ČESKÝ
HYDROMETEOROLOGICKÝ
ÚSTAV

Aktuální výstupy z projektu LIFE-IP Małopolsko - - scénáře emisí z lokálního vytápění pro rok 2023 a jejich dopad na kvalitu ovzduší

Ochrana ovzduší ve státní správě XIV, teorie a praxe
Litomyšl, 14. listopadu 2019

ČHMÚ: Benešová, Honzáková, Šmejdířová, Vlček,
SHMÚ: Štefánik, Krajčovičová
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MAŁOPOLSKA
IN A HEALTHY ATMOSPHERE

Life

LIFE Integrated Project "Implementation of Air Quality Plan for Małopolska Region – Małopolska in a healthy atmosphere", LIFE14IPE PL 021

https://powietrze.malopolska.pl/en/life-project and
http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=search.dspPage&n_proj_id=5440

C6 – interregional modelling

- **Task 1: Residential Emission Inventory**

  (Lead: VITO, Partners: MZP, SHMU, Malopolska)

- **Task 2: Trans-boundary Emission Data Base**

  (Lead: MZP, Partners: VITO, SHMU, Malopolska)

- **Task 3: Inter-regional Air Quality Modelling**

  (Lead: MZP, Partners: VITO, SHMU, Malopolska)

AIMS

Task 2: Trans-boundary Emission Data Base

(Lead: MZP, Partners: VITO, SHMU, Malopolska)

- Development of **regional benzo[a]pyrene emissions**
- Integration of bottom-up and top-down emissions for a **reference year, 2015** and **emission reduction scenarios**

AIMS

Task 3: Inter-regional Air Quality Modelling

(Lead: MZP, Partners: VITO, SHMU, Malopolska)

- **Setting up and running CAMx & CMAQ (CTM)**
- **Setting up measurement-based land-use regresion model RIO** for near real time and historic air quality assessments
- **Intercomparison of CTM and RIO model results**
- **Combination of CTM and RIO tools** for the evaluation of the emission reduction scenarios

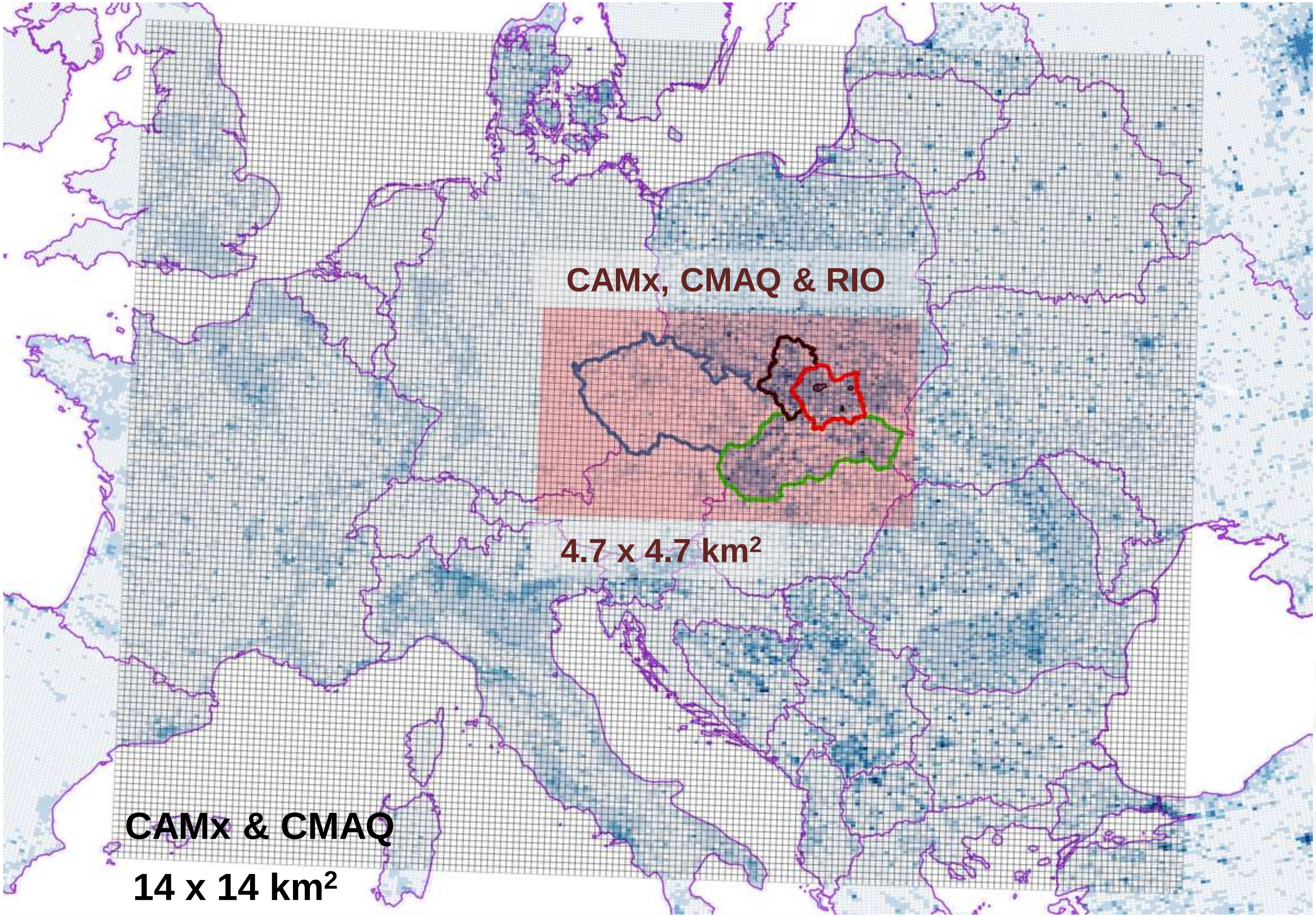
AIMS SUMMARY

- Reliable **measurement-based** model for the description of current air quality in transboundary region → RIO
- CTM model for evaluation of **scenarios**
- **Detailed (harmonized) emissions** as input for CTMs
- Use **CTM and RIO in combination to evaluate** expected improvements of air quality according to **scenarios**

APPROACH

$$CONC_{SCENARIO} = CONC_{REF} \cdot \frac{CTM_{SCENARIO}}{CTM_{REF}}$$

Modelling domains



Transboundary emission inventory

- **Europe** outside of Czech Republic, Poland, and Slovakia:
  - CAMS-REGv1.1-AP for 2015
  - **B(a)P** for 2015: J. Bieser from Hamburg University

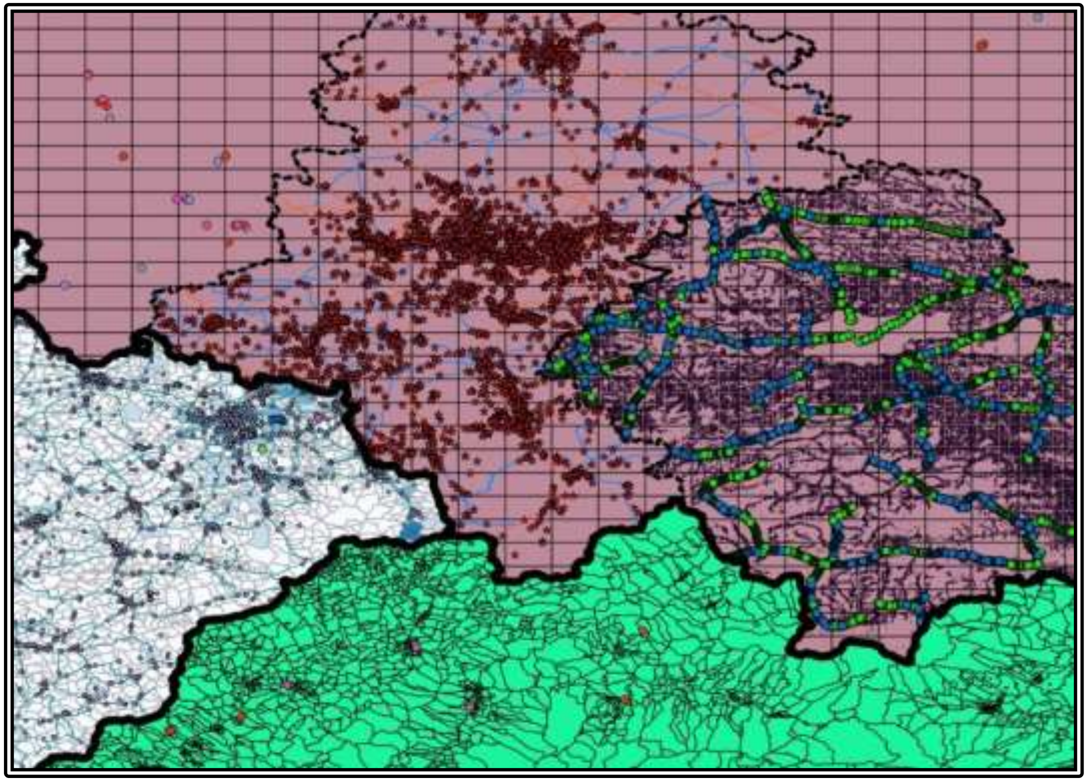
- **Poland**
  - detailed emissions for 2015 provided by GIOS (Główny Inspektorat Ochrony Środowiska) and KOBiZE (Krajowy Ośrodek Bilansowania i Zarządzania Emisjami)

- **Małopolska and Silesia**
  - residential heating emission inventories by ATMOTERM

Transboundary emission inventory

- **Czech Republic**
  - Detailed national inventory REZZO for 2015 + road and off-road transport emissions for 2016 + **fugitive emissions**
- **Slovakia**
  - Detailed residential heating emissions + SNAP 2 point sources
  - CAMS-REGv1.1-AP for 2015 (all other categories except SNAP 2)
- **biogenic emissions**
  - MEGAN model v2.1
- **Małopolska, Silesia, Czech Rep., Slovakia**
  - Residential heating scenarios for 2023 – BAU and „optimistic“

