at this stage a copy of the Access file for each pollutant must be created.

The following steps must be performed in each of this Access pollutant files:

With the button “3 Copy to sector tables” grid data of the selected pollutant will be copied to the individual sector tables “A_PublicPower”, “B_Industry”, “C_OtherStationaryComb”, “D_Fugitive”, “E_Solvents”, “F_RoadTransport”, “G_Shipping”, “H_Aviation”, “I_Offroad”, “J_Waste”, “K_AgriLivestock”, “L_AgriOther” and “M_Other”.

After this the proxy grids can be exported with the button “Generate Proxy Data”. This will generate a proxy data file for each sector of the pollutant, which can be used directly within the gridding system.



area	x	y	emission	gridallocation	ISO2	cellId
2	955	4715	7,116563492013	400374	AT	x955y4715
2	955	4725	20,715169370085	400375	AT	x955y4725
2	955	4735	2,981995043229	400376	AT	x955y4735
2	955	4745	4,136665465987	400377	AT	x955y4745
2	965	4705	0,012004647965	400379	AT	x965y4705
2	965	4715	2,37612745318	400380	AT	x965y4715
2	965	4725	26,293268804124	400381	AT	x965y4725
2	965	4735	36,786380904333	400382	AT	x965y4735
2	965	4745	68,524379248255	400383	AT	x965y4745
2	975	4705	0,028880747278	400385	AT	x975y4705
2	975	4715	27,486732436232	400386	AT	x975y4715
2	975	4725	1,895689970175	400387	AT	x975y4725
2	975	4735	22,666803434007	400388	AT	x975y4735
2	975	4745	57,556300747102	400389	AT	x975y4745
2	975	4755	23,825840264682	400390	AT	x975y4755
2	985	4695	0,00365358851	400391	AT	x985y4695
2	985	4705	1,016903437311	400392	AT	x985y4705
2	985	4715	18,92069542745	400393	AT	x985y4715
2	985	4725	0,283697559744	400394	AT	x985y4725

Figure 20 Part of CAMS 2010 offroad proxy data for NOx transferred to database

The original data file with the MS-Access tools can be deleted after proxy data generation.

The following steps are showing the procedure to convert 2010 CAMS data for NOx from 2018 to a base grid for the gridding system as an example:

1. Copy the file “CalculateBaseGridFromCAMSGrid.accdb” from the folder “Templates_and_Tools” to the folder “CAMS_v2018”
2. Rename the file to e.g. “CAMS_v2018_2010.accdb”
3. In the new file import CAMS proxy data from the ASCII/CSV text file to the table “CAMS_PROXY”
4. Start the conversion with the button “1 Data conversions”
5. Start the query “2 Sum_equal_coordinates” to sum up equal coordinates
6. Copy the file “CAMS_v2018_2010.accdb” to a new file “CAMS_v2018_NOx_2010.accdb”
7. In the new file start the split to sector data with the button “3 Copy to sector tables”
8. Generate proxy files for each sector with the button “Generate Proxy Data”
9. Delete the file “CAMS_v2018_NOx_2010.accdb”

After the generation of proxy files for all pollutants, also the file “CAMS_v2018_2010.accdb” can be deleted

3.2.3.2 Proxy data and emission distribution maps from EDGAR

To derive the base grid from EDGAR proxy data and EDGAR spatial distribution maps and convert it to the format where it can be used by the new gridding system, two Access tools were developed, which can be found in the folder “Templates_and_Tools”:

- “CalculateBaseGridFromEDGARProxies.accdb” and
- “CalculateBaseGridFromEDGARGrid.accdb”

For each base grid which should be derived from EDGAR proxy data or EDGAR spatial distribution maps, the appropriate Access file must be copied from „Template_and_Tools“ and renamed.

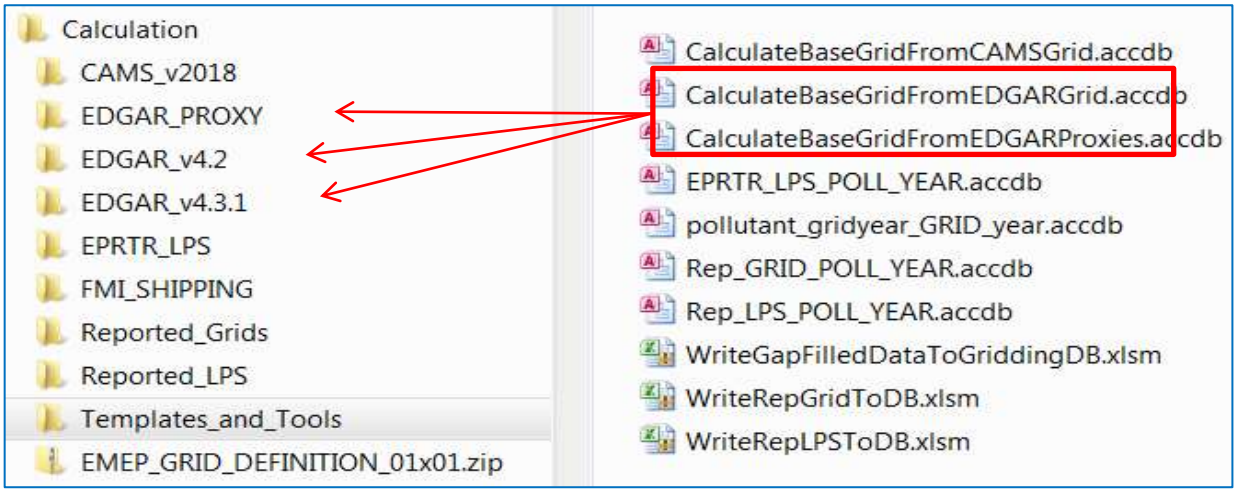


Figure 21 Derivation of base grids from EDGAR data

Both tools consist of tables where original data from EDGAR, which is available as ASCII/CSV files, can be imported. It also contains the EMEP grid definition and a table for the output of the converted base grid.

