CEIP umweltbundesamt

Best practice in gridding emissions – available tools

Sabine Schindlbacher, CEIP
Robert Wankmüller, CEIP
Katarina Mareckova, CEIP

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Party	Gridded emissions in 2012	Party	Gridded emissions in 2012
Austria	✓	Kosovo	
Albania		Kyrgyzstan	
Armenia		Latvia	
Azerbaijan		Liechtenstein	
Belarus	✓	Lithuania	✓
Belgium	✓	Luxembourg	
Bosnia & Herzegovina		Malta	
Bulgaria	✓	Monaco	
Canada		Montenegro	✓
Croatia	✓	Netherlands	✓
Cyprus	✓	Norway	✓
Czech Republic	✓	Poland	✓
Denmark	✓	Portugal	✓
Estonia	✓	Republic of Moldova	
European Union	✓	Romania	
Finland	✓	Russian Federation	✓
France		Serbia	
FYR of Macedonia		Slovakia	✓
Georgia		Slovenia	✓
Germany	✓	Spain	✓
Greece	✓	Sweden	✓
Hungary	✓	Switzerland	
Iceland	✓	Turkey	
Ireland	✓	Ukraine	✓
Italy		United Kingdom	✓
Kazakhstan		United States of America	

Reporting of gridded data to EMEP

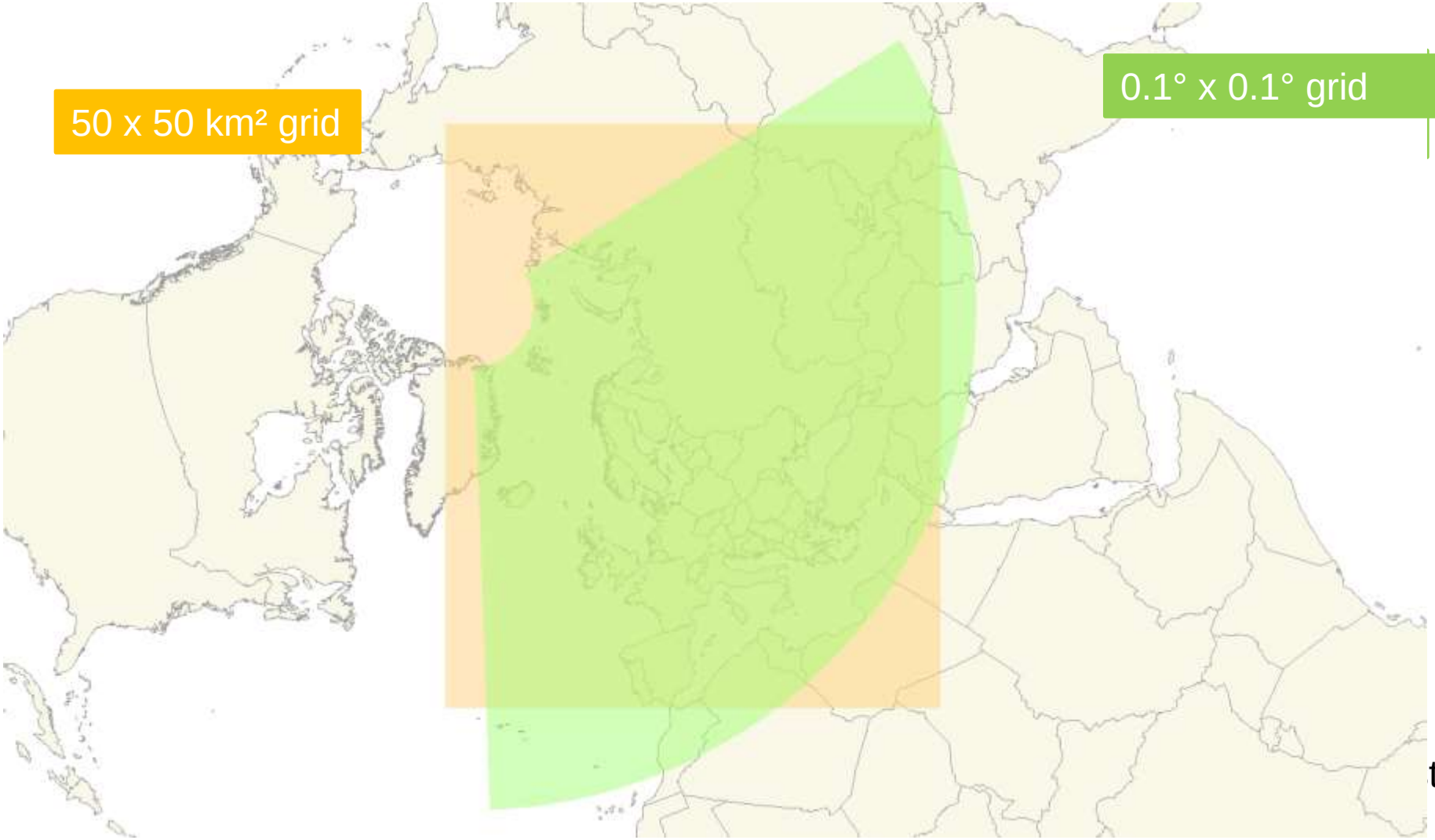
- emission data calculated by Parties within the geographic scope of EMEP shall be spatially allocated in the **EMEP grid** (UNECE, 2014 Guidelines)
- As an alternative, a Party may calculate gridded emissions in a grid of approximately 50 x 50 km^2 until it is technically and economically feasible to switch to a grid of 0.1 x 0.1 degrees (UNECE, 2014 Guidelines)