Transboundary emission inventory



Emission processor FUME http://fume-ep.org/

- Spatial and time disaggregation
- Chemical speciation

2023 scenarios - Małopolska

- Based on Małopolska Voivodship Air Protection Program[1]
- changes in the amount of heat demand (insulation and modernization) -> 0.95
- Lower consumption of wood for heating: cities 60 %, Krakow 0 %, Nowy Sącz 40 %, Tarnów 30 %, other areas 75 %
- 2016–2023 annual replacement of cca 12,500 solid fuel boilers

[1] https://powietrze.malopolska.pl/program-ochrony-powietrza/

2023 scenarios - Małopolska

- Reduction of energy from solid fuels (1 = total reduction)

Region	“business as usual”	“optimistic”
cities	0	0.3
Krakow	1	1
Nowy Sącz	0	0.3
Tarnów	0	0.3
the rest of the territory	0	0.05

- Replacement of energy from solid fuels [%]

Region	Gas	Liquid fuels	Central heating
cities	70	1	29
Krakow	50	1	49
Nowy Sącz	60	1	39
Tarnów	60	1	39
the rest of the territory	80	5	15

2023 scenarios - Małopolska

- Emission factors complied with EN-303: 5/2012 - correction factors were used in the "optimistic" scenario to reflect higher emissions in real operation: gas and liquid fuels 1.05x, wood 1.1x and coal 1.2x;
- In **both scenarios**, a correction factor reflecting higher emissions due to the use of lower quality fuels was expected: liquid fuels 1.05x, solid fuels (except wood) 1.2x.
- Waste incineration: will drop to 90 % in the BAU and to zero in the "**optimistic**";

2023 scenarios - Małopolska

- In the case of fireplaces, particulate filters will be used to reduce particulate matter emissions by 0 % (**BAU**), resp. 80 % (“**optimistic**”)

Scenario	Existing boilers	New boilers until 2019	New boilers since 2020 incl.
“business as usual”	manual, without emission class	automatic boilers, without emission class	automatic boilers, Ekodesign
“optimistic”	manual, Ekodesign	automatic boilers, Ekodesign	

2023 scenarios - Małopolska

"optimistic"

		Valid from
Solid fuel boilers	**Compulsory class:** Ecodesign (class 5 according to PN-EN 303: 5/2012)	
	Old boilers	2023
	New boilers without class specification	2023
	New boilers class 3/4	2027
	Purchase of new boilers after the program comes into force	June 2017
Fireplaces	**Requirements:** Ecodesign, efficiency> 80%, particle filter	
	Existing facilities	2023
	New facilities	2019 or June 2017 ?
Solid fuels	**Limitations**	
	Coal	No sludge, flotoconcentrates, or fuels with 0–1 mm grain size
	Biomass	Humidity must be below 20%

2023 scenarios - Silesia

- **"BAU"** for 2023 based on extrapolation of annual emission changes in years 2015–2017
- changes in 2015-2017 supplied at gmina level by the Silesian Voivodeship for PM_{10}, $PM_{2.5}$, B[*a*]P, SO_2 and NO_X

- **"optimistic"** scenario were based on the Air Protection Program of the Silesian Voivodeship from 2017 (Resolution of the Silesian Parliament no. V/47/5/2017)[1]
- reductions on gmina level for PM_{10}, $PM_{2.5}$, B[*a*]P to be reached in 2027
- for 2023, it was expected that 40% of the total emission reduction expected in 2027 would be achieved

[1] https://www.slaskie.pl/content/1514373867_2017-12-18

2023 scenarios - Silesia

- extrapolation of 2015–2017 trends to 2023 has great uncertainty
- 2027 reductions were
  - lacking most of the substances needed for CTM
  - based on model simulation (not on fuel-boiler related EFs)

- extrapolation was done for PM_{10} only
- emissions of other substances for each gmina based on PM_{10} reduction and expected reduction of given substance according to MP scenarios

Scénáře 2023 – Česká republika

- navrhnuty podle platné legislativy, prognóz spotřeby paliv dle MPO, statistik prodejů kotlů, kotlíkových dotací a údajů o nově dokončených bytech
- emise byly počítány pro provozní režim kotlů 15/85 (viz Směrnice o Ekodesignu 2009/125/EC)
- vycházely z počtu bytů z roku 2018. Do modelu zahrnuty údaje o nově dokončených bytech s převažujícím způsobem vytápění od roku 2015
- poměr plynových kotlů konvenční/kondenzační stanoven na 80/20

Scénáře 2023 – Česká republika

- Oba scénáře přechod části rodinných domů od TP na ZP za následujících podmínek:
  - v ZÚJ v obcích < 10 tis. obyv. převedeno 10 % RD;
  - v ZÚJ v obcích > 10 tis. obyv. převedeno 20 % RD;
  - poměr bytů vytápěných uhlím a dřevem zůstal zachován;
  - převodu pouze pokud se v obci nacházelo min. 10 bytů vytápěných ZP.

Scénáře 2023 – Česká republika

- **Výsledné emise v obou scénářích poměr spotřeby paliva dle typu spalovacího zařízení (-> EF) vycházel ze statistiky MPO pro rok 2018**

- „**BAU**“ 5 % rodinných domů vytápěných pevnými palivy přejde na bezemisní zdroje (tepelná čerpadla, solární panely apod.) bez ohledu na velikost obce.
- „**Optimistická**“ varianta – 15 % RD za stejných podmínek

- **„Optimistická“** varianta předpokládala dodržení legislativních požadavků :-) (kotle 1. a 2. emisní třídy nahrazeny za nové nebo jiný zdroj tepla)
- **„BAU“** - požadavky na obměnu kotlů nebudou zcela dodrženy a část nevyhovujících kotlů bude stále v provozu.

Scénáře 2023 – Česká republika

Scénář	Zastoupení dle převažujícího způsobu vytápění [%]					Celkový počet bytů
	Zemní plyn	Uhlí	Biomasa	Kapalná paliva	Propan-butan	
2015 ref	69	16	14	0	1	2 289 951
2023 BAU	73	14	12	0	1	2 300 630
2023 optimistický	75	13	11	0	1	2 240 069

2023 scenarios – Slovakia

Scenario	Factor of emission change wrt 2015			
	PM_{10}	$PM_{2,5}$	NO_2	SO_2
„BAU“	0,85	0,85	0,84	0,85
„optimistic“	0,84	0,84	0,80	0,40

- Other emissions were kept unchanged…

Emissions scenarios

inventory / emissions [t]	SO_2	NO_X	NH_3	CO	NMVOC	BZN	BAP	PM_{10}	$PM_{2.5}$
CZ 2015 ref	17 373	8 631	3 618	717 034	200 764	255,9	15,6	63 377	62 116
CZ 2023 BAU	14 982	8 632	3 719	584 538	162 530	213,4	12,8	50 010	48 984
CZ 2023 opt	13 539	8 364	3 332	415 489	103 367	123,8	6,1	24 769	24 221
PL_MP 2015 ref	12 270	3 882	115	145 758	15 669		7,3	13 520	13 229
PL_MP 2023 BAU	10 536	4 408	58	121 254	13 069		6,2	10 826	10 564
PL_MP 2023 opt	106	6 248	30	14 426	788		1,1	1 094	1 075

inventory / emissions [t]	SO_2	NO_X	NH_3	CO	NMVOC	BZN	BAP	PM_{10}	$PM_{2.5}$
				scenario / ref					
CZ 2023 BAU	0,86	1,00	1,03	0,82	0,81	0,83	0,82	0,79	0,79
CZ 2023 opt	0,78	0,97	0,92	0,58	0,51	0,48	0,39	0,39	0,39
PL_MP 2023 BAU	0,86	1,14	0,51	0,83	0,83		0,85	0,80	0,80
PL_MP 2023 opt	0,01	1,61	0,27	0,10	0,05		0,15	0,08	0,08
PL_SL 2023 BAU	0,93	1,06	0,70	0,89	0,89	1,00	0,86	0,88	0,85
PL_SL 2023 opt	0,80	1,11	0,79	0,77	0,75	1,00	0,68	0,77	0,72
SK 2023 BAU	0,85	0,84		1,00	1,00	1,00	1,00	0,85	0,85
SK 2023 opt	0,41	0,79		1,00	1,00	1,00	1,00	0,84	0,84

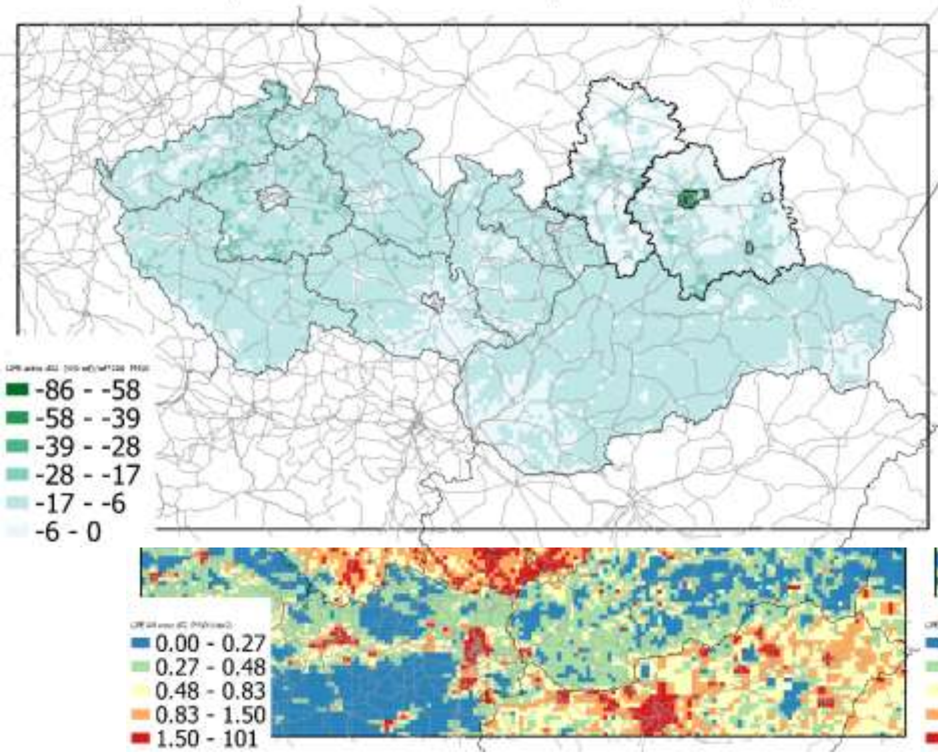
CZ 2023 opt	-3 834	-267	-286	-301 546	-97 397	-132,1	-9,5	-38 608	-37 895
PL_MP 2023 BAU	-1 734	526	-56	-24 504	-2 600		-1,1	-2 694	-2 665
PL_MP 2023 opt	-12 164	2 366	-84	-131 332	-14 881		-6,3	-12 426	-12 154
PL_SL 2023 BAU	-1 930	585	-47	-27 276	-2 894	0,0	-1,3	-2 999	-2 967
PL_SL 2023 opt	-5 388	1 048	-33	-58 166	-6 590	0,0	-2,8	-5 503	-5 383
SK 2023 BAU	-174	-531		0	0	0,0	0,0	-1 831	-1 776
SK 2023 opt	-688	-687		0	0	0,0	0,0	-1 970	-1 911

