Emissions data for of heavy metal and POP modelling

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Processing of emissions data

Annual gridded data for the new EMEP domain (0.1°×0.1°)

Primary emissions data (prepared by CEIP):

- Gridded sectoral emissions (Pb, Cd, Hg, PCDD/Fs, HCB)
- Gridded sectoral emissions of 4 PAHs (BaP, BbF, BkF, IP)
- No gridded data for PCBs (no congener composition reported)

Additional data and auxiliary parameters (prepared by MSC-E):

- PCBs gridded emissions based on national data and expert estimates
- Seasonal variation of emissions (all HMs and POPs)
- Vertical distribution of emissions (all HMs and POPs)
- Emission speciation (Hg) and congener composition (PCDD/Fs)
- Global and historical emissions (Hg, PCBs, PCDD/Fs, HCB)

Review of emission parameters

Ranking of key emission parameters

Emission parameter	Pb and Cd	PAHs	Hg	PCDD/Fs PCBs	HCB
Gridded emissions	1	1	1	1	1
Chemical composition	-	-	2	2	-
Temporal variation	2	2	6	6	5
Vertical distribution	3	3	7	7	6
Global emission inventory	4	4	3	3	3
Historical emissions	5	5	4	4	2
Emissions to other media	6	6	5	5	4

- 1st priority - 2nd priority - 3rd priority

Joint CEIP / MSC-E technical reports on HM and POP emission inventory improvement (2017)

Preparation of PCB emissions

Available information on PCB emissions:

- Reported national totals and gridded data without congener composition
- Gridded global inventory of 22 PCB congeners (*Breivik et al.*, 2007)

Emissions data for modelling:

- Indicator congener: PCB-153
- Spatial distribution: Reported national data (or population density)
- Country totals: Expert estimates (*Breivik et al.*, 2007)

Limitations and requirements:

- No congener composition is reported
- Available expert estimates are quite outdated
- Modelling also needs PCB emissions to other media (soil, water)

Possible solution – National reporting of rough estimates of congener composition or updates of available expert estimates

Data processing: Chemical composition

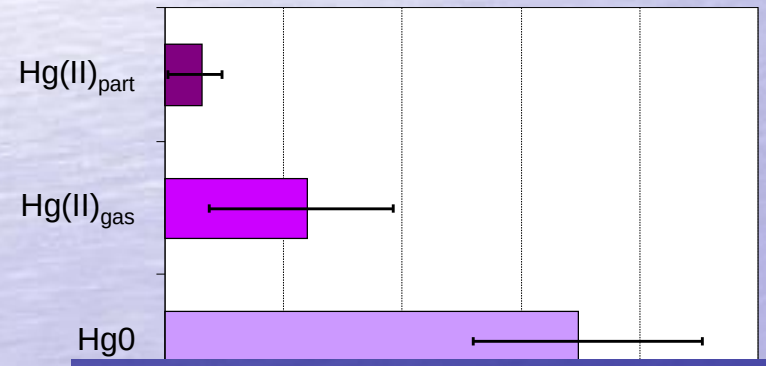
Mercury

Species: Hg^0, $Hg(II)_{gas}$, $Hg(II)_{part}$

Reported emissions: total Hg

Expert estimates: UNEP GMA 2013 (*AMAP/UNEP, 2013)*

Average Hg emission speciation in the EMEP countries



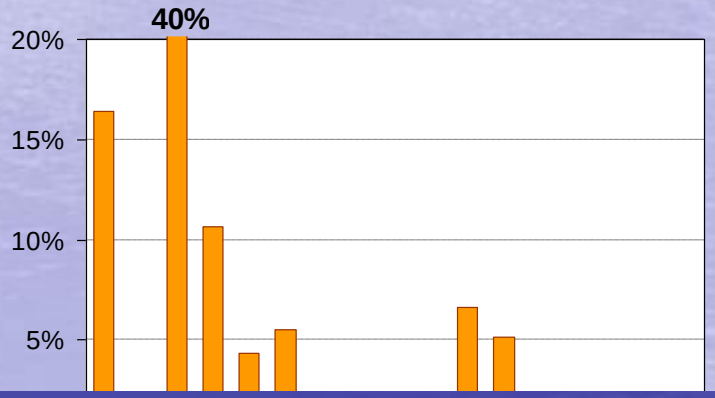
PCDD/F

Species: 17 toxic congeners

Reported emissions: total toxicity equiv.

Expert estimates: POPCYCLING-Baltic project (*Pacyna et al.*, 2003)

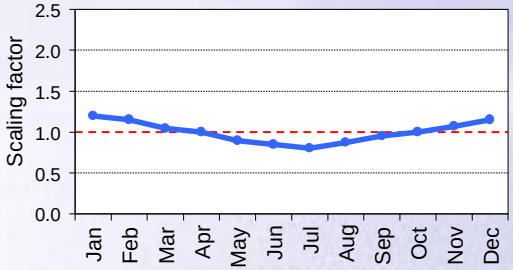
Average PCDD/F congener composition in the EMEP countries



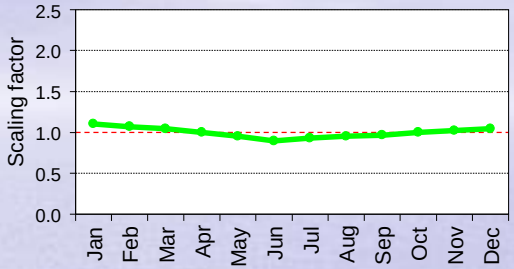
Hg and POPs modelling is very sensitive to chemical composition but available expert estimates are uncertain and outdated

Data processing: Seasonal variation

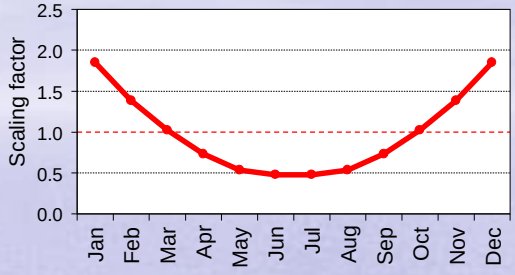
Public power (A)