The EMEP Grid

- is a 0.1°×0.1° latitude-longitude projection in the geographic coordinate World Geodetic System (WGS) latest revision, WGS 84

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

The EMEP Grid



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Reporting of gridded data to EMEP

- Every **four years** from **2017** onward, Parties shall report for the year x-2 updated aggregated sectoral (**GNFR**) gridded emissions and LPS emissions (UNECE, 2014 Guidelines)
- Next reporting of gridded emissions: **1 May 2017**
- Pollutants: SO_x, NO_2, NMVOC, CO, $PM_{2.5}$, PM_{10}, Cd, Hg, Pb, PAHs, PCDD/F, PCBs, HCB
- Reporting encouraged: BC, TSP, As, Cr, Cu, Ni, Se and Zn

GNFR sectors

List of GNFR14 sectors
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
N_Natural
O_AviCruise
P_IntShipping
z_Memo

A to M are important for gridding

SNAP sectors vs. GNFR sectors

- No direct conversion from SNAP to GNFR possible

SNAP Sector		NFR14 Code	NFR14 Longname		GNFR14 Sector
SNAP 1	←	1A1a	Public electricity and heat production	→	A_PublicPower
SNAP 1	←	1A1b	Petroleum refining	→	B_Industry
SNAP 1	←	1A1c	Manufacture of solid fuels and other energy industries	→	B_Industry
SNAP 3	←	1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel	→	B_Industry
SNAP 3	←	1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals	→	B_Industry
SNAP 3	←	1A2c	Stationary combustion in manufacturing industries and construction: Chemicals	→	B_Industry
SNAP 3	←	1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	→	B_Industry
SNAP 3	←	1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	→	B_Industry
SNAP 3	←	1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals	→	B_Industry
SNAP 8	←	1A2gvii	Mobile Combustion in manufacturing industries and construction: (please specify in the IIR)	→	I_Offroad
SNAP 3	←	1A2gviii	Stationary combustion in manufacturing industries and construction: Other (please specify in the IIR)	→	B_Industry
SNAP 8	←	1A3ai(i)	International aviation LTO (civil)	→	H_Aviation
SNAP 8	←	1A3aii(i)	Domestic aviation LTO (civil)	→	H_Aviation
SNAP 7	←	1A3bi	Road transport: Passenger cars	→	F_RoadTransport
SNAP 7	←	1A3bii	Road transport: Light duty vehicles	→	F_RoadTransport
SNAP 7	←	1A3biii	Road transport: Heavy duty vehicles and buses	→	F_RoadTransport
SNAP 7	←	1A3biv	Road transport: Mopeds & motorcycles	→	F_RoadTransport
SNAP 7	←	1A3bv	Road transport: Gasoline evaporation	→	F_RoadTransport
SNAP 7	←	1A3bvi	Road transport: Automobile tyre and brake wear	→	F_RoadTransport
SNAP 7	←	1A3bvii	Road transport: Automobile road abrasion	→	F_RoadTransport
SNAP 8	←	1A3c	Railways	→	I_Offroad
SNAP 8	←	1A3di(ii)	International inland waterways	→	G_Shipping

NFR Aggregation for gridding

- To which GNFR sector a NFR Code belongs to you can also check in Annex 1 Emissions reporting template

: :	*NFR sectors to be reported*			**Main Pollutants** (from 1990)			
				NOx (as NO_2)	NMVOC	SOx (as SO_2)	NH_3
NFR Aggregation for Gridding and LPS (GNFR)	**NFR Code**	**Longname**	**Notes**	**kt**	**kt**	**kt**	**kt**
A_PublicPower	1A1a	Public electricity and heat production					
B_Industry	1A1b	Petroleum refining					
B_Industry	1A1c	Manufacture of solid fuels and other energy industries					
B_Industry	1A2a	Stationary combustion in manufacturing industries and construction: Iron and steel					
B_Industry	1A2b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals					
B_Industry	1A2c	Stationary combustion in manufacturing industries and construction: Chemicals					
B_Industry	1A2d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print					
B_Industry	1A2e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco					
B_Industry	1A2f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals					