Transboundary emission inventory PM_{10}

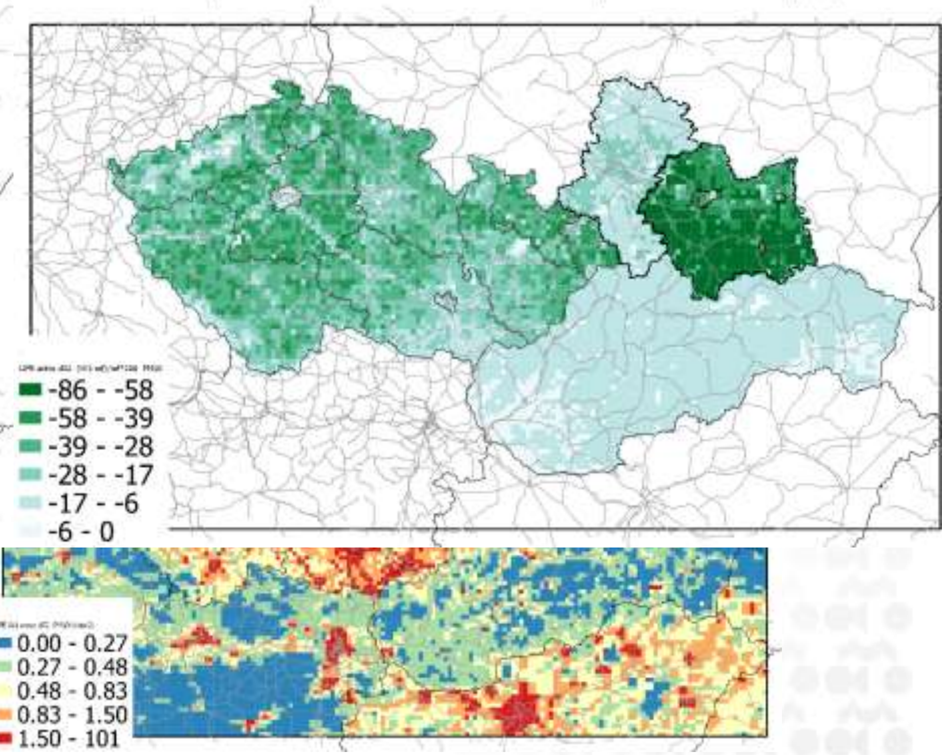
PM_{10} annual emissions (CAMS-REGv1.1-AP)
2015 ref [t.km^{-2}]

PM_{10} annual emissions (anthropogenic)
2015 ref [t.km^{-2}]

Relative change of PM_{10} annual emissions
100*(2023 BAU – 2015 ref) / 2015 ref [%]

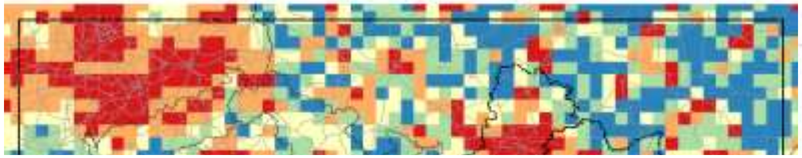


Relative change of PM_{10} annual emissions
100*(2023 optimistic – 2015 ref) / 2015 ref [%]

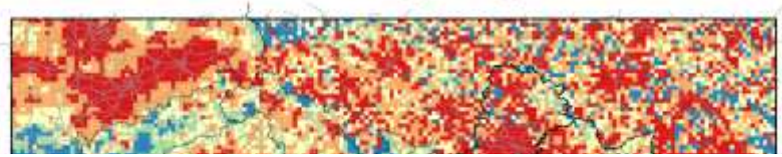


Transboundary emission inventory B[*a*]P

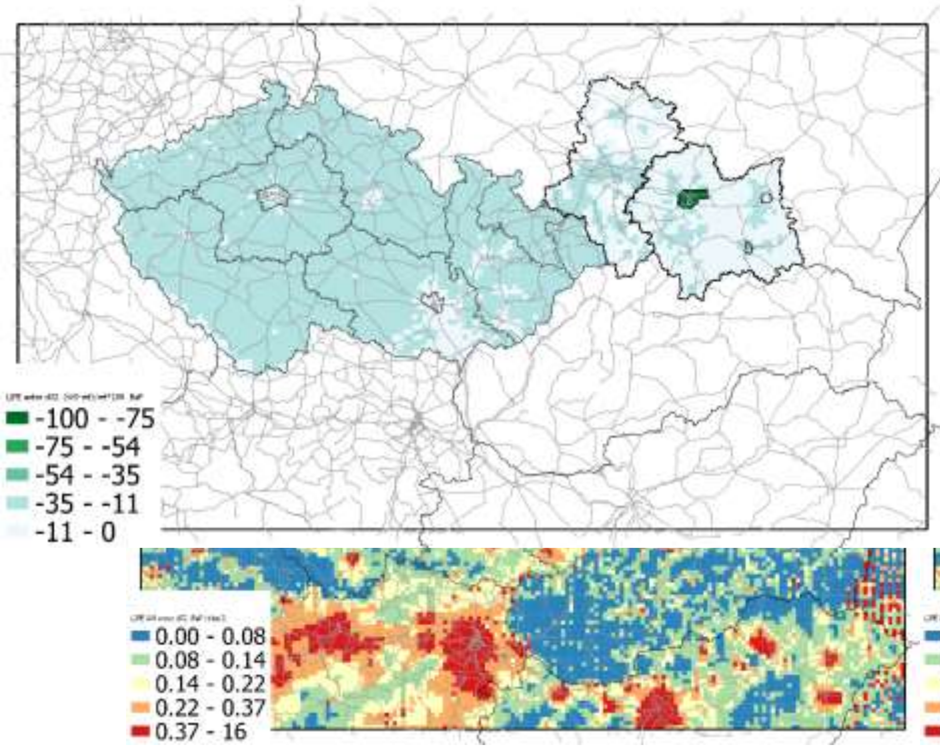
B[*a*]P annual emissions (J. Bieser, LIFE-IP MP)
2015 ref [kg.km^{-2}]



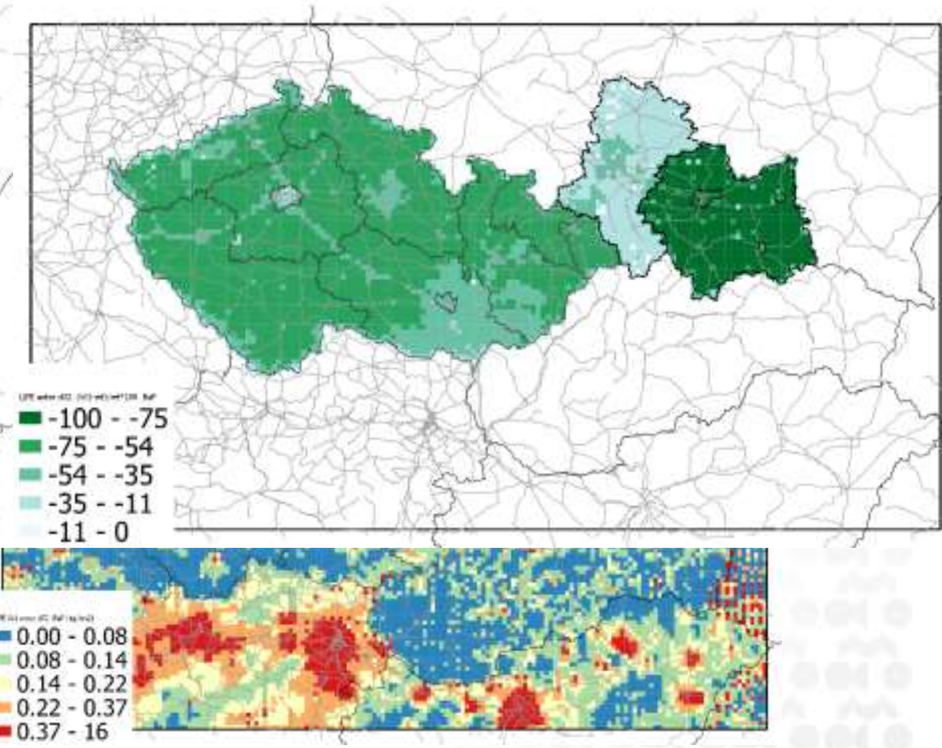
B[*a*]P annual emissions (anthropogenic)
2015 ref [kg.km^{-2}]



Relative change of B[a]P annual emissions
100*(2023 BAU – 2015 ref) / 2015 ref [%]



Relative change of B[a]P annual emissions
100*(2023 optimistic – 2015 ref) / 2015 ref [%]