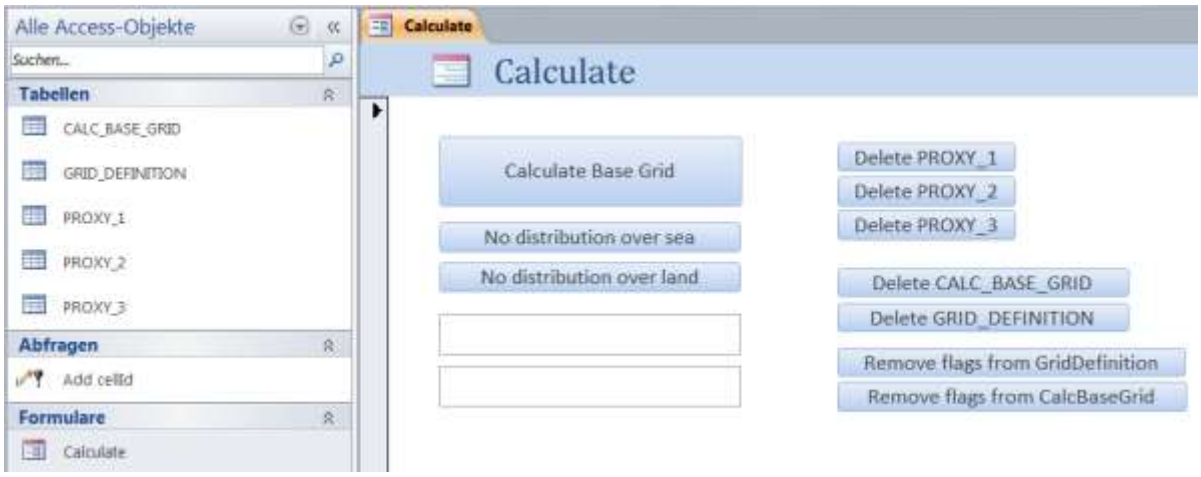


Figure 22 Tool for the preparation of base grids from EDGAR proxy data

The figure above shows the MS-Access tool, with the tables “PROXY_1”, “PROXY_2” and “PROXY_3” for the original EDGAR proxy data. This means that up to three proxy maps can be combined to calculate a certain base grid. The table “GRID_DEFINITION” contains the EMEP grid definition and “CALC_BASE_GRID” is the table for the converted base grid.

After at least one proxy table is filled with proxy data from EDGAR, the button “Calculate Base Grid” starts the conversion process, where only proxy cells which are set in “GRID_DEFINITION” are taken from the proxy tables, allocated to the appropriate country/area and weighted regarding the fraction value in the grid definition. If more than one proxy table is filled, the sum of the individual proxy data is used for the base grid weighting. Because EDGAR proxy data uses the lower left corner of a grid cell to determine a certain cell, and the CEIP system uses the centre of a grid cell, the coordinates are automatically converted for the calculation.

Cells on borders between country/area and sea are a special case, because the proxy value is distributed also in this case regarding the fraction and therefore a part is allocated to the sea and another part to the country/area. But if the proxy information is only for distribution over land areas the allocation to the sea cell

is not right. The function “No distribution over sea” takes care of this and redistributes the proxy value allocated to the sea cell to the same cell which is allocated to the adjacent land area. Of course sometimes it might also be necessary to redistribute land fractions to the sea cell, if the base grid is calculated for the distribution of emissions over sea areas. This can be done with the button “No distribution over land”.

After the proxy base grid is calculated, it can be used from the gridding system directly, without exporting the data from “CALC_BASE_GRID”. This means the Access tool for converting EDGAR proxy data to base grid information transforms to a database with base grid information for the gridding system.

area	x	y	emission	gridallocation	ISO2	cellid
30	925	5695	5,58627992	476038	BAS	x925y5695
30	965	5555	2,02030136	476065	BAS	x965y5555
30	975	5495	6,01599264	476072	BAS	x975y5495
30	975	5515	15,10884	476074	BAS	x975y5515
30	975	5525	11,1805416	476075	BAS	x975y5525
30	975	5555	4,93555244	476078	BAS	x975y5555
30	985	5505	4,58301298	476086	BAS	x985y5505
30	985	5535	12,8928768	476089	BAS	x985y5535
30	985	5565	10,6769136	476092	BAS	x985y5565
30	985	5705	0,38151573	476095	BAS	x985y5705
30	995	5505	4,73410226	476101	BAS	x995y5505
30	995	5515	10,87695	476102	BAS	x995y5515
30	995	5575	10,1732856	476106	BAS	x995y5575
30	1005	5465	4,48228742	476112	BAS	x1005y5465
30	1005	5495	19,137864	476115	BAS	x1005y5495
30	1005	5505	15,864282	476116	BAS	x1005y5505
30	1005	5515	6,0435336	476117	BAS	x1005y5515
30	1005	5565	5,036278	476119	BAS	x1005y5565