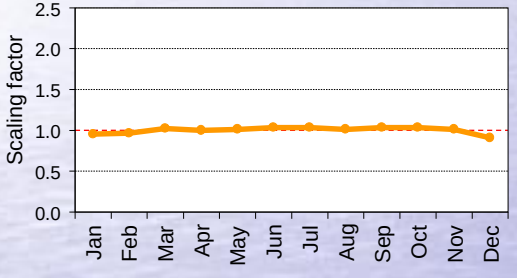
Industry (B)



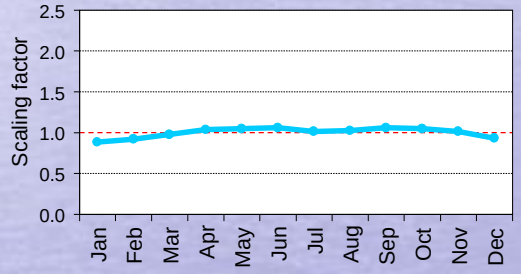
Residential combustion (C)



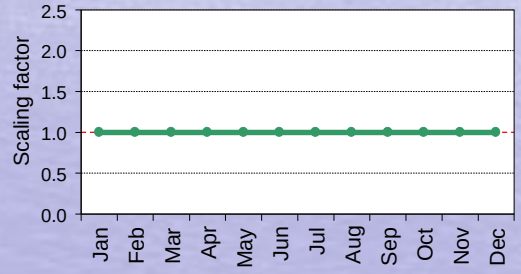
Solvents (E)



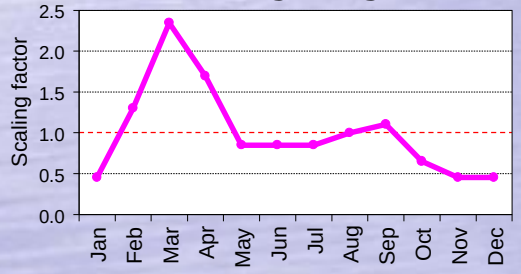
Transport (F, G, H, I)



Fugitive (D), Waste (J), Livestock (K)

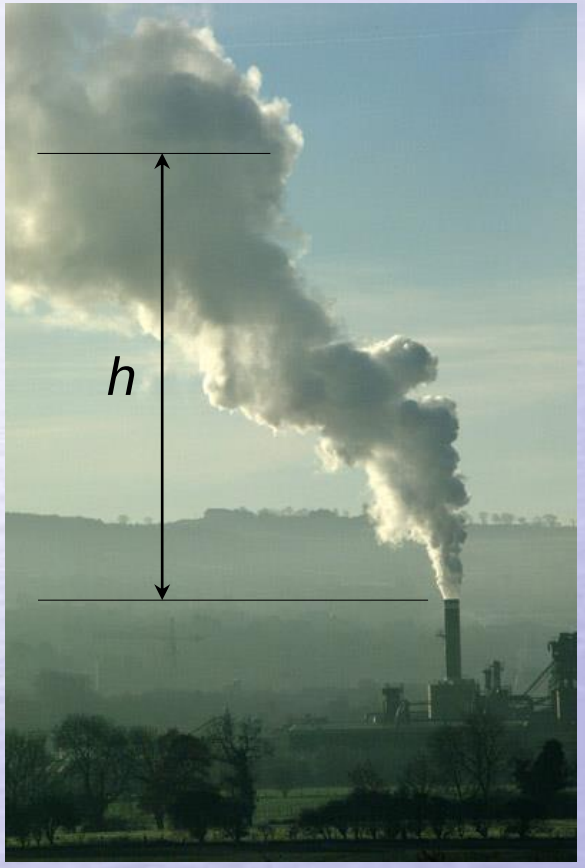


Field burning in agriculture (L)

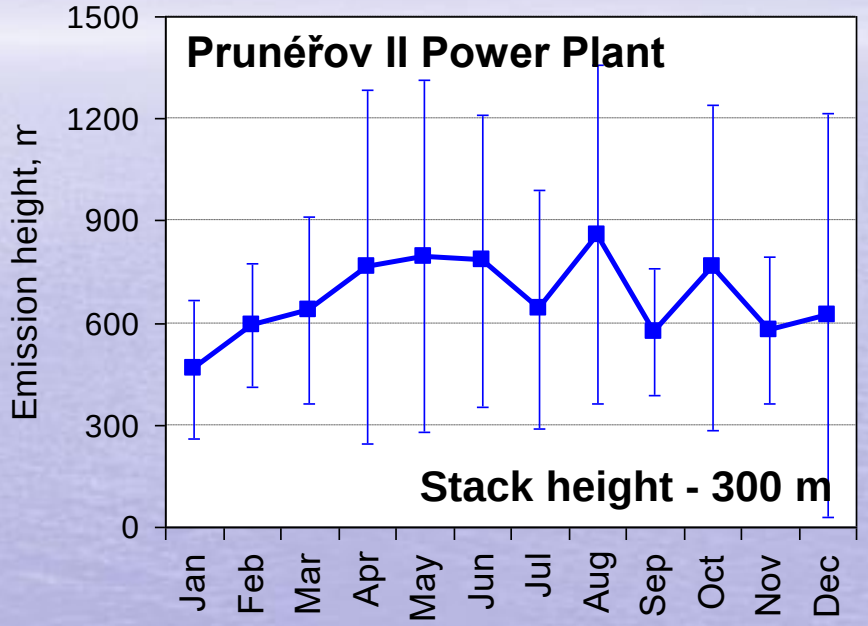


Source: Parameterization of seasonal variations developed by TNO (*van der Gon et al.*, 2011)