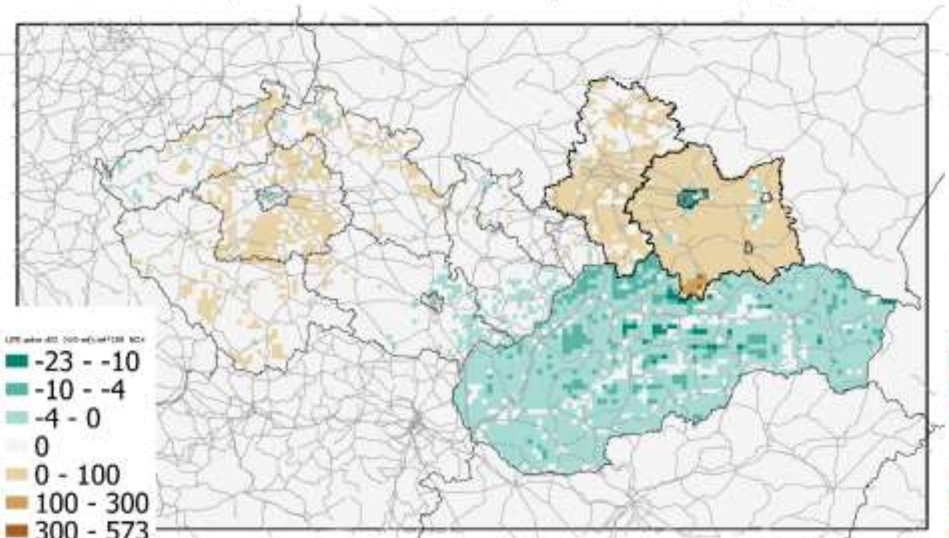


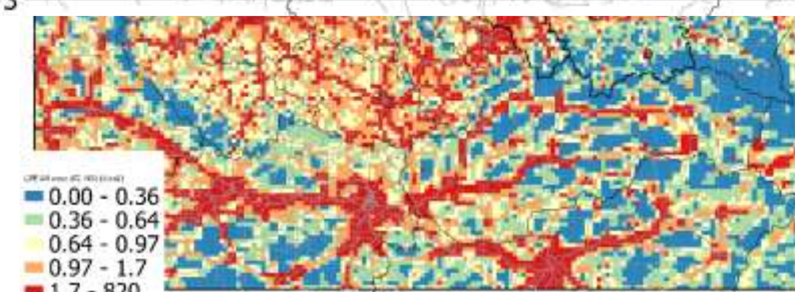
Transboundary emission inventory NO_X

NO_X annual emissions (CAMS-REGv1.1-AP)
2015 ref [$t.km^{-2}$]

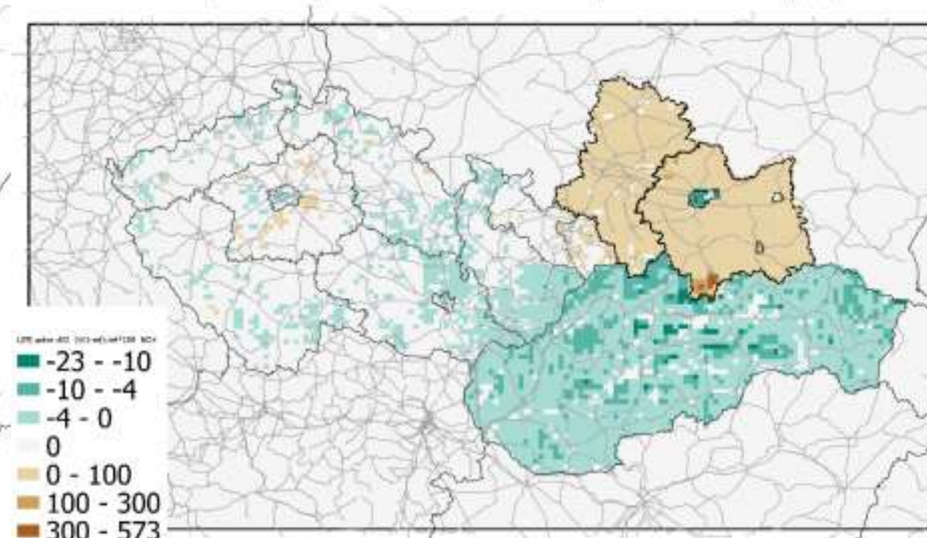
NO_X annual emissions (anthropogenic)
2015 ref [$t.km^{-2}$]

Relative change of NO_X annual emissions
100*(2023 BAU – 2015 ref) / 2015 ref [%]





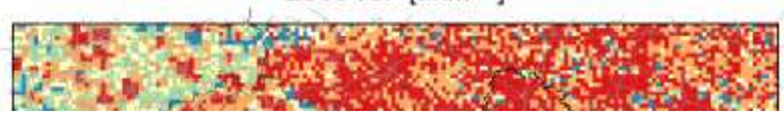
Relative change of NO_X annual emissions
100*(2023 optimistic – 2015 ref) / 2015 ref [%]



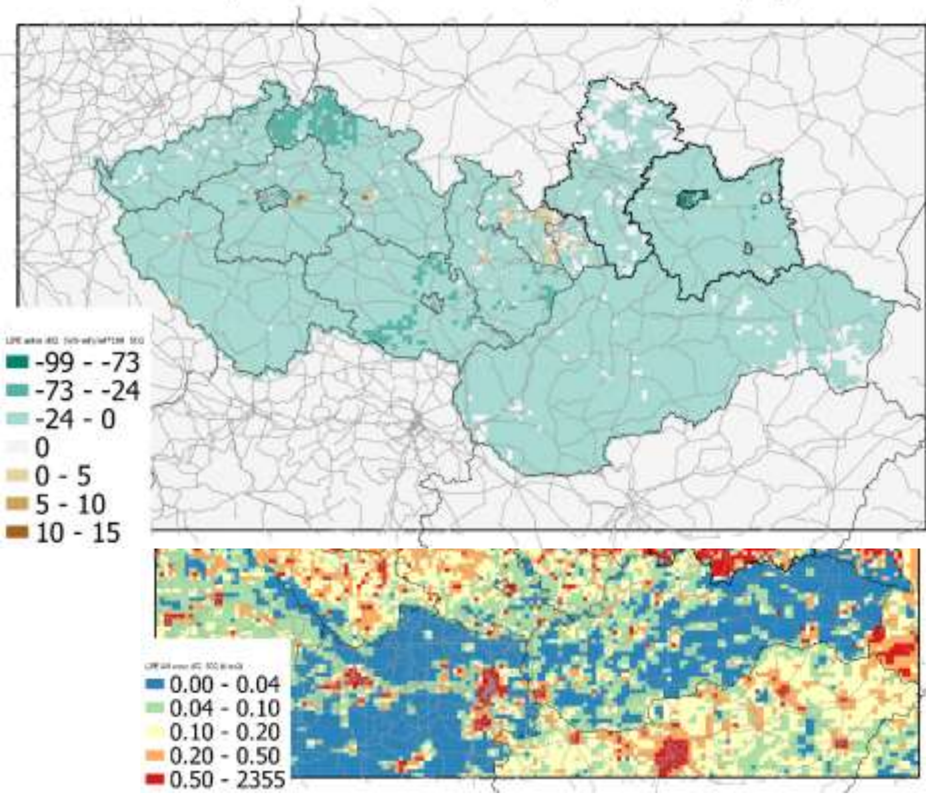
Transboundary emission inventory SO_2

SO_2 annual emissions (CAMS-REGv1.1-AP)
2015 ref [t.km^{-2}]

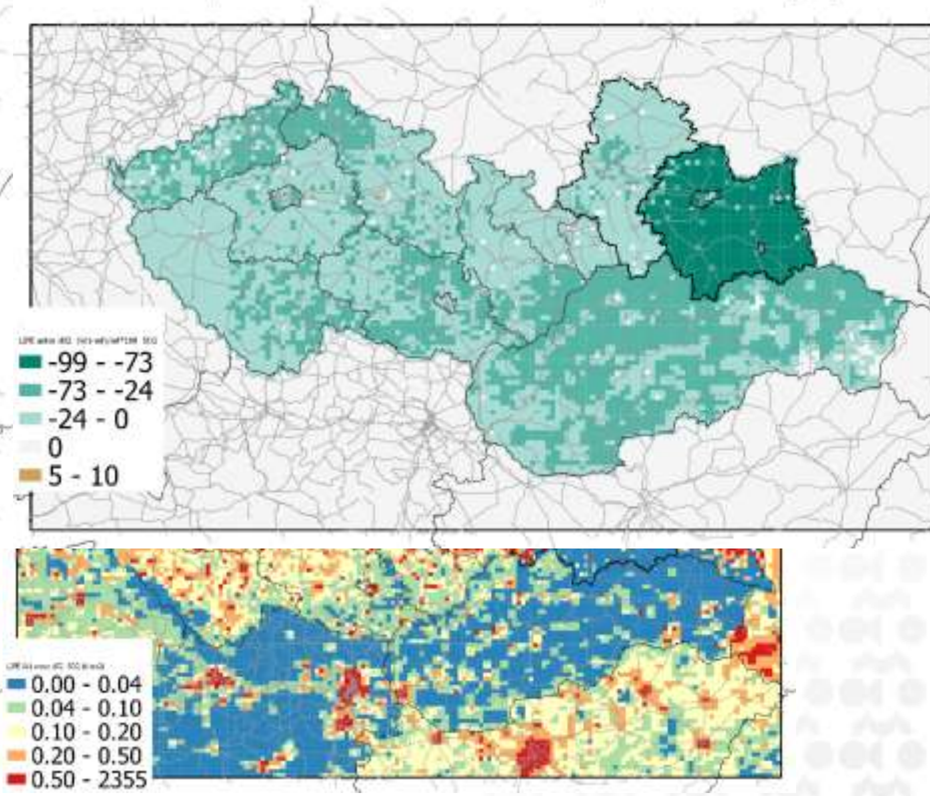
SO_2 annual emissions (anthropogenic)
2015 ref [t.km^{-2}]