Figure 23 Part of EDGAR shipping proxy data transferred to database

Because other tables, except the “CALC_BASE_GRID” table, are not used anymore after the calculation process, their content can be easily deleted with the buttons “Delete PROXY_1”, “Delete PROXY_2”, “Delete PROXY_3” and “Delete GRID_DEFINITION”. With “Delete CALC_BASE_GRID” the base grid table can be deleted if the base grid calculation should be repeated. In this case also the set flags from the table “GRID_DEFINITION” should be deleted with the button “Remove flags from GridDefinition”. This is necessary, because, after the base grid for a certain grid cell was calculated, a flag is set for this grid cell in the table “GRID_DEFINITION” to be able to stop the calculation and afterwards continue it only for the cells which were not considered so far. So if the whole base grid should be calculated again, this flags must be removed first.

Also the function to redistribute sea grid cells to land or land grid cells to sea sets a flag to each dataset in “CALC_BASE_GRID” which was considered for redistribution so far, to be able to start over if the redistribution process is interrupted. If this redistribution should be started from the beginning the flags have to be removed first with “Remove flags from CalcBaseGrid”.

The following steps are showing the procedure to convert EDGAR proxy data for population density to a base grid for the gridding system as an example:

1. Copy the file “CalculateBaseGridFromEDGARProxies.accdb” from the folder “Templates_and_Tools” to the folder “EDGAR_PROXY”
2. Rename the file to e.g. “edgar_proxy_population_2010.accdb”
3. Import EDGAR proxy data from the ASCII text file to the table “PROXY_1”
4. Start the conversion with the button “Calculate Base Grid”
5. Redistribute proxy values over sea to land with the button “No distribution over sea”
6. Delete the proxy table with the button “Delete PROXY_1”

7. Delete the grid definition table with the button “Delete GRID_DEFINITION”
8. Compress the database with the Access function “Compress and repair”

3.2.4 Other LPS derived from E-PRTR

To use large point sources from E-PRTR data has to be extracted from the E-PRTR database. The LPS datasets from E-PRTR must be converted to the same structure as reported LPS.

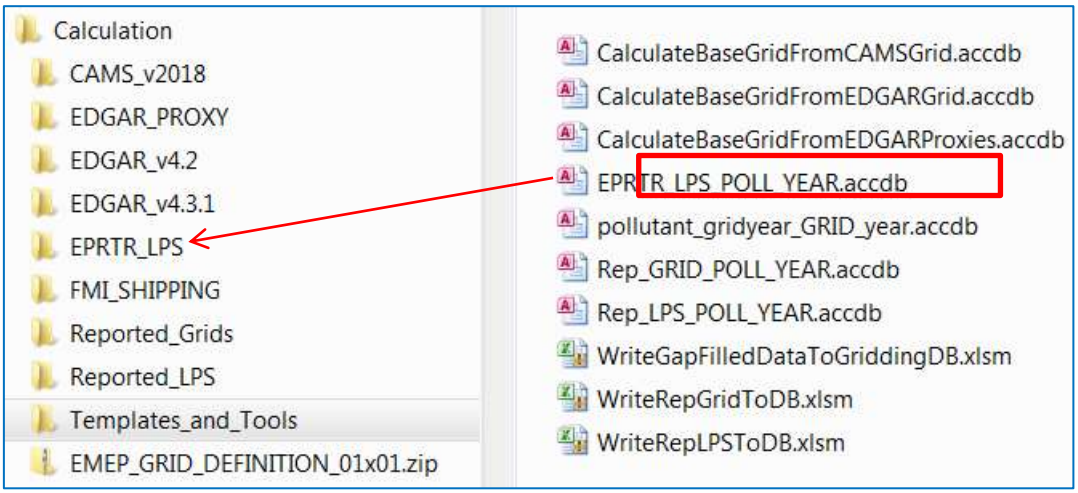


Figure 24 Preparation of LPS derived from E-PRTR as input data

To transfer E-PRTR LPS to the Access database the Access template “EPRTR_LPS_POLL_YEAR.accdb” from the folder “Templates_and_Tools” can be used. In a copy of this file “POLL” needs to be replaced with the corresponding pollutant abbreviation (e.g. “NOx”) and “YEAR” with the emission year of the E-PRTR LPS. E.g. if E-PRTR NOx LPS emissions from the year 2012 should be transferred, the file name must be renamed to “EPRTR_LPS_NOx_2012.accdb”. The Access file contains one table with the name “EPRTR”. This table contains the following fields:

- ISO2 (Type: Text, Field size: 3, INDEXED)
- year (Type: Number, Field size: Integer)
- lps (Type: Text, Field size: 255)
- sector (Type: Text, Field size: 25, INDEXED)
- heightclass (Type: Number, Field size: Integer)
- x (Type: Number, Field size: Double, INDEXED)
- y (Type: Number, Field size: Double, INDEXED)
- Pollutant (Type: Text, Field size: 10)
- unit (Type: Text, Field size: 2)
- emission (Type: Number, Field size: Double)