Data processing: Vertical distribution



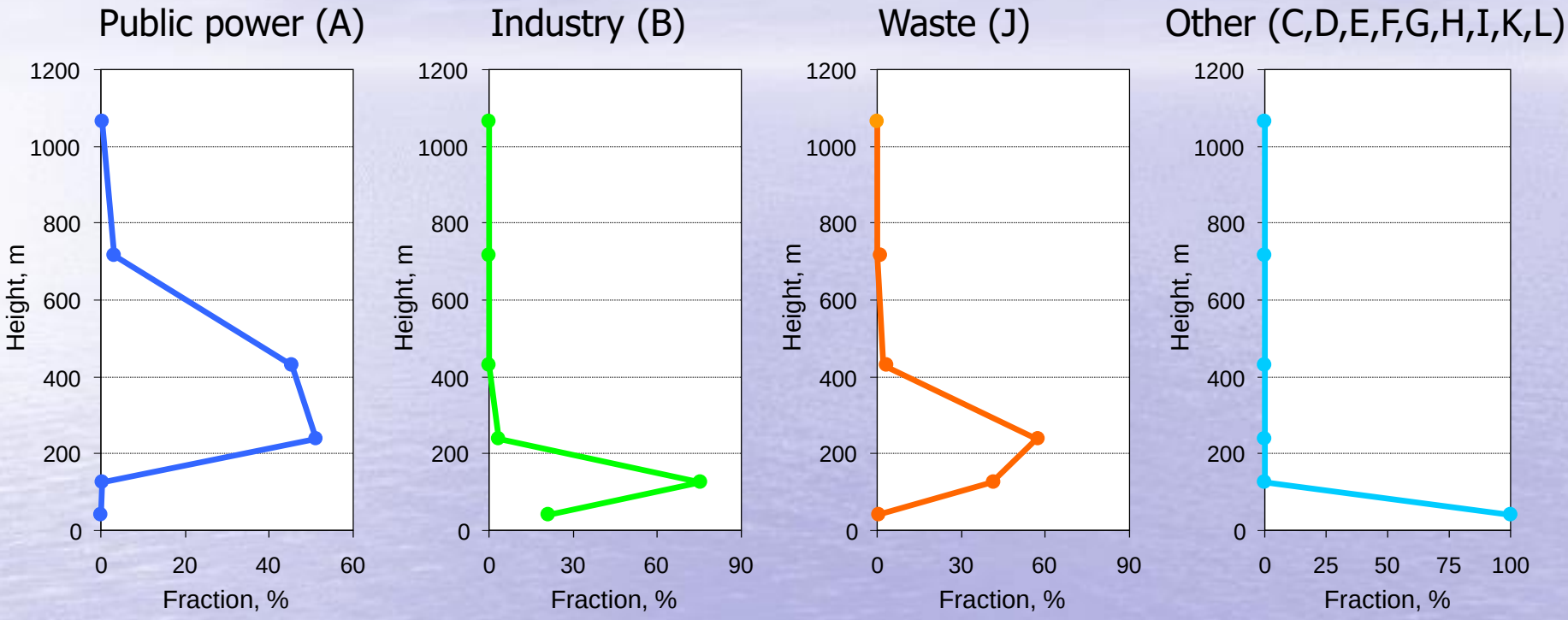
Estimates of effective emissions height (Brigg's approach)



Required parameters:

- Stack height
- Stack diameter
- Gas outflow velocity
- Gas temperature

Data processing: Vertical distribution

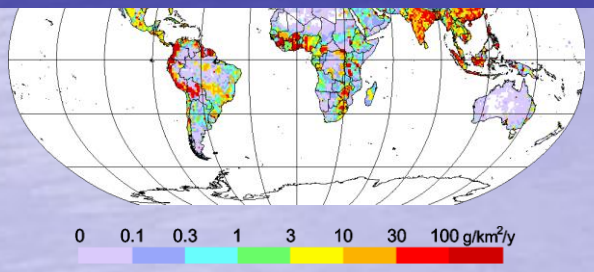


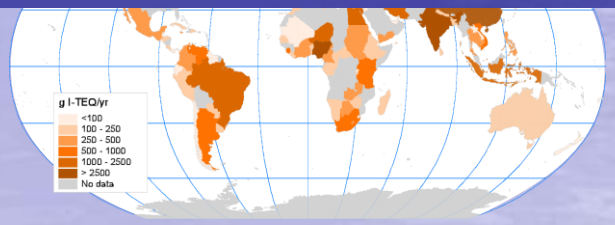
Source: Vertical emission profiles calculated by the SMOKE emission preprocessor (*Bieser et al.*, 2011)

Compilation of global emissions

Chemicals	*Years*	*Resolution*	*Dataset*
Pb	1989	1°×1°	NILU/CGEIC, 2000
Cd	1995	n/a	Pacyna&Pacyna, 2001
Hg	2010, 2015	0.5°×0.5°	AMAP/UNEP, 2013; 2018
	1970-2012	0.1°×0.1°	EDGAR (JRC, 2018)
PCBs	1930-2100	1°×1°	Breivik et al., 2007
PAHs	1960-2014	0.1°×0.1°	Shen et al., 2013
PCDD/Fs	2004	n/a	Wang et al., 2016
	1999-2014	n/a	SC inventory, 2018
HCB	1995	n/a	Bailey et al., 2001

Further development of global inventories requires co-operation with other international bodies (UN Env., Minamata and Stockholm Conv.)





Model evaluation of emissions: Case studies

Objective:

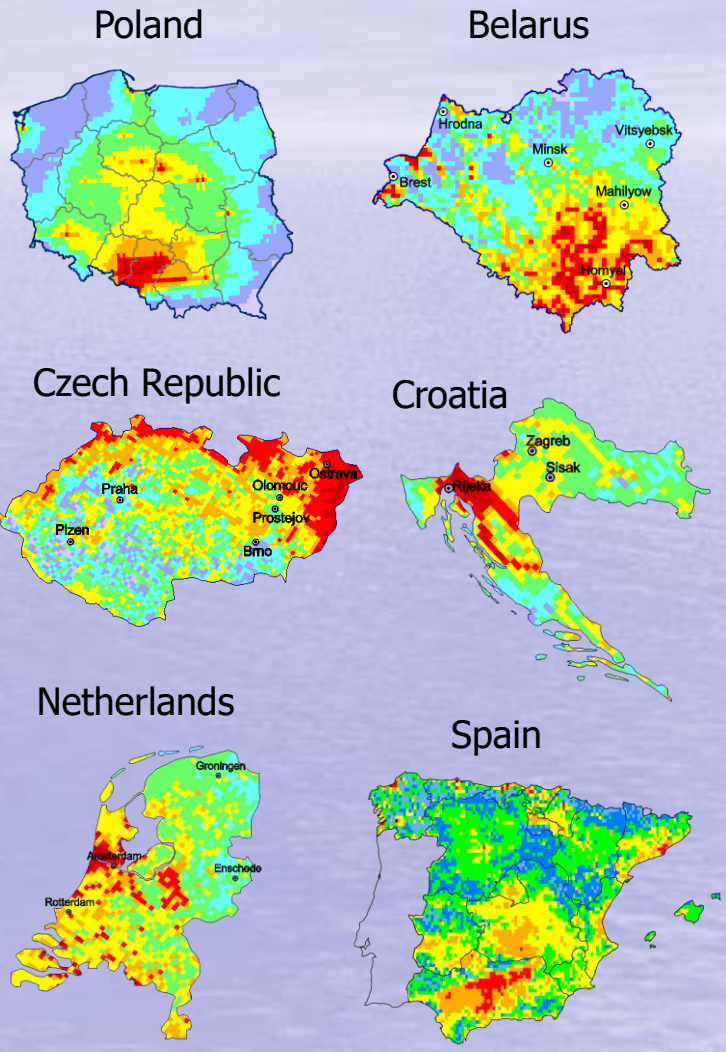
Evaluation of pollution levels in a country involving variety of national data