Relative change of SO_2 annual emissions
100*(2023 BAU – 2015 ref) / 2015 ref [%]



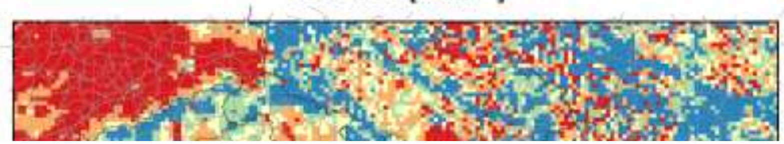
Relative change of SO_2 annual emissions
100*(2023 optimistic – 2015 ref) / 2015 ref [%]



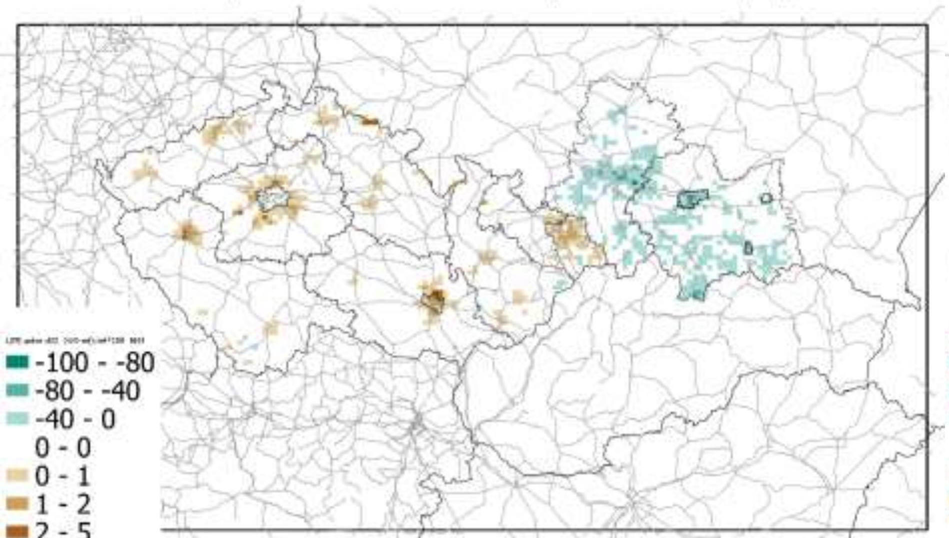
Transboundary emission inventory NH_3

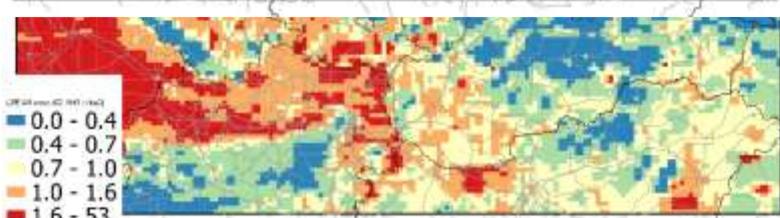
NH_3 annual emissions (CAMS-REGv1.1-AP)
2015 ref [t.km^{-2}]

NH_3 annual emissions (anthropogenic)
2015 ref [t.km^{-2}]

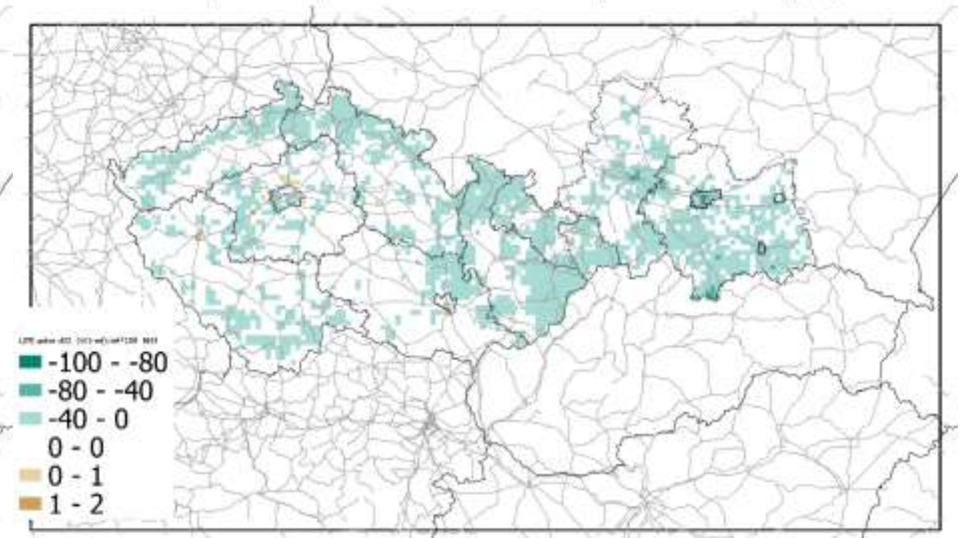


Relative change of NH_3 annual emissions
100*(2023 BAU – 2015 ref) / 2015 ref [%]



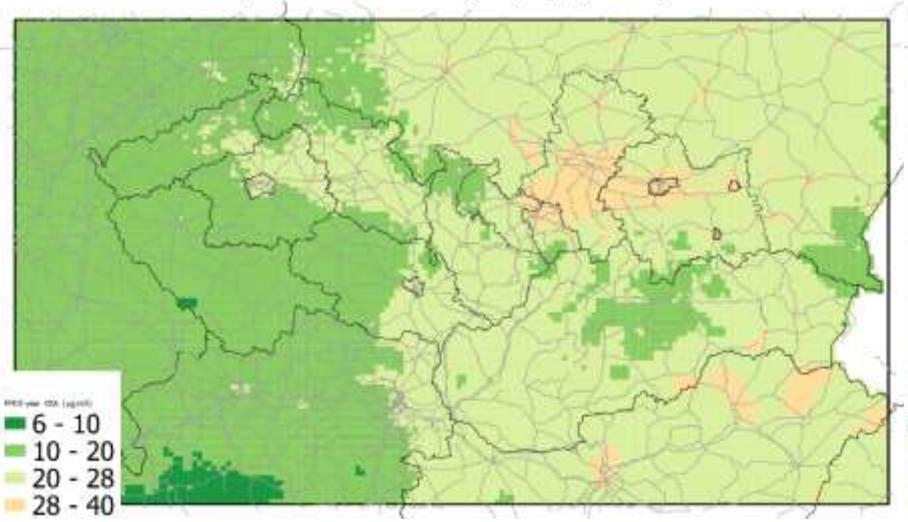


Relative change of NH_3 annual emissions
100*(2023 optimistic – 2015 ref) / 2015 ref [%]



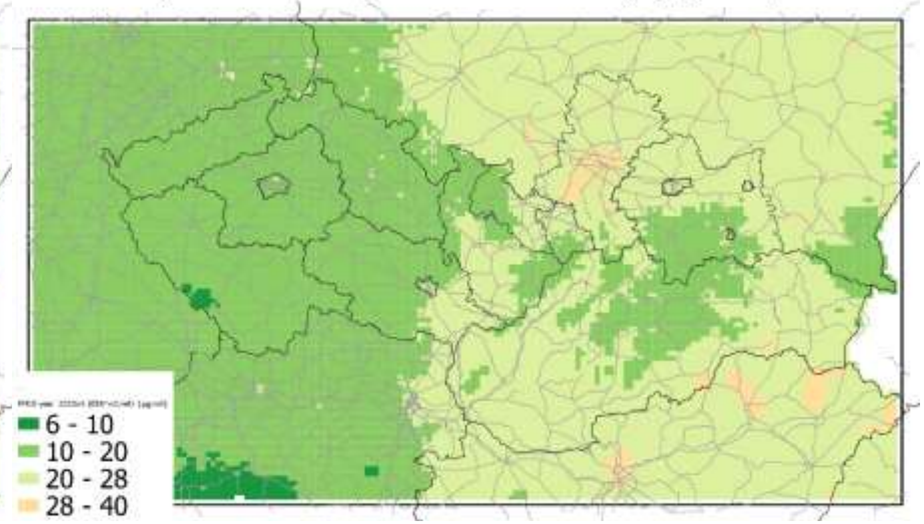
PM_{10} annual average, 2015 ref

(EEA on CAMx grid) [$\mu g.m^{-3}$]



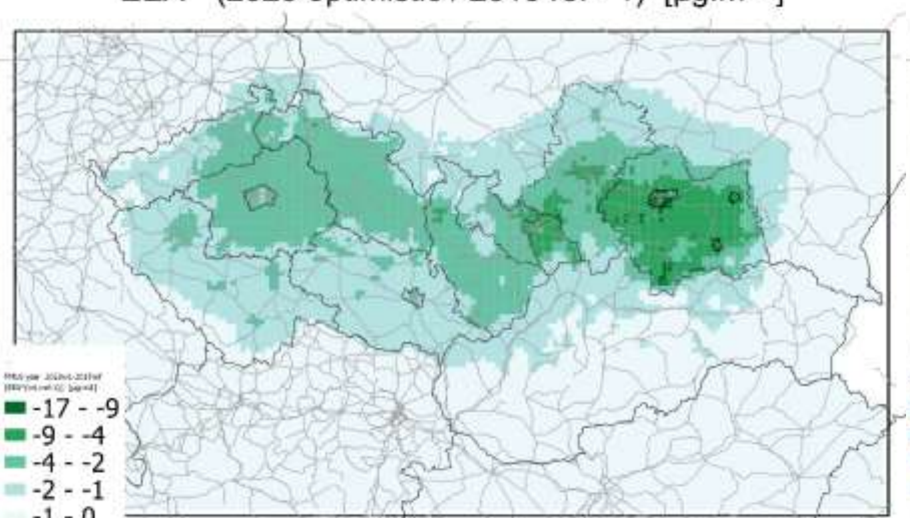
PM_{10} annual average, 2023 optimistic

(EEA * 2023 optimistic / 2015 ref) [$\mu g.m^{-3}$]