ISO2	year	lps	sector	heightclass	x	y	pollutant	unit	emission
AT	2012	Norske Skog Bruck GmbH	A_PublicPower	0	1525	4745	NOx	Gg	0,287
AT	2012	Energie AG Oberösterreich Kraftwerke GmbH	A_PublicPower	0	1285	4805	NOx	Gg	0,163
AT	2012	Energie AG Oberösterreich Kraftwerke GmbH	A_PublicPower	0	1355	4805	NOx	Gg	0,215
AT	2012	Gas Connect Austria GmbH	A_PublicPower	0	1685	4835	NOx	Gg	0,224
AT	2012	Gas Connect Austria GmbH	A_PublicPower	0	1605	4705	NOx	Gg	0,141
AT	2012	Linz Strom GmbH	A_PublicPower	0	1435	4825	NOx	Gg	0,195
AT	2012	VERBUND Thermal Power GmbH & Co KG	A_PublicPower	0	1545	4695	NOx	Gg	0,735
AT	2012	WIEN ENERGIE GmbH	A_PublicPower	0	1645	4815	NOx	Gg	0,174
AT	2012	WIEN ENERGIE GmbH	A_PublicPower	0	1645	4815	NOx	Gg	0,377
AT	2012	OMV Refining and Marketing GmbH	A_PublicPower	0	1645	4815	NOx	Gg	0,935
BE	2012	ARCELORMITTAL LIEGE sa - Centrale d'énergies	A_PublicPower	0	555	5065	NOx	Gg	0,23
BE	2012	INDUSTRIE DU BOIS VIELSALM & CIE - IBV	A_PublicPower	0	595	5025	NOx	Gg	0,258
BE	2012	SPANOLUX	A_PublicPower	0	595	5025	NOx	Gg	0,182
BE	2012	ELECTRABEL - COGENERATION SOLVAY	A_PublicPower	0	465	5045	NOx	Gg	0,352
BE	2012	ELECTRABEL - CENTRALE BAUDOUR/St GHISLA	A_PublicPower	0	385	5045	NOx	Gg	0,104
BE	2012	ELECTRABEL - CENTRALE DES AWIRS	A_PublicPower	0	545	5055	NOx	Gg	0,295
BE	2012	ELECTRABEL - CENTRALE D'AMERCOEUR	A_PublicPower	0	435	5045	NOx	Gg	0,401
BE	2012	RENOGEN SA	A_PublicPower	0	605	5035	NOx	Gg	0,123
BE	2012	MARCINELLE ENERGIE S.A.	A_PublicPower	0	445	5045	NOx	Gg	0,115
BE	2012	ELECTRAWINDS BIOSTOOM	A_PublicPower	0	295	5125	NOx	Gg	0,105
BE	2012	ESSO RAFFINADERIJ	A_PublicPower	0	435	5125	NOx	Gg	1,09
BE	2012	E.ON GENERATION BELGIUM	A_PublicPower	0	445	5095	NOx	Gg	0,246
BE	2012	ELECTRABEL SITE LANXESS RUBBER	A_PublicPower	0	435	5125	NOx	Gg	0,111
BE	2012	ZANDVLIET POWER - TERREIN BASF	A_PublicPower	0	425	5135	NOx	Gg	0,24
BE	2012	ELECTRABEL CENTRALE HERDERSBRUG	A_PublicPower	0	325	5125	NOx	Gg	0,284
BE	2012	ELECTRABEL - CENTRALE DROGENBOS	A_PublicPower	0	425	5085	NOx	Gg	0,496
BE	2012	ELECTRABEL WKK LANXESS (BAYER)	A_PublicPower	0	425	5135	NOx	Gg	0,15
BE	2012	ESSENT ENERGIE BELGIE	A_PublicPower	0	435	5125	NOx	Gg	0,243
BE	2012	E.ON GENERATION BELGIUM	A_PublicPower	0	545	5095	NOx	Gg	1,31
BE	2012	ELECTRABEL CENTRALE RODENHUIZE	A_PublicPower	0	375	5115	NOx	Gg	0,456
BE	2012	EDF LUMINUS	A_PublicPower	0	375	5115	NOx	Gg	0,223
BE	2012	TOTAL RAFFINADERIJ ANTWERPEN	A_PublicPower	0	435	5125	NOx	Gg	3,32
BE	2012	Electrabel Centrale Knippegroen	A_PublicPower	0	385	5115	NOx	Gg	0,406

Figure 25 Part of the E-PRTR NOx LPS for 2012 transferred to database

For the extraction from E-PRTR LPS data from the E-PRTR database the following SQL-Statements can be used (the string “YEAR” in the statements below have to be replaced by the emission year, e.g. 2012, and the string “POLLUTANT” have to be replaced by the corresponding pollutant for which LPS data should be extracted, e.g. CO):

SELECT FACILITYREPORT.CountryCode AS ISO2, '**YEAR**' AS [year], FACILITYREPORT.FacilityName AS lps, "A_PublicPower" AS sector, 0 AS heightclass, ((Int([Long]*10)/10)+0.05)*100 AS x, ((Int([Lat]*10)/10)+0.05)*100 AS y, Long AS Longitude, Lat AS Latitude, POLLUTANTRELEASE.PollutantCode AS pollutant, "Gg" AS unit, [TotalQuantity]/1000000 AS emission INTO **POLLUTANT**_EPRTR_SECTOR_1_GNFR_A FROM (FACILITYREPORT INNER JOIN POLLUTANTRELEASE ON FACILITYREPORT.[FACILITYREPORTID] = POLLUTANTRELEASE.[FACILITYREPORTID]) INNER JOIN POLLUTANTRELEASEANDTRANSFERREPORT ON FACILITYREPORT.[PollutantReleaseAndTransferReportID] = POLLUTANTRELEASEANDTRANSFERREPORT.[PollutantReleaseAndTransferReportID] WHERE (((POLLUTANTRELEASE.PollutantCode)='**POLLUTANT**') AND ((POLLUTANTRELEASE.ReleaseMediumCode)='AIR') AND ((POLLUTANTRELEASEANDTRANSFERREPORT.ReportingYear) = **YEAR**) AND