Countries involved:

Czech Republic, Croatia, the Netherlands, Belarus, UK, Poland, Spain, France, Germany

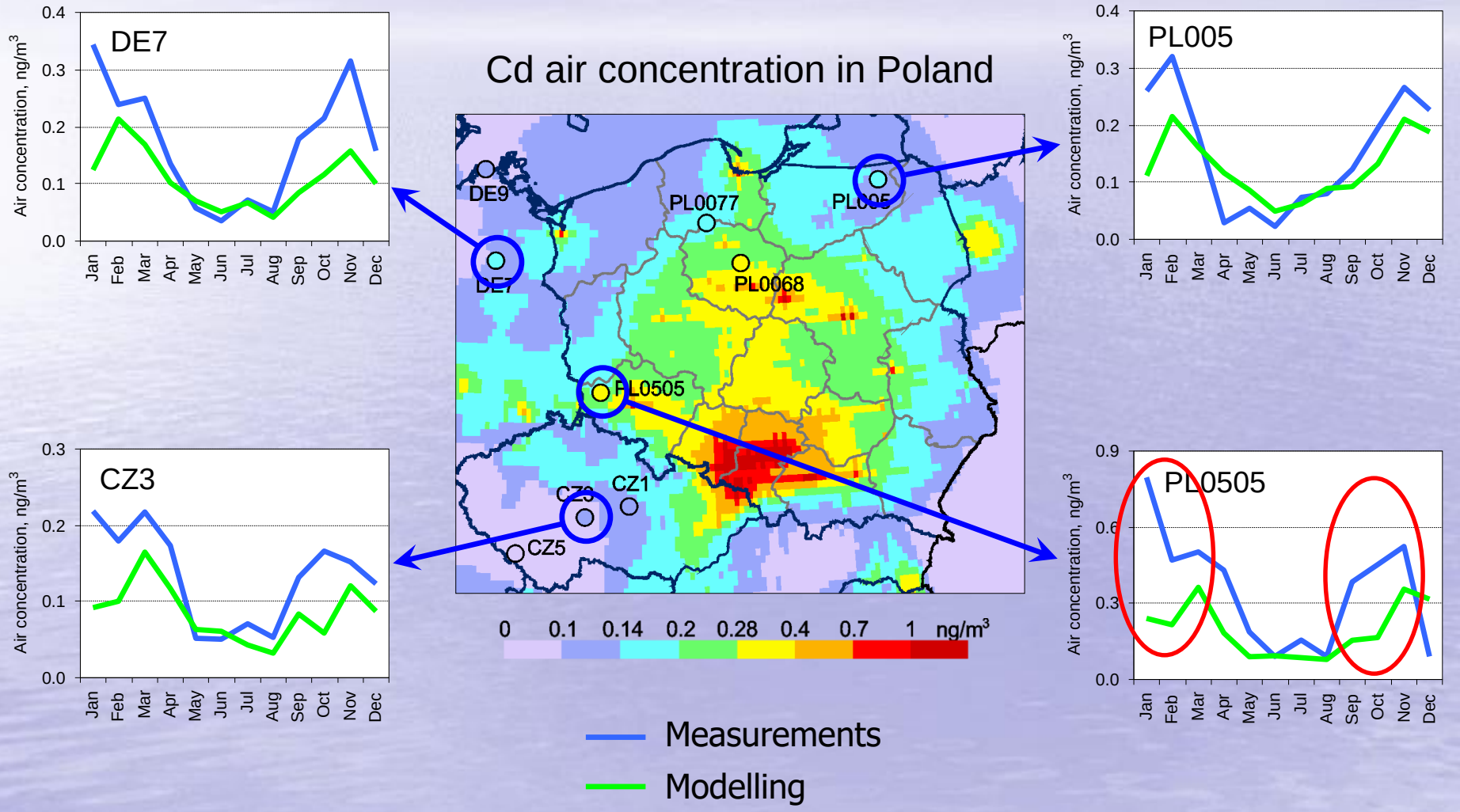
Evaluation of emissions:

- Preliminary analysis based on comparison of modelling results with measurements
- Development of emission scenarios (e.g. using statistical optimization)
- Model evaluation of scenarios