Best practice in gridding

You can find **comprehensive guidance** in chapter 7 of the

EMEP/EEA Air Pollutant Emission **Inventory Guidebook 2013**

Best practice in gridding – Spatial disaggregation

- Step 1 → Identify the grid cells for your country from the EMEP grid
- Step 2 → Collect and prepare spatial proxy data to be able to allocate emissions to specific grid cells
- Step 3 → Calculate the fractions of each spatial proxy for all grid cells of your country
- Step 4 → Define which proxies should be used for the distribution of the individual sector emissions
- Step 5 → Distribute the sector total emissions regarding the spatial proxies for each pollutant and sector

Step 1: Identify the grid cells for your country from the EMEP grid

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- List of 8627 lines for Turkey
- center of a 0.1°x0.1° cell in degrees

ISO2	country_name	longitude	latitude	fraction
TR	Turkey	25.65	40.15	0.12
TR	Turkey	25.75	40.05	0.02
TR	Turkey	25.75	40.15	0.87
TR	Turkey	25.75	40.25	0.03
TR	Turkey	25.85	40.05	0.00
TR	Turkey	25.85	40.15	0.93
TR	Turkey	25.85	40.25	0.20
TR	Turkey	25.95	39.85	0.07
TR	Turkey	25.95	40.15	0.59
TR	Turkey	25.95	40.25	0.25
TR	Turkey	26.05	39.45	0.11
TR	Turkey	26.05	39.55	0.08
TR	Turkey	26.05	39.75	0.03
TR	Turkey	26.05	39.85	0.31
TR	Turkey	26.05	39.95	0.01
TR	Turkey	26.05	40.15	0.02
TR	Turkey	26.05	40.65	0.32
TR	Turkey	26.05	40.75	0.22
TR	Turkey	26.15	39.45	0.42
TR	Turkey	26.15	39.55	0.97

Step 1: Identify the grid cells for your country from the EMEP grid

- ESRI shape files with 0.1°x0.1° (long-lat) grid definition
- The **shapefile** format is a popular geospatial vector data format for Geographic Information System (**GIS**) software.
- 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.

Best practice in gridding – Spatial disaggregation

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Step 2: Collect and prepare spatial proxy data to be able to allocate emissions to specific grid cells

- National Datasets
  - Population and employment
  - Gas distribution networks
  - Agricultural data
  - Road network information
  - Rail network information
  - Airport activity data
  - Aviation
  - National shipping
  - Point source information
  - Local inventory data

Step 2: Collect and prepare spatial proxy data to be able to allocate emissions to specific grid cells

- International Datasets: There are a number of different international datasets that can be used to derive spatial proxy data
  - INSPIRE (http://www.inspire-geoportal.eu)
  - EDGAR (http://edgar.jrc.ec.europa.eu)
  - APMOSPHERE (http://www.apmosphere.org)
  - CORINE (http://www.eea.europa.eu/data-and-maps/data)
  - ESA GlobCover (http://ionia1.esrin.esa.int)
  - ICAO (http://www.icaodata.com)
  - Eurostat (http://ec.europa.eu/eurostat/ramon)
  - Lloyds Register (http://www.lr.org)

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Step 3: Calculate the fractions of each spatial proxy for all grid cells of your country

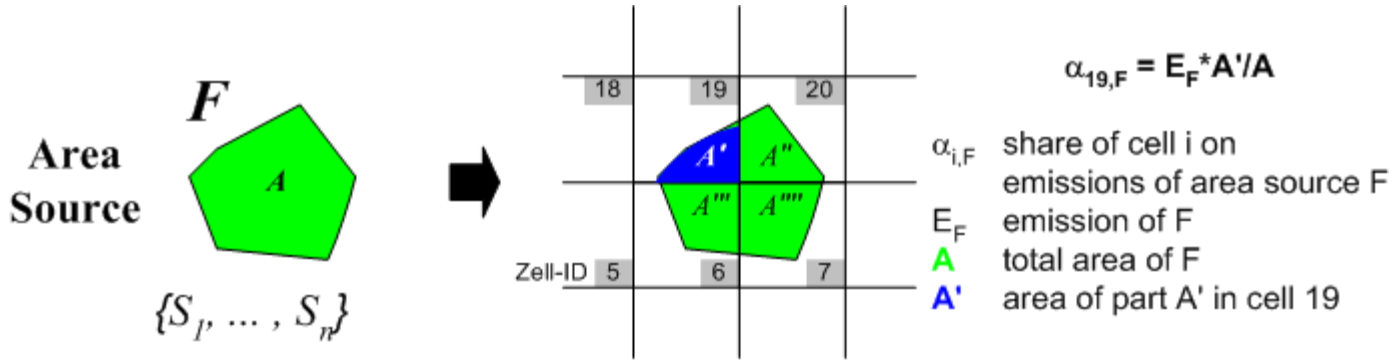
- This is generally done by transfering the different spatial forms from a proxy map to the EMEP grid cells

- Spatial forms can be
  - Area sources (urban areas, agricultural areas, etc)
  - Line sources (streets, railways, rivers, etc.)
  - and Point sources (power plants, industrial plants, etc.)