For A_PublicPower:
((FACILITYREPORT.MainIASectorCode)='1'));

For B_Industry:
((FACILITYREPORT.MainIASectorCode)='2' Or (FACILITYREPORT.MainIASectorCode)='3' Or (FACILITYREPORT.MainIASectorCode)='4' Or (FACILITYREPORT.MainIASectorCode)='6'));

For J_Waste:
((FACILITYREPORT.MainIASectorCode)='5'));

For K_AgriLivestock:
((FACILITYREPORT.MainIASectorCode)='7'));

For L_AgriOther:
((FACILITYREPORT.MainIASectorCode)='8'));

For M_Other:
((FACILITYREPORT.MainIASectorCode)='9'));

3.2.5 International shipping proxy derived from FMI data

The shipping data in NetCDF format was read out with the “raster” and “sp” package of R-Studio software (version 0.98.1028). The daily sum was summarized to annual sum and exported in GeoTIFF format in WGS84 projection. Pollutants Ash, EC, OC and SO4 were summed up to PM2.5.

For further processing the dataset was loaded to ArcGIS software (Version 10.4) where centroid points of each raster cell were calculated. In a next step the generated point data set was intersected with the original emep grid (as a shapefile). Only data covering both extents were taken for further calculations. Because of a marginally mismatch of the grid cell a generalize function harmonised multiple cellpoints of the shipping emission data to the EMEP raster. The mean value was assigned.

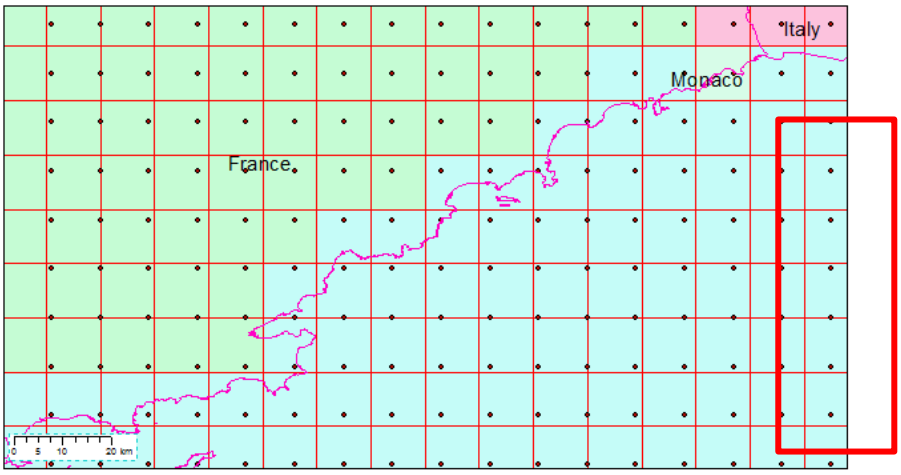


Figure 26 Generalization of multiple cellpoints

Finally the emission values were divided proportionally to each area code within the grid definition of the EMEP ESRI Shapefile and copied to proxy Access database files which can be used by the gridding system.

area	x	y	emission	gridallocation	ISO2	cellId
30	915	5695	2128,48413085938	476037	BAS	x915y5695
30	925	5695	1167,8876953125	476038	BAS	x925y5695
30	925	5705	3034,5927734375	476039	BAS	x925y5705
30	935	5695	690,005310058594	476040	BAS	x935y5695
30	935	5705	1531,13879394531	476041	BAS	x935y5705
30	945	5485	5251,70751953125	476042	BAS	x945y5485
30	945	5505	26036,0390625	476043	BAS	x945y5505
30	945	5515	508,291595458984	476044	BAS	x945y5515
30	945	5705	4199,4482421875	476045	BAS	x945y5705
30	945	5715	818,3681640625	476046	BAS	x945y5715
30	955	5485	380,217620849609	476047	BAS	x955y5485
30	955	5495	2692,44832992554	476048	BAS	x955y5495
30	955	5505	13040,0537109375	476049	BAS	x955y5505
30	955	5515	559,970764160156	476050	BAS	x955y5515
30	955	5535	71,0288162231445	476051	BAS	x955y5535
30	955	5545	116,535003662109	476052	BAS	x955y5545
30	955	5565	38,6174125671387	476053	BAS	x955y5565
30	955	5575	17214,154296875	476054	BAS	x955y5575
30	955	5705	1323,99035644531	476055	BAS	x955y5705
30	955	5715	725,5720825195 31	476056	BAS	x955y5715

Figure 27 Part of the NOx FMI shipping data for 2015

3.3 Usage and functionality of the grid calculation tool

The gridding tool can be managed via the form “Calculate” of the appropriate copy of the Access database „pollutant_year_GRID_gridyear.accdb“ for a certain pollutant and year (see chapter 3.1 Structure and configuration of the grid calculation tool).