Poland: Cd from residential combustion

Detailed analysis of Cd levels involving measurements and modelling



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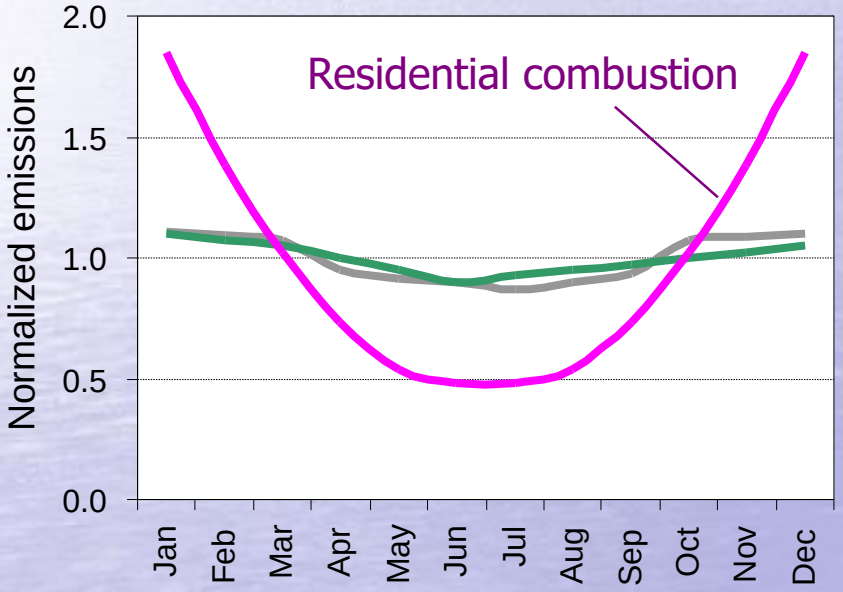
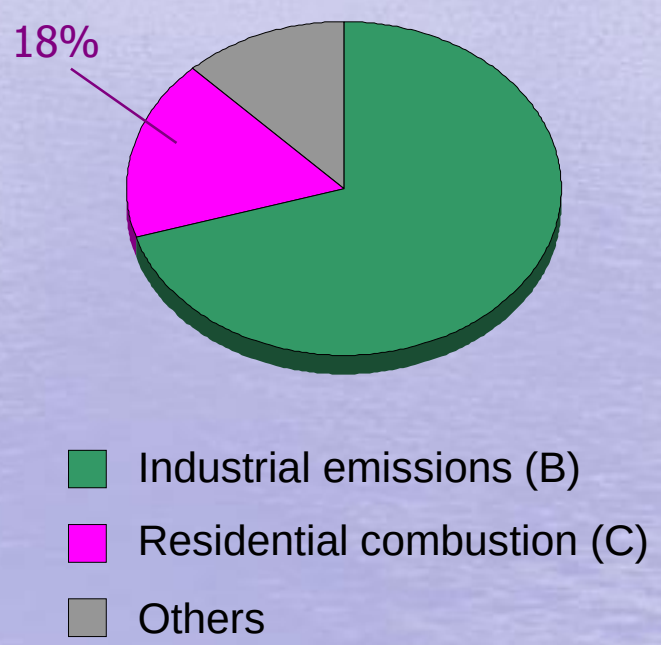
Preliminary analysis of possible reasons

Seasonal variation of anthropogenic emissions

Seasonal variation of emissions
(TNO expert estimates)