- For line and area sources conversion to grid cells GIS software is needed, where spatial intersect operations (between the proxy layer and the EMEP grid layer) can be executed (e.g. ArcGIS, GRASS GIS, etc.)

Area sources (polygons) to grids

- Intersecting a polygon with the EMEP grid will produce individual polygons for each grid cell

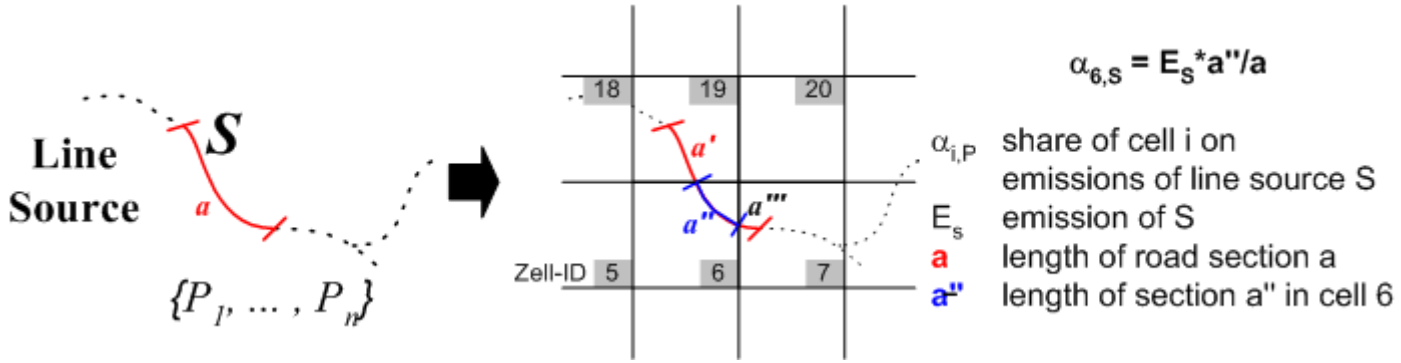


- The fraction of the area of the new polygons can be used to distribute the source (e.g. agricultural area) to the grid cells.

- With this information you can calculate the fractions of each grid cell for the emission distribution

Line sources to grids

- Intersecting a line feature with the EMEP grid will produce shorter separated lines for each grid cell

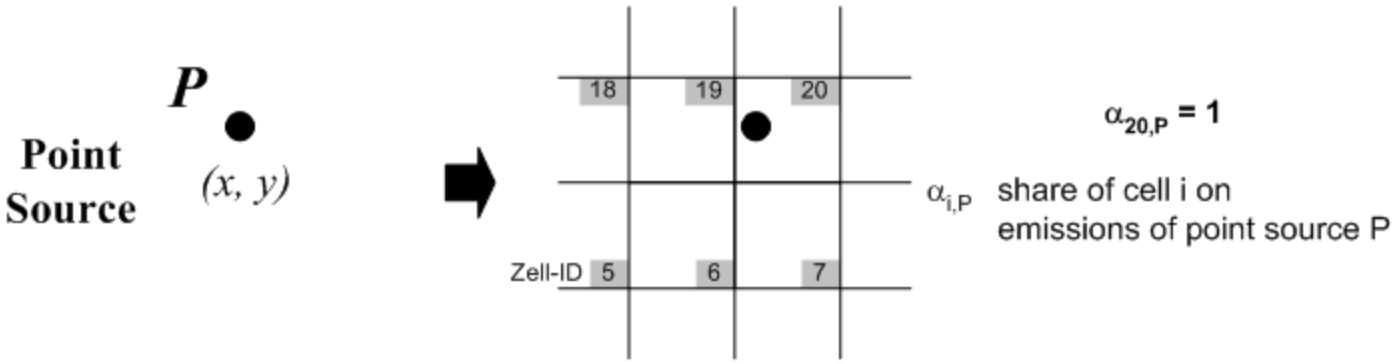


- The fraction of the new lines can be used to distribute the source (e.g. Street) to the grid cells.

- With this information you can calculate the fractions of each grid cell for the emission distribution

Point sources to grids

- Point sources can be allocated directly to the grid within which they are contained by converting the coordinates of the source (usually long/lat information) to EMEP grid cells



Converting between different spatial projections

- In a number of cases you may need to combine different spatial datasets with different spatial projections
- Most GIS software (e.g. ESRI ArcGIS) can convert the geographic coordinate system to any projected coordinate system
- The Open Geospatial Consortium Inc. provides guidance and standards for coordinate transformation (http://www.opengeospatial.org/standards/ct)

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Step 4: Define which proxies should be used for the distribution of the individual sector emissions