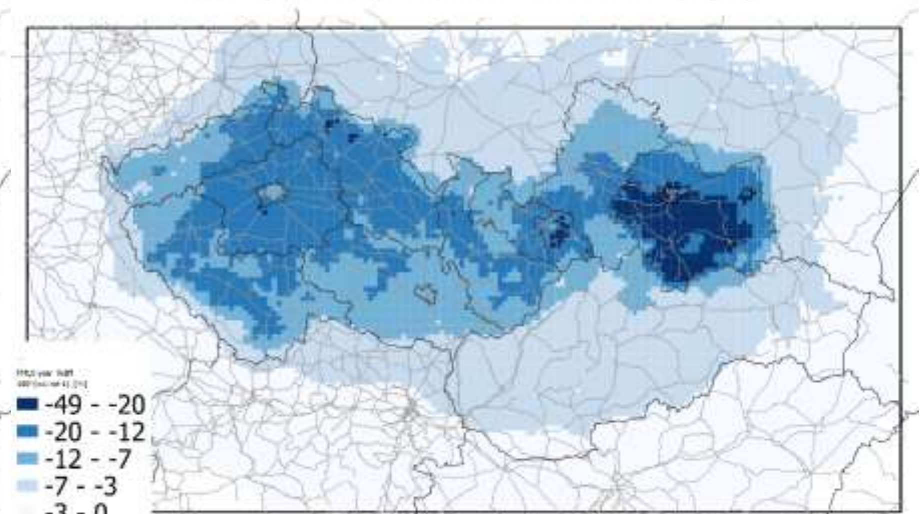
Absolute change of PM_{10} annual average

EEA * (2023 optimistic / 2015 ref - 1) [$\mu g.m^{-3}$]



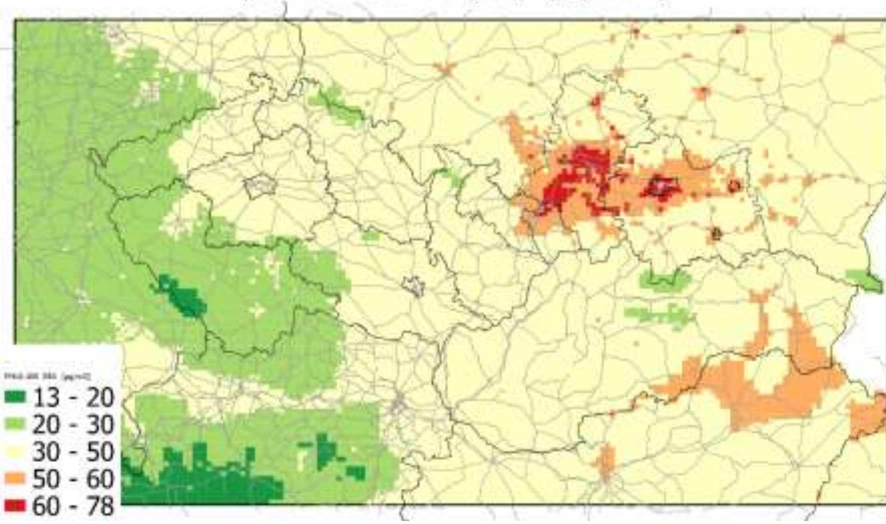
Relative change of PM_{10} annual average

100 * (2023 optimistic / 2015 ref - 1) [%]



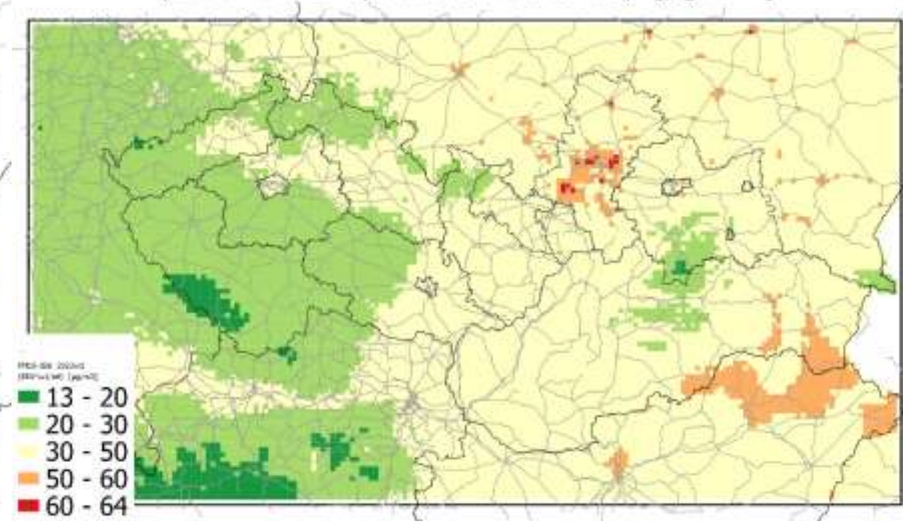
PM_{10} 36th highest daily average, 2015 ref

(EEA on CAMx grid) [μg.m^{-3}]



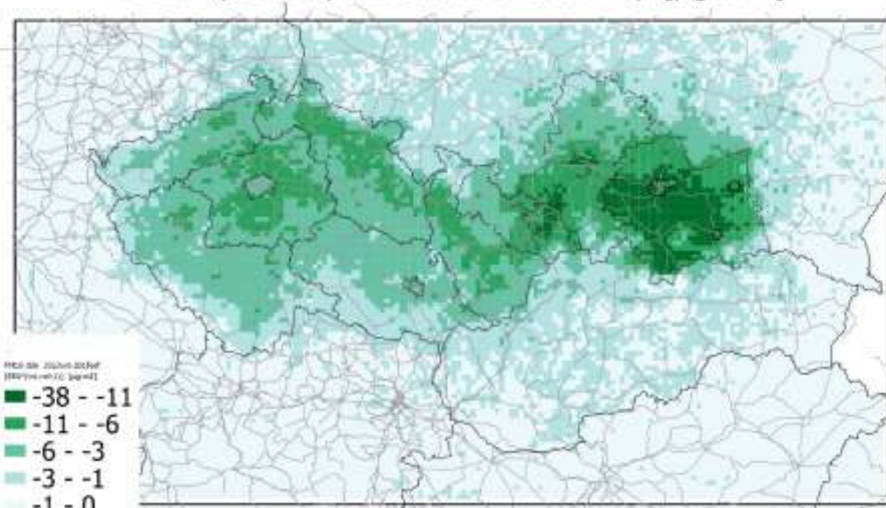
PM_{10} 36th highest daily average, 2023 optimistic

(EEA * 2023 optimistic / 2015 ref) [μg.m^{-3}]



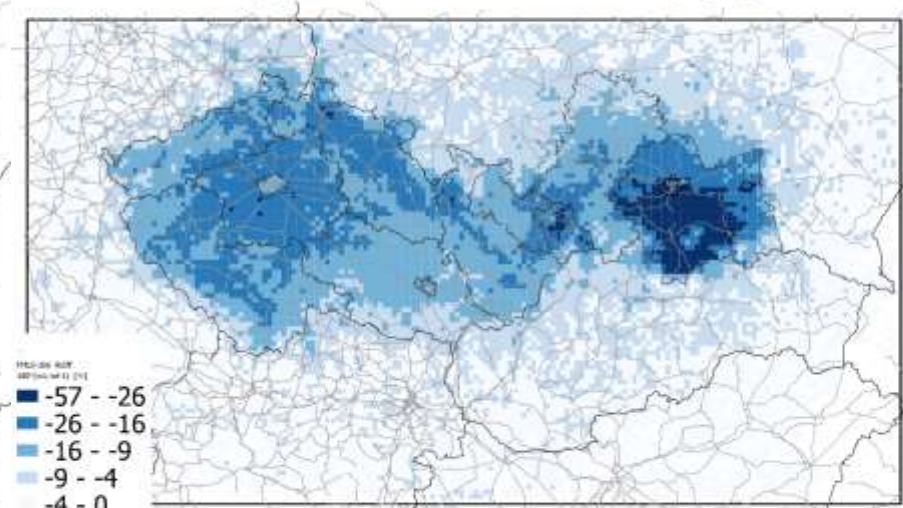
Absolute change of PM_{10} 36th highest daily average

EEA * (2023 optimistic / 2015 ref - 1) [μg.m^{-3}]



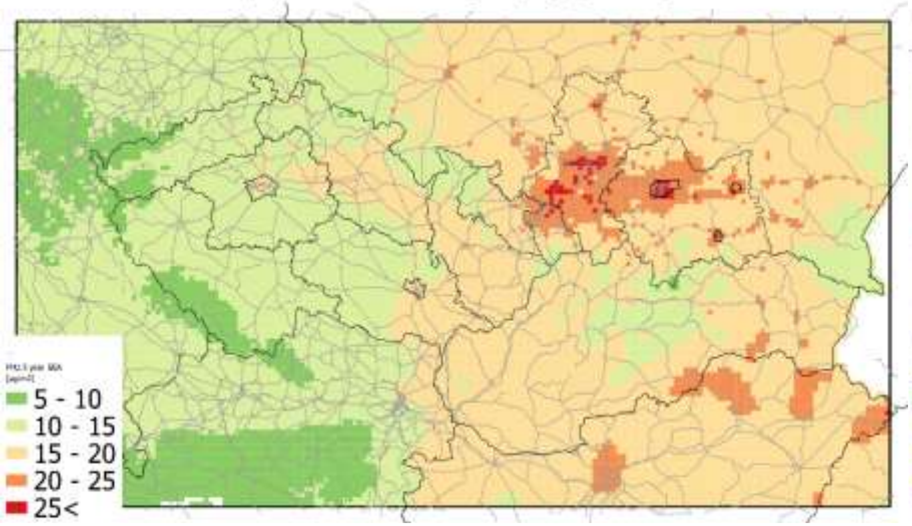
Relative change of PM_{10} 36th highest daily average

100 * (2023 optimistic / 2015 ref - 1) [%]