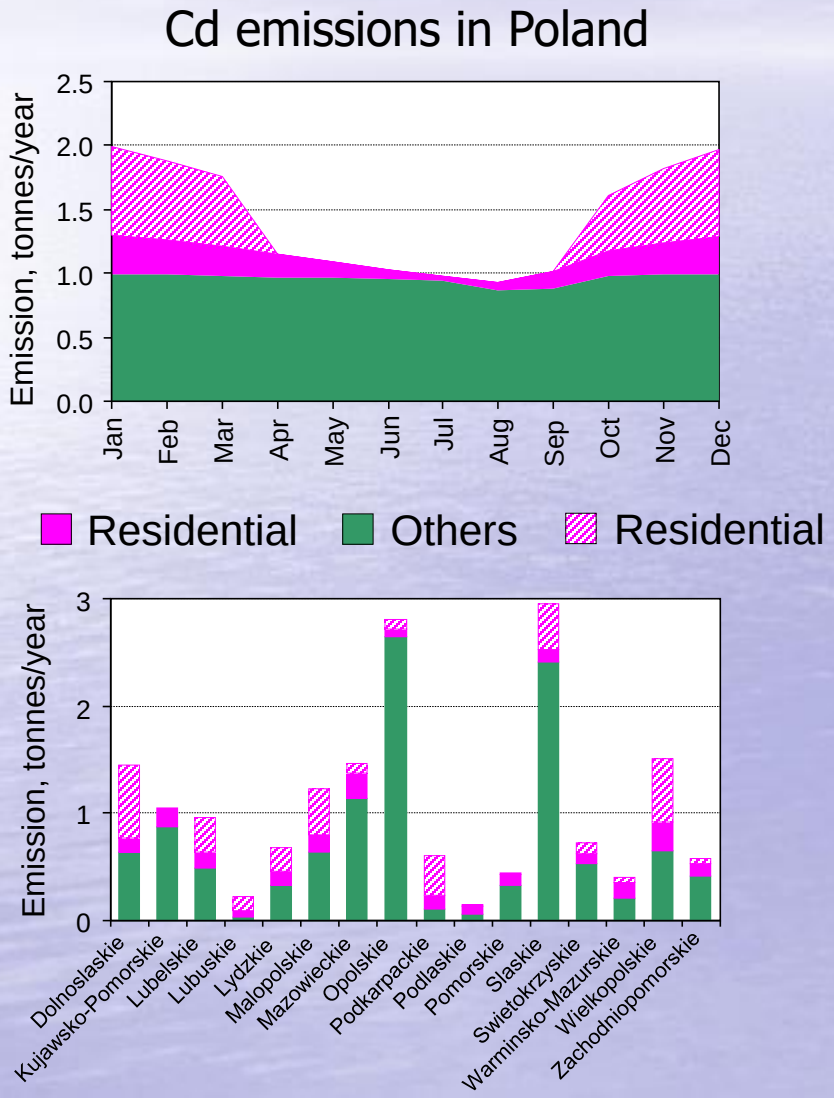


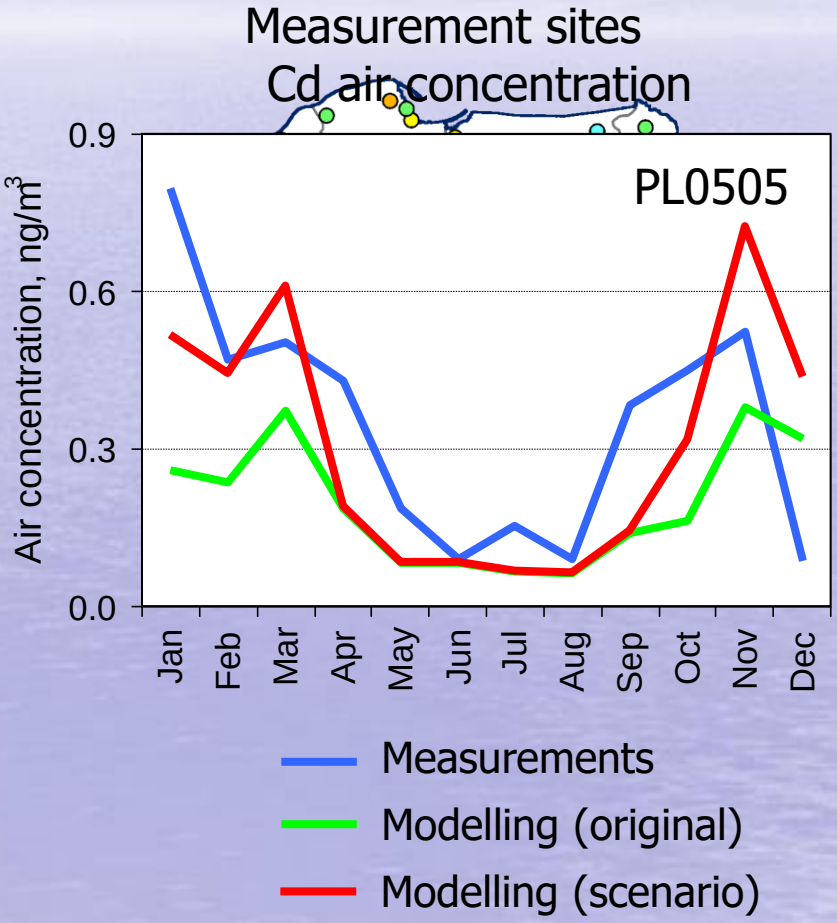
Contribution of major sectors to
Cd emissions in Poland



Emission scenario

Statistical optimization of Cd emissions based on measurement data

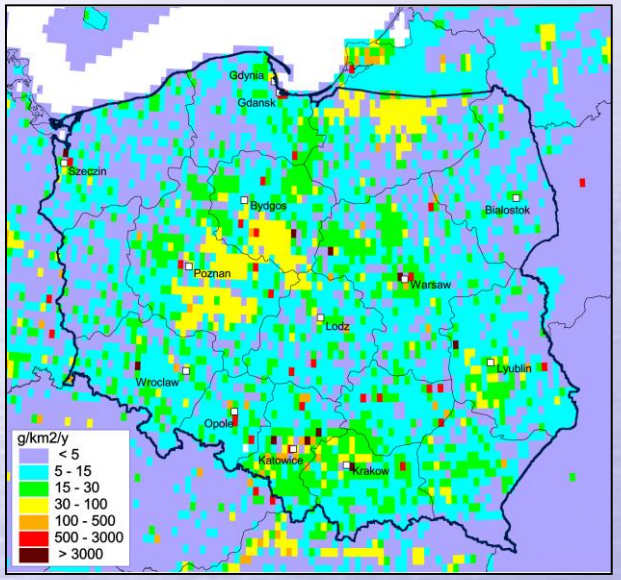




Emissions change

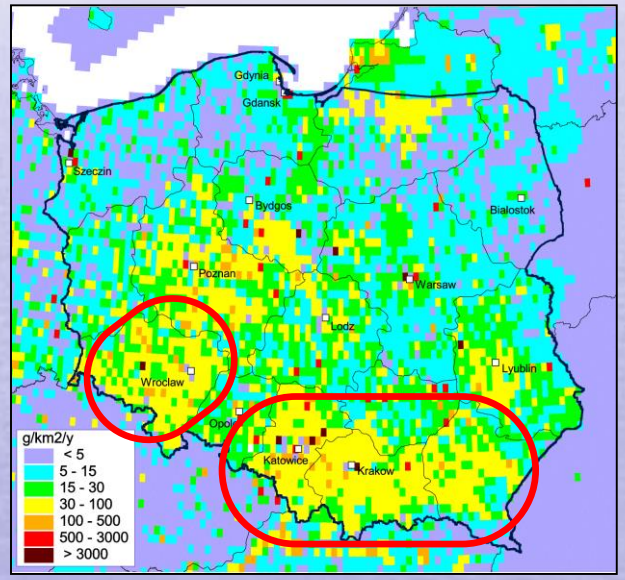
Annual anthropogenic emissions of Cd in Poland in 2014