Sector	Proxy 1	Proxy 2	Proxy 3
B_Industrial Combustion	E-PRTR	CLC (commercial and industrial units)	CLC (urban areas)
C_Small Combustion	Population (GWPv3)	-	-
G_RoadRail	TREMOVE	Open street maps and Digital charts of the world (motorways, roads)	CLC (urban areas)
O_Agri Livestock	CLC (agricultural areas, pasture)	EUROSTAT (animal stocks)	

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Step 5: Distribute the sector total emissions regarding the spatial proxies for each pollutant and sector

- If you have more than one spatial proxy allocated to a sector you can
  - define a weighting for each proxy and calculate an overall grid cell distribution
  - or split the sector emission (e.g. on NFR level) and distribute each part with a different spatial proxy

- If you want to allocate LPS emissions directly to the EMEP grid you have to subtract these emissions from the sector total emissions you distribute with the proxies

Step 5: Distribute the sector total emissions regarding the spatial proxies for each pollutant and sector

NOx emission from C_SmallComb in cell i

$$emission_{ix} = emission_t \times \frac{value_{ix}}{\sum_{jx} value_{ix}}$$

Population in cell i

Population of the whole area/country

Where:

i : is a specific geographic feature; (grid cell)

$emission_{ix}$: is the emissions attributed to a specific geographical feature (e.g. a grid, line, point or administrative boundary) within the spatial surrogate dataset x; (e.g. population)

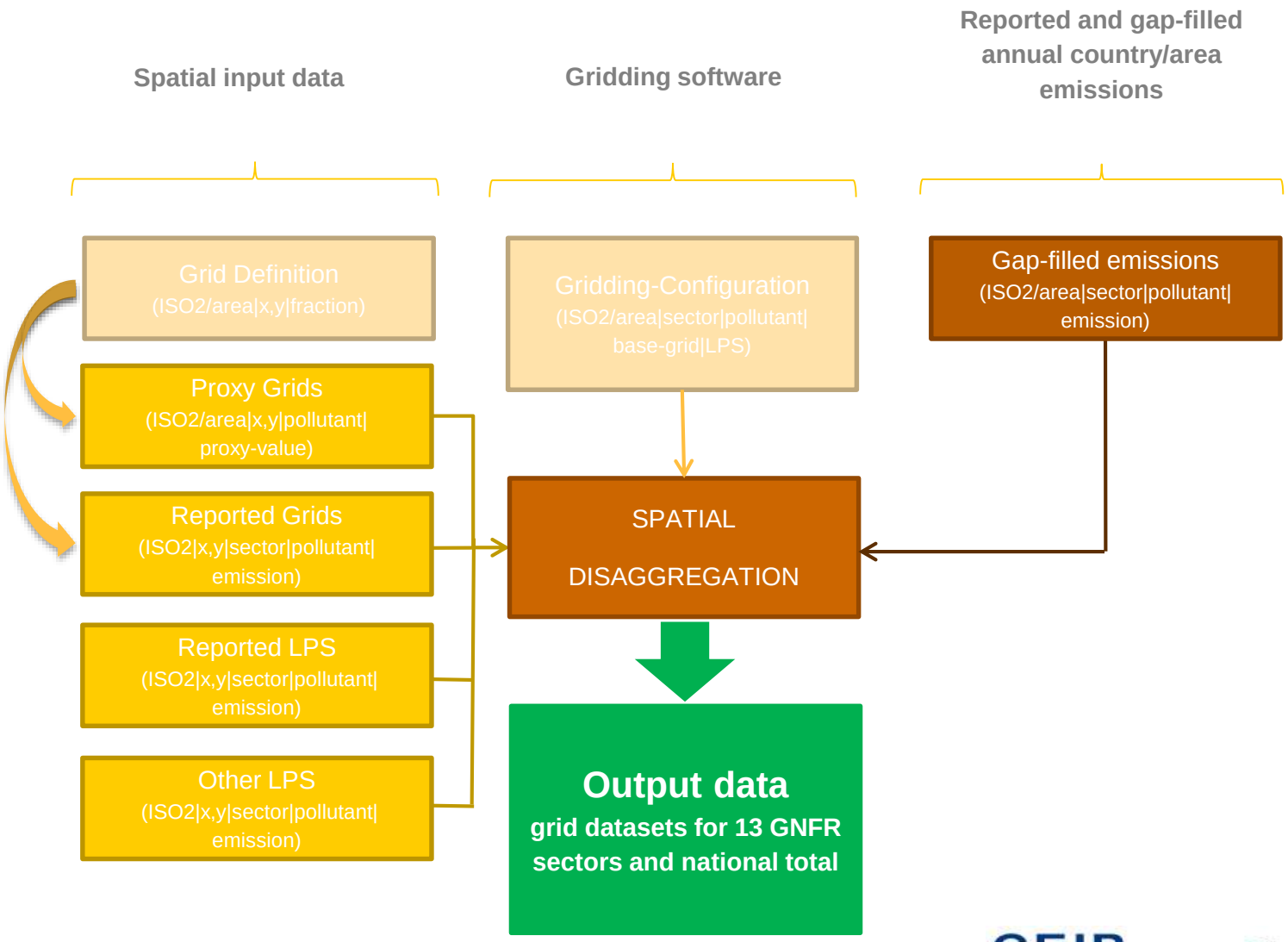
$emission_t$: is the total national emission for a sector to be distributed across the national area using the (x) surrogate spatial dataset; (e.g. NOx emissions from C_SmallComb)

$value_{ix-jx}$: are the surrogate data values of each of the specific geographical features within the spatial surrogate dataset x.