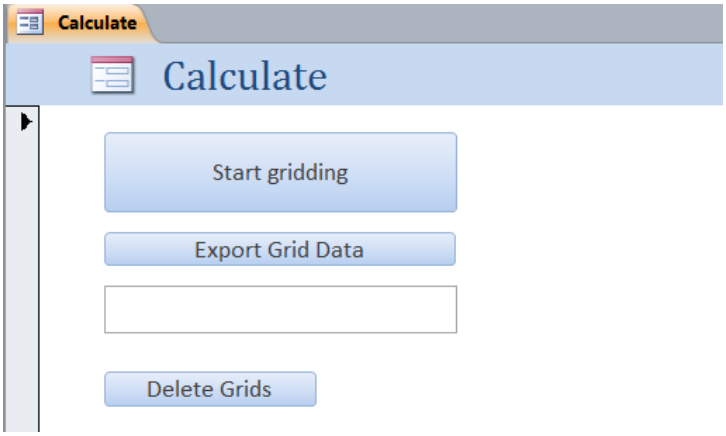


Figure 28 Tool for distributing gap-filled emission data

After the calculation is started with the button „Start gridding“ the steps “Base grid allocation”, “Calculate Sector Grids” and “Calculate NT” are performed automatically in this order. If one step is already calculated, the system is automatically proceeding with the next step. If the calculation process is cancelled at any time, pushing the button “Start gridding” continues the process exactly from the point where it stopped.

After “Calculate NT” has been successfully finished a data export to individual CSV files for each GNFR sector and the national total is carried out automatically. This export can also be started manually via the button „Export Grid data“.

Via the button “Delete Grids” the grid tables, including the calculation flags and comments in “SECTOR_EMISSIONS”, can be deleted and the calculation can be started from the beginning.

After the process is started, up to 24 hours are required (depending on the computational power).

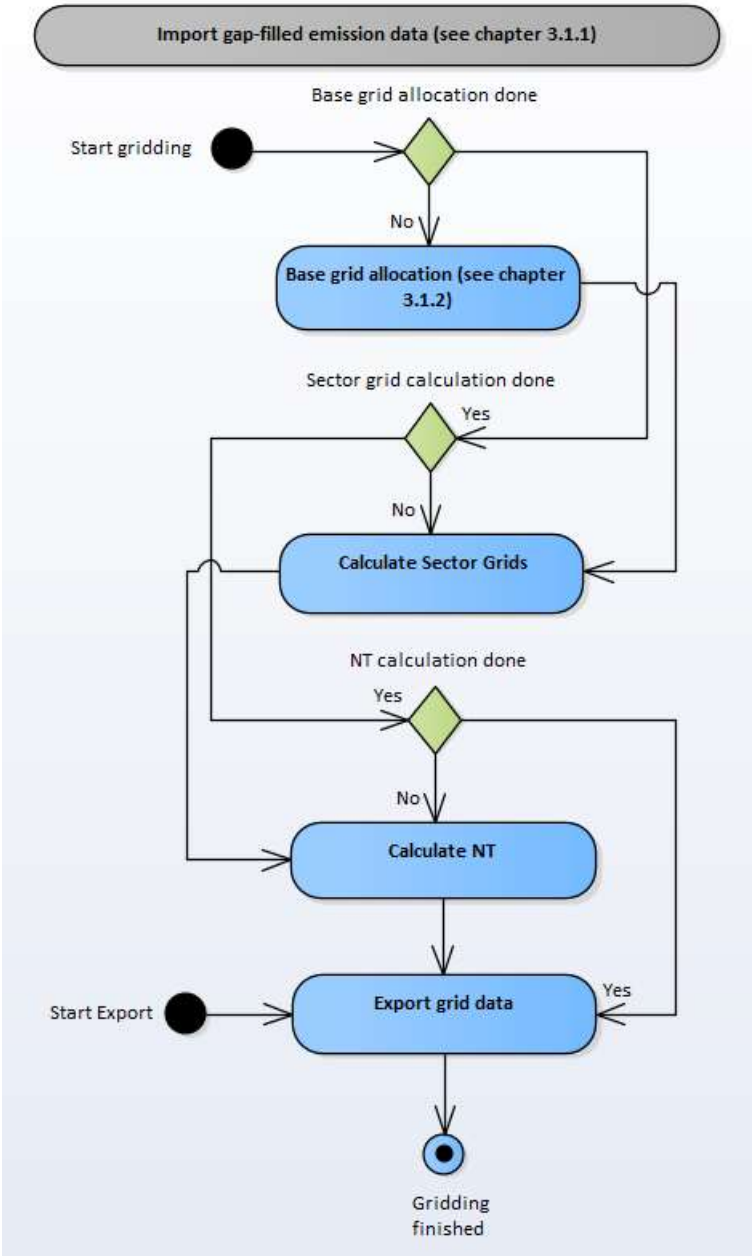


Figure 29 The individual parts of the grid calculation tool

The process can be started via the button “Start gridding”.

- If no base grid allocation is done yet, the automatized base grid allocation ist started at first.
- If the automatized base grid allocation is done, the actual gridding process to calculate the set of GNFR grids is started automatically. It starts immediately after pressing the button “Start gridding” if there is already a base grid allocation.
- Afterwards the national total grid as a sum of the GNFR grids is calculated. It starts immediately after pressing the button “Start gridding” if the GNFR grids are already calculated.

- As last step the calculated grid data is exported as CSV files. This export starts immediately after pressing the button “Start gridding” if the GNFR grids are already calculated. In addition grid data can also be exported via the button „Export Grid Data“.