Original



Total: 13.6 t/y

Scenario

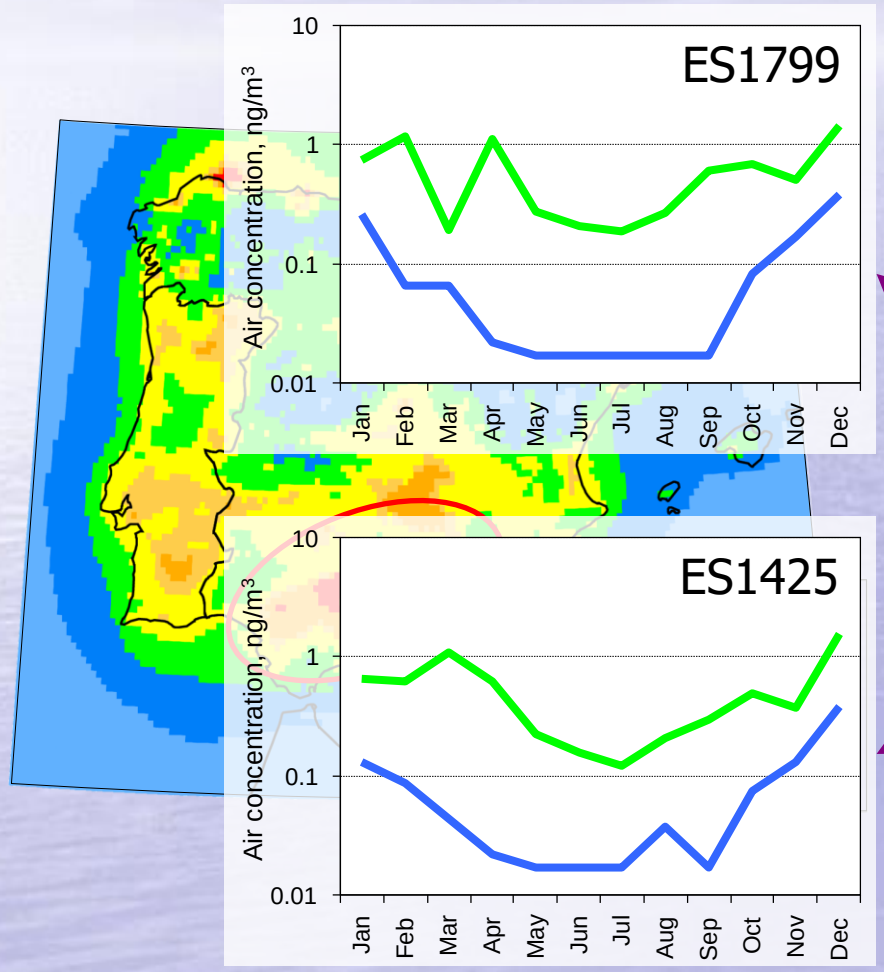


Total: 17.2 t/y (26% increase)

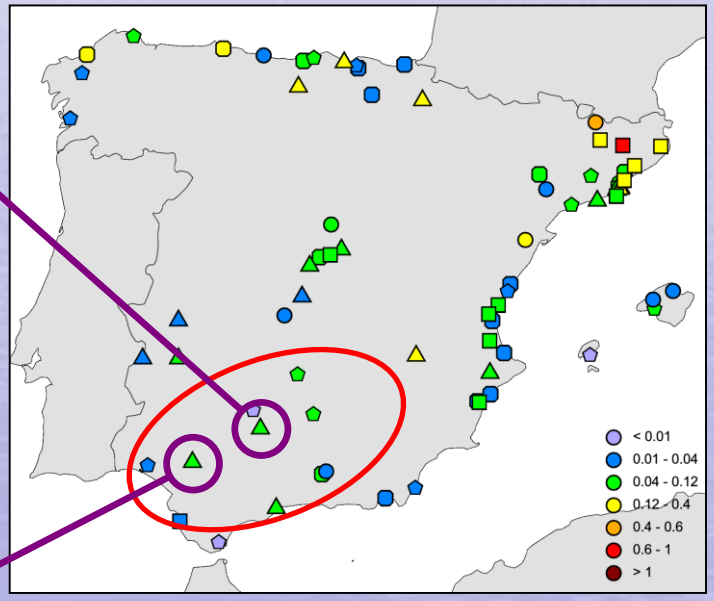
Probably, emissions of Cd from residential combustion are significantly underestimated in the south and southwest parts of Poland

Spain: PAH emissions from agriculture

Annual air concentration of B(a)P in Spain in 2014



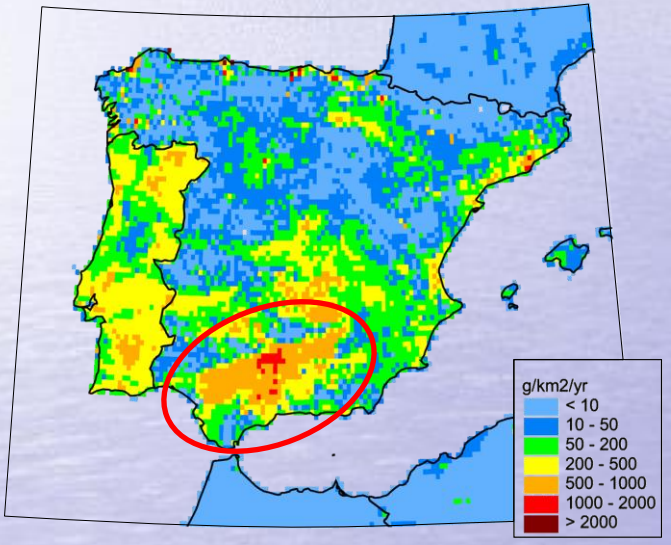
Measurements



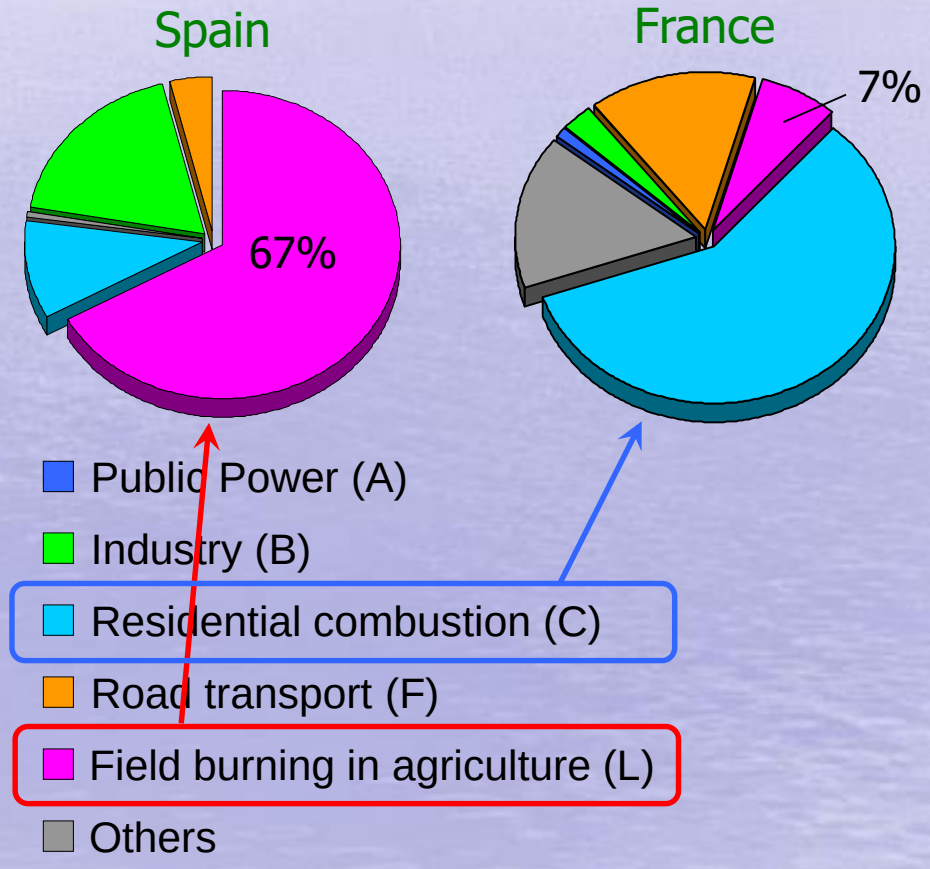
Spain: PAH emissions from agriculture

Anthropogenic emissions of B(a)P in Spain in 2014

B(a)P emissions (2014)