Worst Practice

- Not to submit any gridded data

CEIP new gridding system



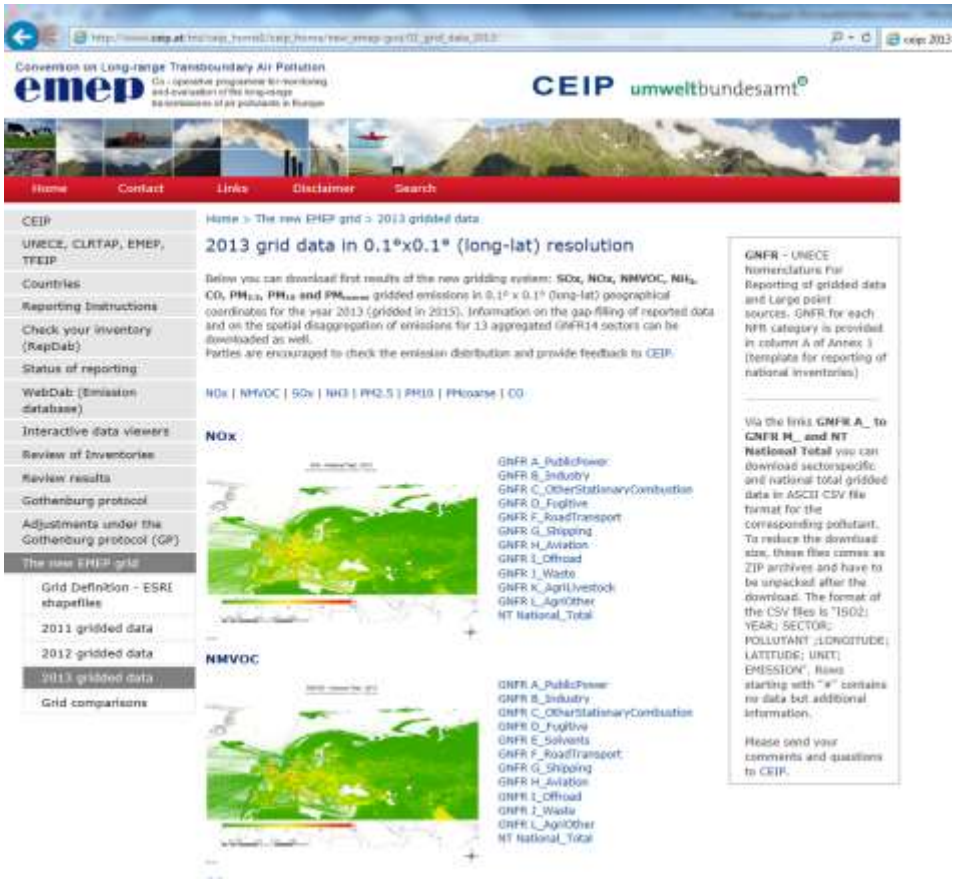
Derived proxy grids from EDGAR data

Sector from EDGAR	IPCC Code	CO	SO_2	NO_X	NMVOC	NH_3	PM_{10}
Energy Industry	1A1a			NOx (A)	NMVOC (A)		PM10 (A)
Energy industry and waste incinerator	1A1a + 6C	CO (A)	SO2 (A)			NH3 (A)	
Refineries and transformation	1A1b + 1A1c					NH3 (B)	
Transformation fossil fuel production refineries steel	1A1b + c + 1B + 2C1 + 2C2				NMVOC (D)		
Combustion in manufacturing industry	1A2	CO (B)	SO2 (B)	NOx (B)	NMVOC (B)	NH3 (B)	PM10 (B)
Transport non-road and road	1A3					NH3	
Non-road transportation	1A3a + c + d + e	CO	SO2	NOx	NMVOC		PM10
Road transportation	1A3b	CO (F)	SO2 (F)	NOx (F)	NMVOC (F)		PM10 (F)
Residential	1A4	CO (C)	SO2 (C)	NOx (C)	NMVOC (C)	NH3 (C)	PM10 (C)
Transformation, Oil production and refinering	1B1 + 1B2 + 1A1b + c	CO (D)	SO2 (D)	NOx (D)			PM10 (D)
Industrial process and product use	2			NOx (B)			
Non-metallic mineral processes	2A					NH3 (B)	
Chemical Industry	2B					NH3 (B)	
Metal processes	2C	CO (B)	SO2 (B)				