3.4 Automated checks

3.4.1 Checks on spatial input data

During the transformation of reported grid and LPS data, as well as proxy data from EDGAR and E-PRTR, to the database files of the gridding system the following automated checks have been implemented so far (see also chapter 3.2 Preparation of spatial input data):

- Sector name – only the exact GNFR sector names of the template are valid. Different names (e.g. „IndustrialComb“ instead of „Industry“) are not accepted.
- LPS coordinates outside country borders are not accepted
    - Exception: in some cases LPS over sea areas are valid (e.g. drilling platforms from Norway in the North Sea)
- Grid cells outside country borders
    - Exception: in some cases grid cells over sea areas are valid (e.g. national shipping emissions from Norway and the United Kingdom in the North Sea)

3.4.2 Checks on grid results within the gridding system

For each Country/Area/Pollutant combination is checked if the grid sum of the individual sectors and the national total matches exactly the gap-filled emission values (see chapter 3.1.1 Table „SECTOR_EMISSIONS“).

4 GLOSSARY

CLRTAP

The LRTAP Convention entered into force 1983. The Convention which has 51 Parties was the first international legally binding instrument to deal with air pollution on regional bases. The aim of the Convention is that Parties shall endeavor to limit and, as far as possible, gradually reduce and prevent air pollution including long-range transboundary air pollution by developing policies and strategies to combat the discharge of air pollutants through exchanges of information, consultation, research and monitoring.

EMEP

The EMEP (European Monitoring and Evaluation Programme) is carried out in collaboration with a broad network of scientist and national experts. The EMEP provides scientific support to the LRTAP Convention on „Atmospheric monitoring and modeling“, „Emission inventories and emission projections“ and „Integrated assessment modeling“.

CEIP

CEIP (the EMEP Centre on Emission Inventories and Projections) collects emissions and projections of acidifying air pollutants, heavy metals, particulate matter and photochemical oxidants from Parties to the LRTAP Convention, reviews submitted inventories in order to improve the quality of reported data, prepares data sets as input for long-range transport models and provides support to the Parties, UNECE secretariat and IC.

CAMS

The Copernicus Atmosphere Monitoring Service (CAMS) provides consistent and quality-controlled information related to air pollution and health, solar energy, greenhouse gases and climate forcing, everywhere in the world.

E-PRTR

The European Pollutant Release and Transfer Register (E-PRTR) is the Europe-wide register that provides easily accessible key environmental data from industrial facilities in European Union Member States and in Iceland, Liechtenstein, Norway, Serbia and Switzerland.

EDGAR

The Emissions Database for Global Atmospheric Research (EDGAR) provides global past and present day anthropogenic emissions of greenhouse gases and air pollutants by country and on spatial grid.

EMEP domain

The EMEP domain covers the geographic area between 30°N-82°N latitude and 30°W-90°E longitude.

FMI

The mission of the Finnish Meteorological Institute (FMI) is to produce high-quality observation and research data on the atmosphere and seas.

NFR

Nomenclature for Reporting

Shapefile

The shapefile format is a popular geospatial vector data format for Geographic Information System (GIS) software. It is developed and regulated by Esri as a (mostly) open specification for data interoperability among Esri and other GIS software products. The shapefile format can spatially describe vector features (points, lines, and polygons), representing for example large point sources, streets, lakes, or in this case grid cells. Each item usually has attributes that describe it. In the shapefiles for the grid definition each cell has attributes about where it is located (long and lat), the cell fraction and the country/area name.

Gridding / Spatial disaggregation

Spatial allocation of emissions among grid cells by using spatial proxy information of different sources (EMEP, EDGAR, E-PRTR, FMI, etc.)

5 APPENDIX

5.1 Visualizing the results of the gridding tool in ESRI ArcGIS

This chapter gives guidance on how the generated grids can be visualised in ESRI ArcGIS:

a) Generate a folder where all the ArcGIS files can be stored.
b) Store the Access database with all the sector grid tables and the national total table in this folder as "*.mdb" file, to be able to access included tables from ArcGIS.
c) Store the ArcGIS map document "BaseGrid01x01.mxd"[3] or another already existing grid visualisation map to the new folder and rename it to "pollutant_year_GRID_gridyear.mxd", whereas "pollutant" should be replaced with the appropriate pollutant, "year" with the current year and "gridyear" with the year of the included gridded emissions.
d) Add up the emissions of cells with the same spatial location, but different country/area allocation. This must be done because for the visualisation we need only one grid cell for each long-lat coordinate and no country/area information. This can be done in ArcGIS by doing the following for each table:
    - Right click on the "Layers" menu entry, select "Add data…", select the database file and choose the table you want add (e.g. "A_PublicPower")
    - Right click to the added table and select "Open" from the context menu to open the table
    - Go to the column "cellId" and right click to the header – from the context menu select "Summarize…"
    - From the appearing dialogue expand the "emission" entry at "2. Choose one or more summary statistics to be included in the output table" and set a checkmark at "Sum"
    - Still in the summarize dialogue at "3. Specify output table" go to the folder you created for the ArcGIS data and type in the file name "pollutant_sector_year_GRID_gridyear_SUM.dbf", whereas "pollutant" should be replaced with the appropriate pollutant (e.g. "NOx"), "sector" with the GNFR sector (e.g. "A_PublicPower"), "year" with the current year (e.g. "2016") and "gridyear" with the year of the included gridded emissions (e.g. "2014")
    - When asked if the table should be added to the map say "yes"