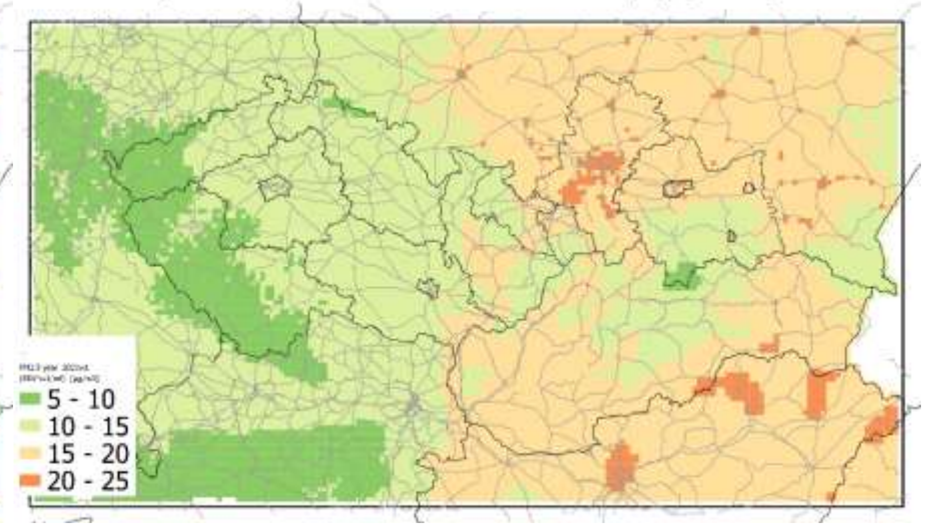
$PM_{2.5}$ annual average, 2015 ref

(EEA on CAMx grid) [$\mu g.m^{-3}$]



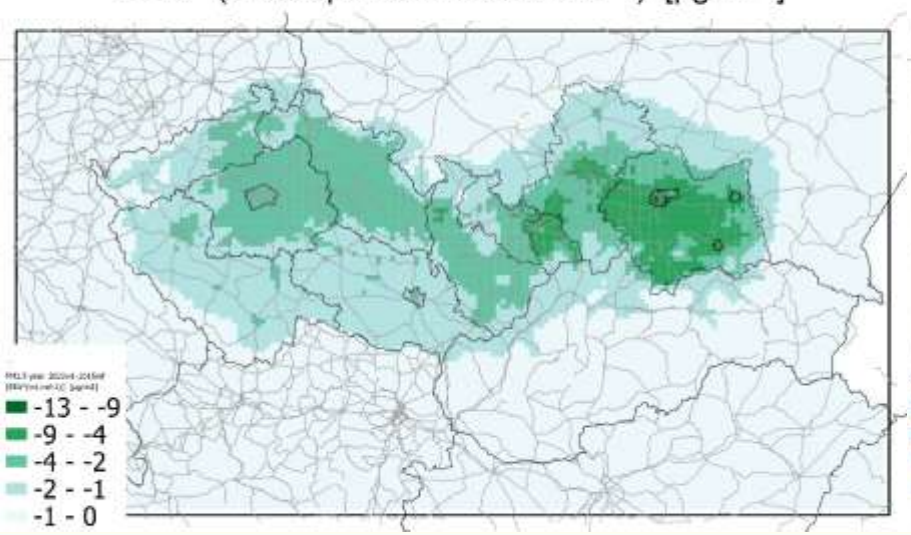
$PM_{2.5}$ annual average, 2023 optimistic

(EEA * 2023 optimistic / 2015 ref) [$\mu g.m^{-3}$]



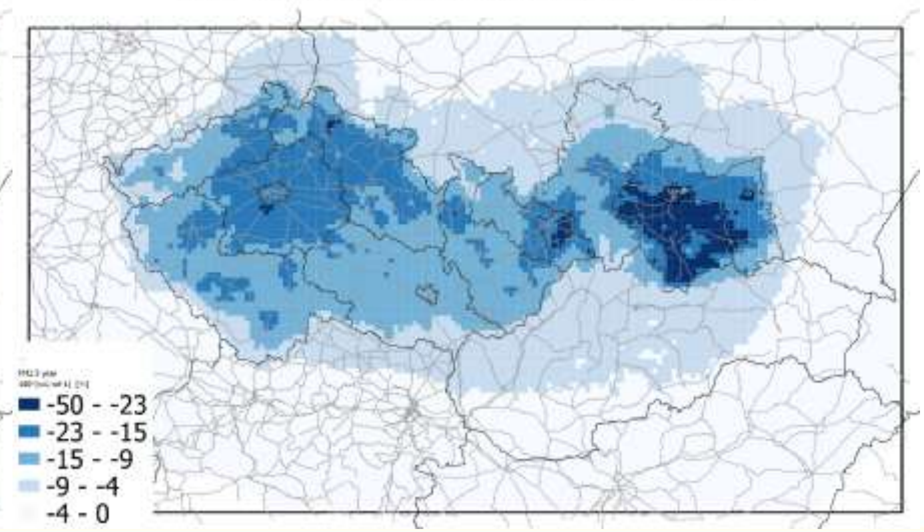
Absolute change of $PM_{2.5}$ annual average

EEA * (2023 optimistic / 2015 ref - 1) [$\mu g.m^{-3}$]



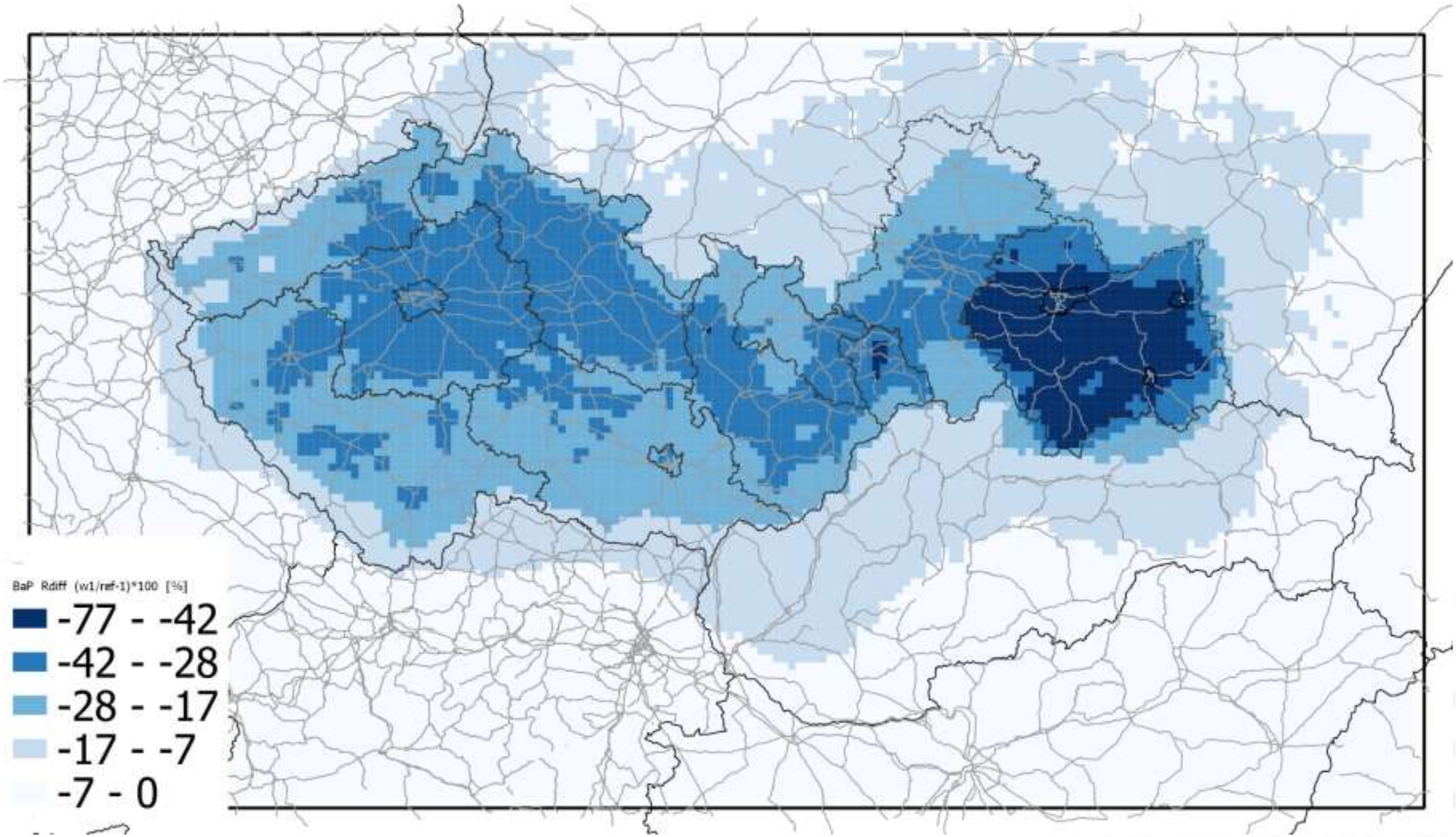
Relative change of $PM_{2.5}$ annual average

100 * (2023 optimistic / 2015 ref - 1) [%]



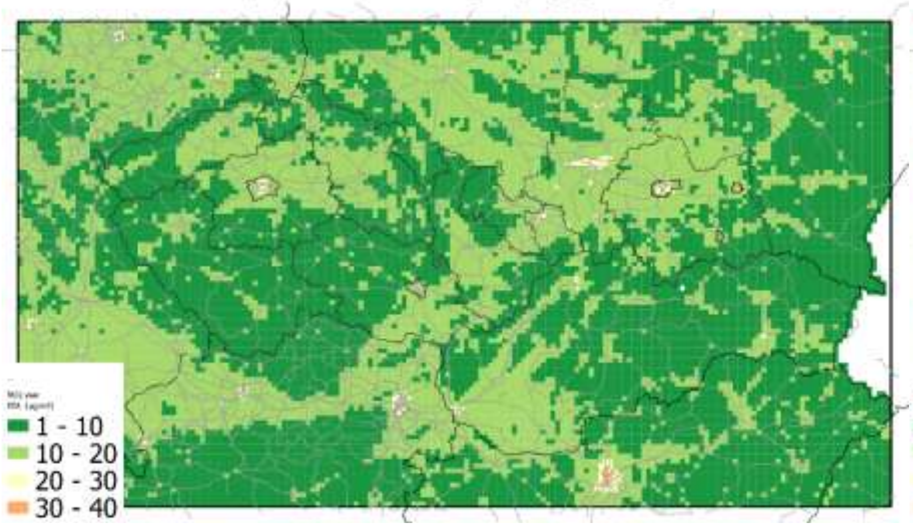
Relative change of B[*a*]P annual average