Non-metallic paper chemical industry	2A + 2B + 2D	CO (B)	SO2 (B)				
Non-metallic paper chemical food industry	2A + 2B + 2D + 2E + 2F + 2G				NMVOC (B)		
Solvents production and application	3				NMVOC (E)		
Process emissions during production and application	2 + 3						PM10 (B)
Manure management	4B			NOx (K)		NH3 (K)	PM10 (K)
Agricultural soils	4C + 4D			NOx (L)		NH3 (L)	PM10 (L)
Agricultural waste burning	4F	CO (L)	SO2 (L)	NOx (L)	NMVOC (L)	NH3 (L)	PM10 (L)
Solid waste disposal	6A + 6C		SO2 (J)	NOx (J)	NMVOC (J)		PM10 (J)
EDGAR PROXY	POPULATION	CO (J) (M)	SO2 (M)	NOx (M)	NMVOC (M)	NH3 (J) (M)	PM10 (M)
EDGAR PROXY	FISHING	CO (G)	SO2 (G)	NOx (G)	NMVOC (G)	NH3 (G)	PM10 (G)
EDGAR PROXY	DOMEST_INT_LTO	CO (H)	SO2 (H)	NOx (H)	NMVOC (H)	NH3 (H)	PM10 (H)
EDGAR PROXY	SHIPS		SO2 (P)	NOx (P)	NMVOC (P)	NH3 (P)	PM10 (P)
EDGAR PROXY	RAILWAYS+RURAL_POP	CO (I)	SO2 (I)	NOx (I)	NMVOC (I)	NH3 (I)	PM10 (I)
EDGAR PROXY	ROADS TIMES INHABITANTS					NH3 (F)	

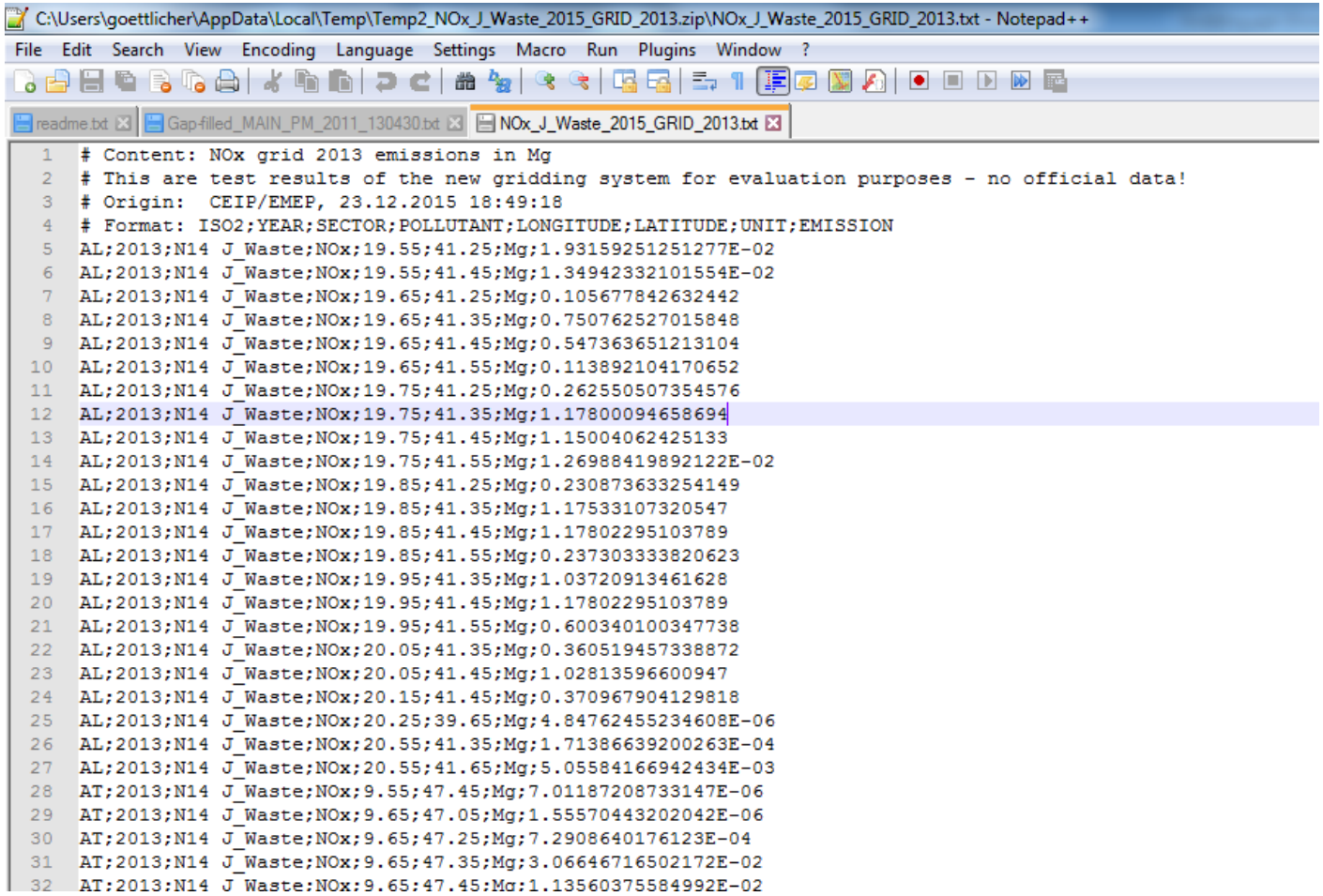
(A) PublicPower | (B) Industry | (C) OtherStationaryComb | (D) Fugitive | (E) Solvents | (F) RoadTransport