Repeat this for all sector tables (A_PublicPower, B_Industry, C_OtherStationaryComb, D_Fugitive, E_Solvents, F_RoadTransport, G_Shipping, H_Aviation, I_Offroad, J_Waste, K_AgriLivestock, L_AgriOther, M_Other) and the national total table

e) Link grid data from the tables to the spatial grid by doing the following:
    - Right click on "EMEP_domain_01deg_polygon", select "Joins and Relates" and "Join…"
    - At "1. Choose the field in this layer that the join will be based on" select "ID"
    - At "2. Choose the table to join to this layer, or load the table from disk" select the sector table you want to visualise (e.g. "NOx_A_PublicPower_2016_GRID_2014_SUM")
    - "3. Choose the field in the table to base the join on" should automatically be set to "cellId" – if not select it manually
    - As join option select "Keep only matching records" and then say "OK"
    - Save the join as new layer by right click "EMEP_domain_01deg_polygon" again and select "Data" and "Export data…"
    - As "Export" option "All features" must be selected and as coordinate system "this layer's source data"

[3] Included in an ArcMap package with the base grid definitions of all countries/areas within the EMEP domain, which can be downloaded from

- Give the “Output feature class” the name “pollutant_sector_year_GRID_gridyear.shp”, whereas “pollutant” should be replaced with the appropriate pollutant (e.g. “NOx”), “sector” with the GNFR sector (e.g. “A_PublicPower”), “year” with the current year (e.g. “2016”) and “gridyear” with the year of the included gridded emissions (e.g. “2014”)
- Add the new layer to the map
- Right mouse click to the new layer and select “Properties”
- Go to “Symbology” and select “Quantities” – “Graduated colors”
- Select for “Value” “Sum_emissi” and for “Normalization” “none”
- Select as many “Classes” as you want (e.g. 15) and a “Color Ramp” of your choice (e.g. “green to red”)
- The “Symbol” should be without outline color
- Say “OK” and visualise the grid

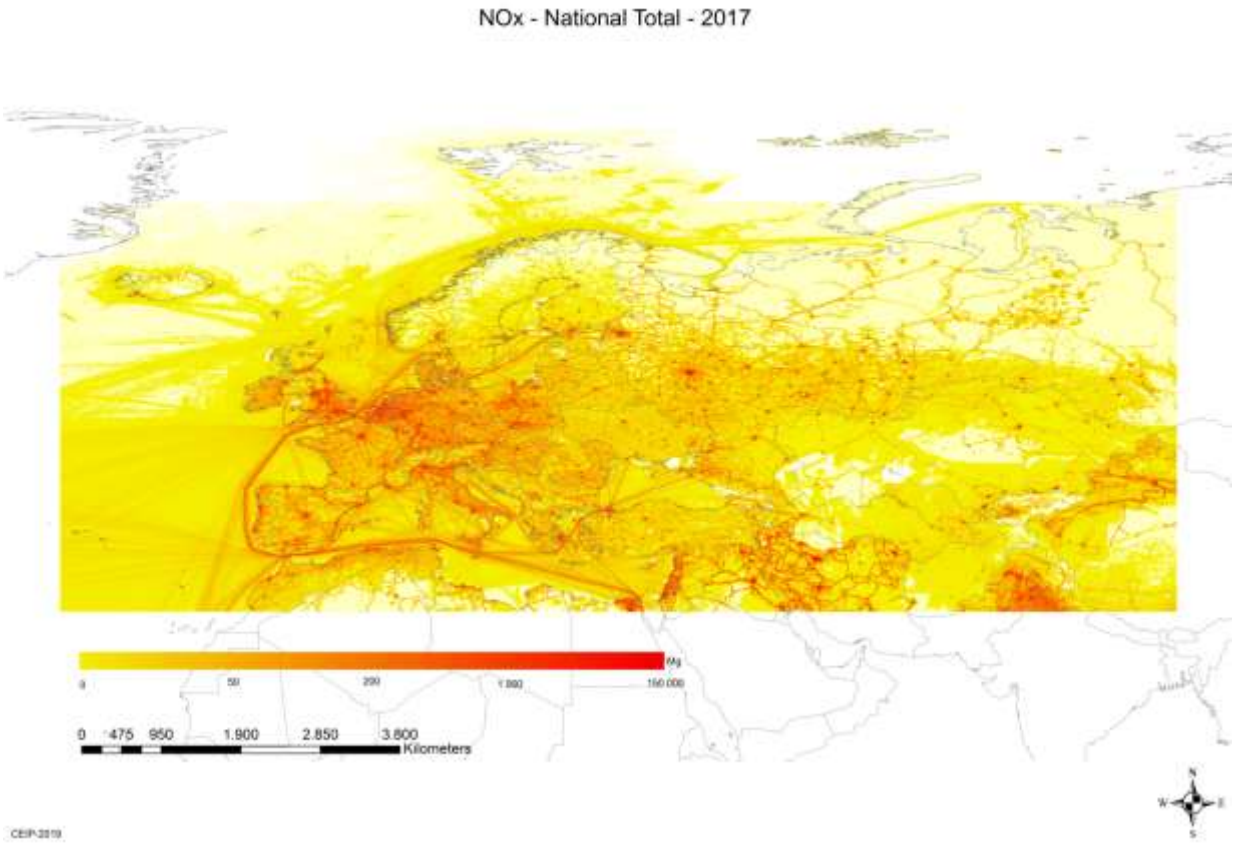


Figure 30 Example of a grid visualisation (NOx, National Total, 2017)