100 * (2023 optimistic / 2015 ref - 1) [%]



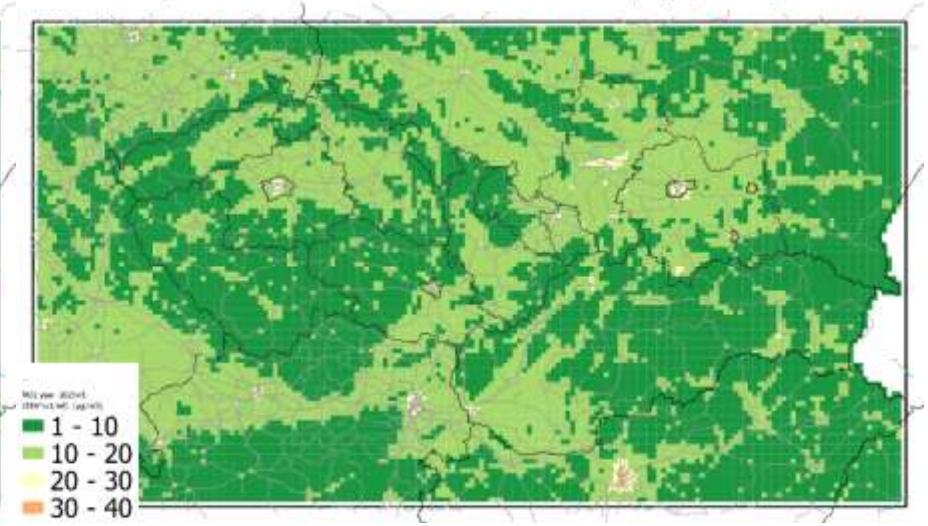
NO_2 annual average, 2015 ref

(EEA on CAMx grid) [µg.m^{-3}]



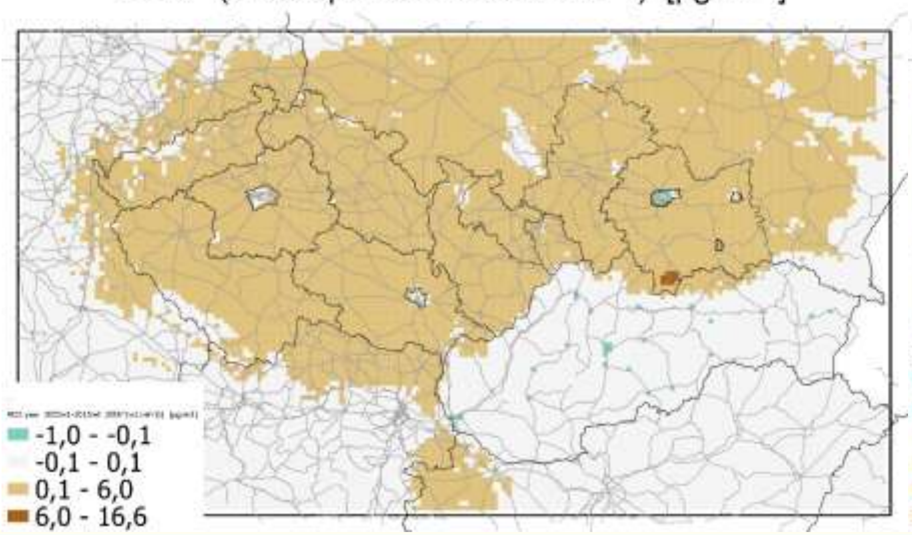
NO_2 annual average, 2023 optimistic

(EEA * 2023 optimistic / 2015 ref) [µg.m^{-3}]



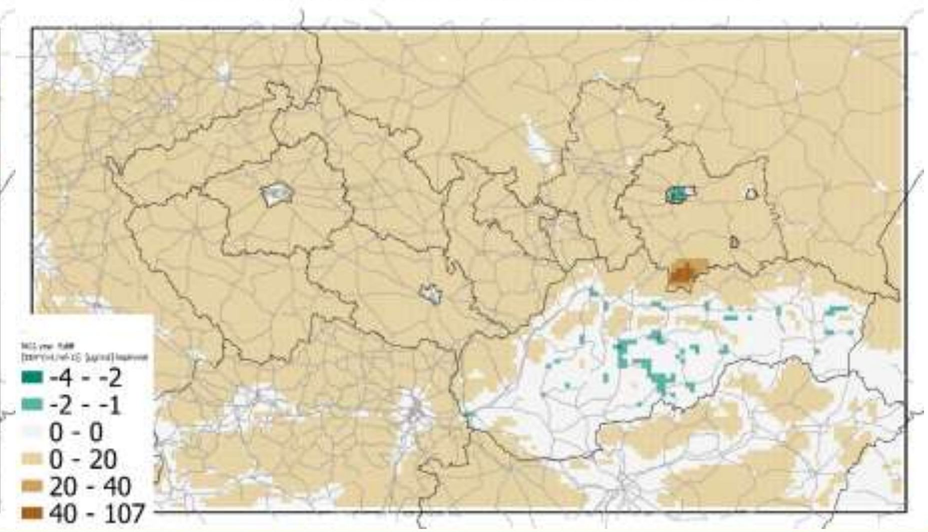
Absolute change of NO_2 annual average

EEA * (2023 optimistic / 2015 ref - 1) [µg.m^{-3}]



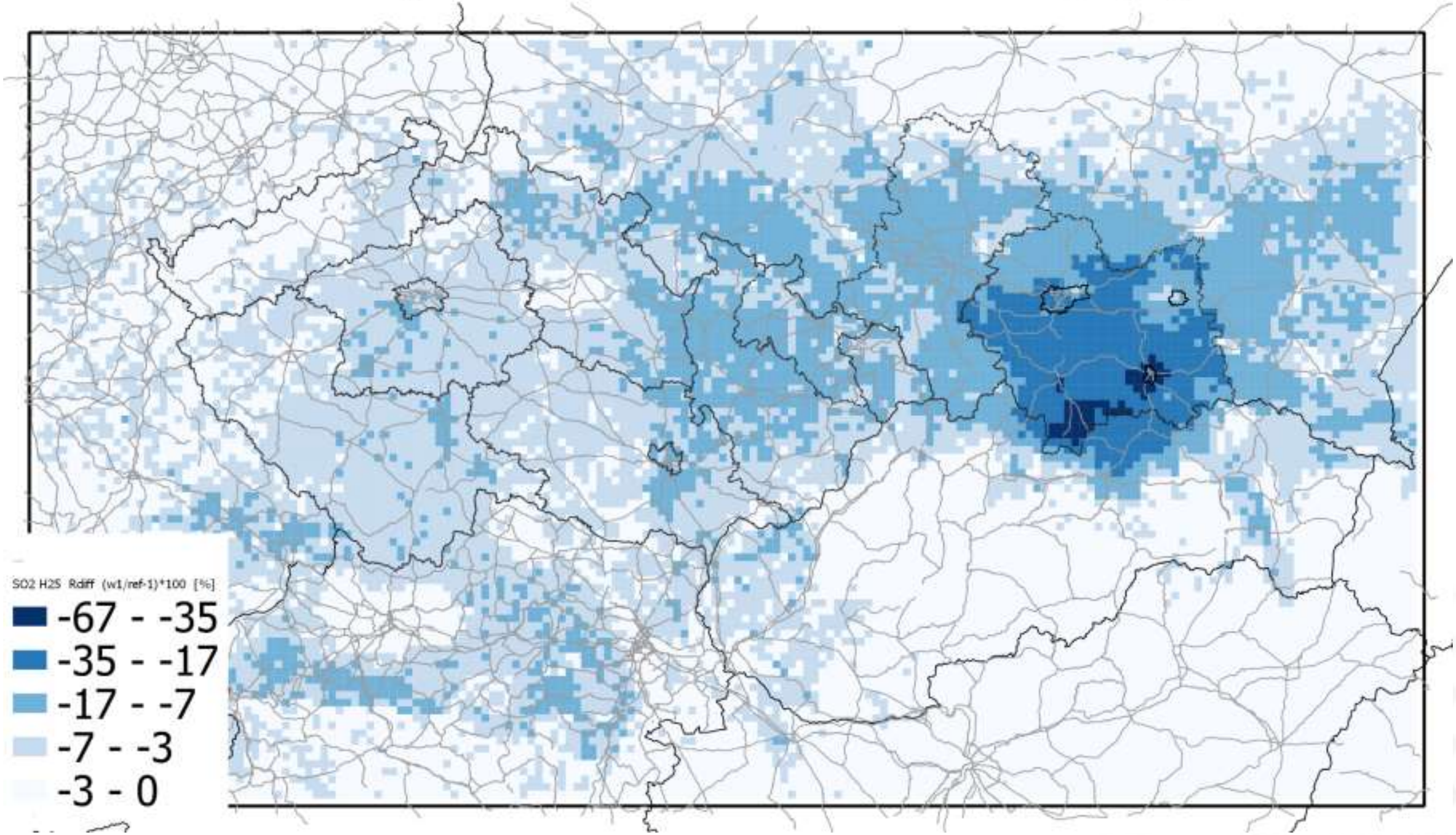
Relative change of NO_2 annual average

100 * (2023 optimistic / 2015 ref - 1) [%]



Relative change of SO_2 25th highest hourly average

100 * (2023 optimistic / 2015 ref - 1) [%]



Děkuji za pozornost!