(G) Shipping | (H) Aviation | (I) Offroad | (J) Waste | (K) AgriLivestock | (L) AgriOther | (M) Other

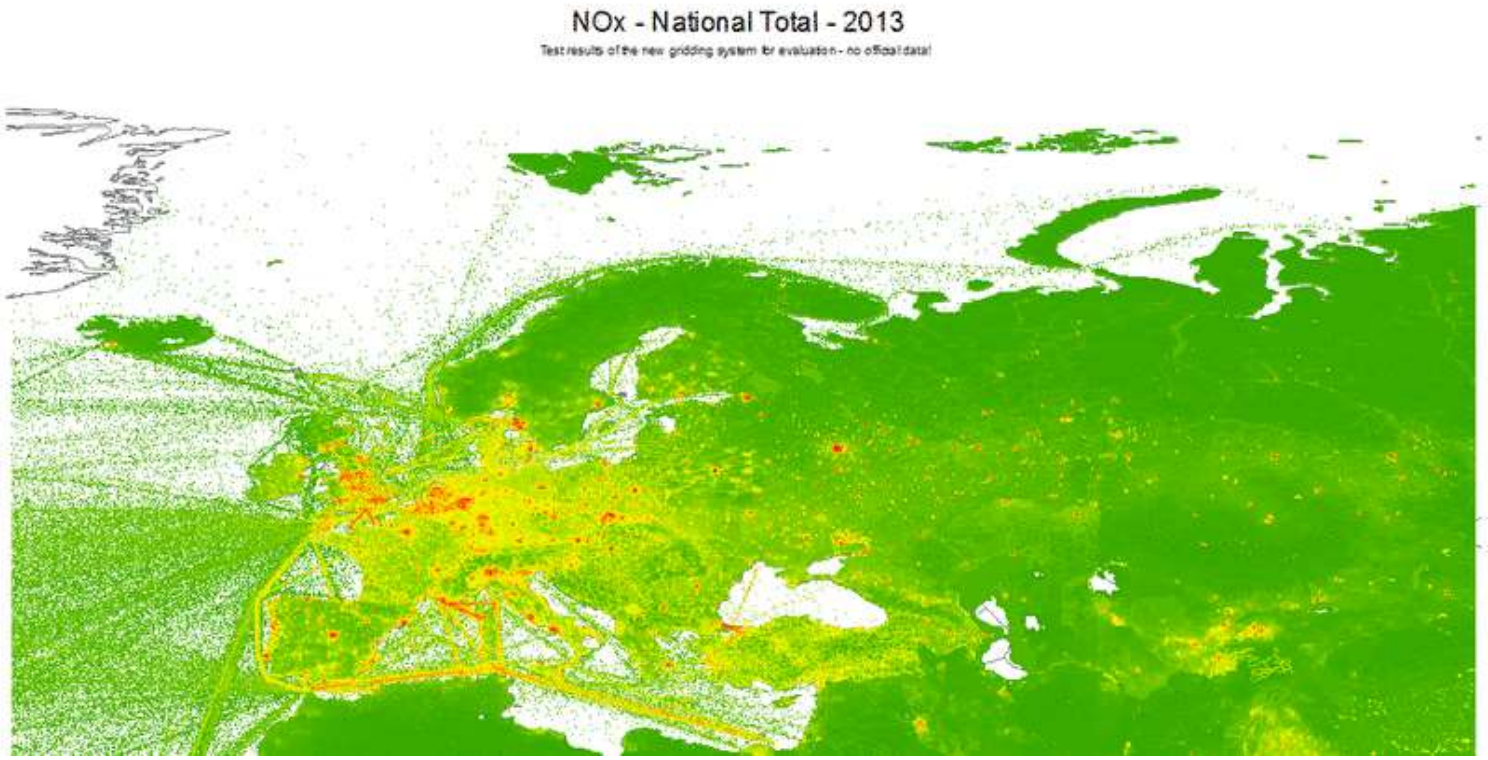
CEIP gap-filling



CEIP gap-filling



Thank you very much for your attention



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