Sectoral composition of B(a)P emissions



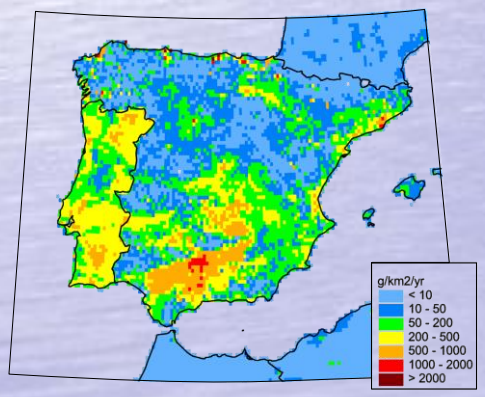
Emission scenario

Annual anthropogenic emissions of B(a)P in Spain in 2014

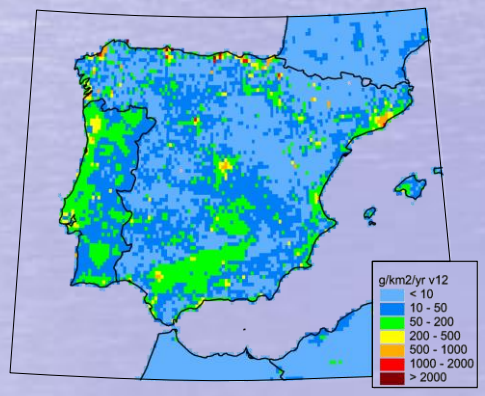
Base case: Reported emission data (2014)

Scenario: Field burning emissions (L) decreased from 67% to 8% to fit measurement data

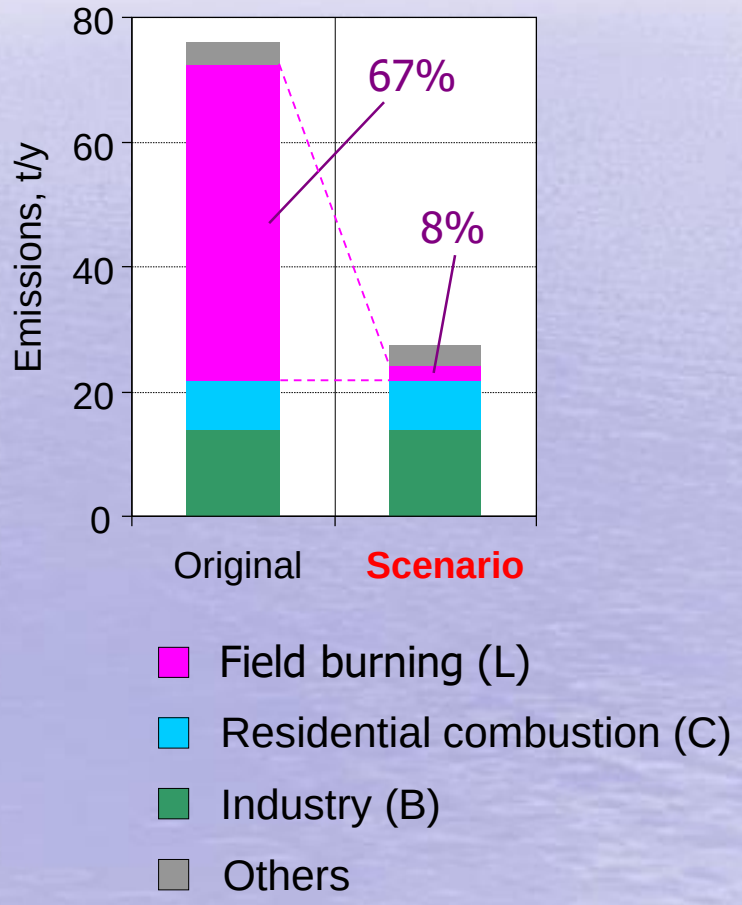
Original emissions



Scenario emissions



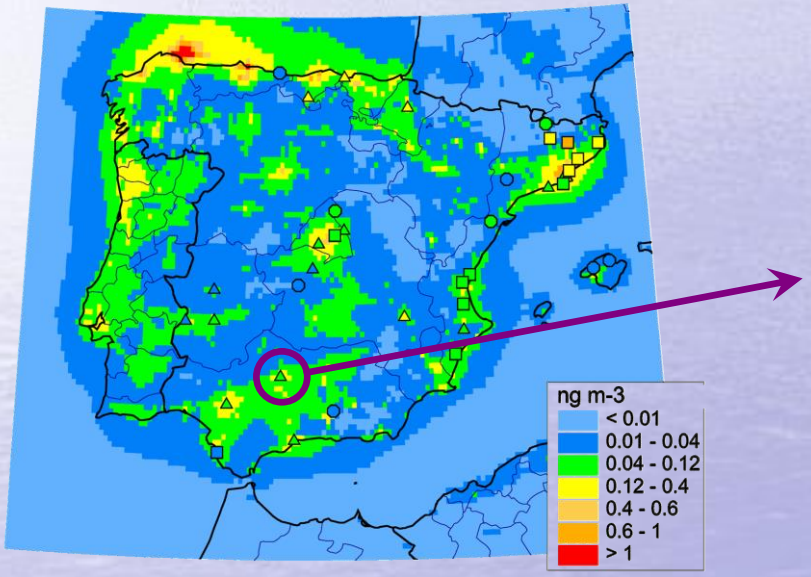
B(a)P emissions in Spain (2014)

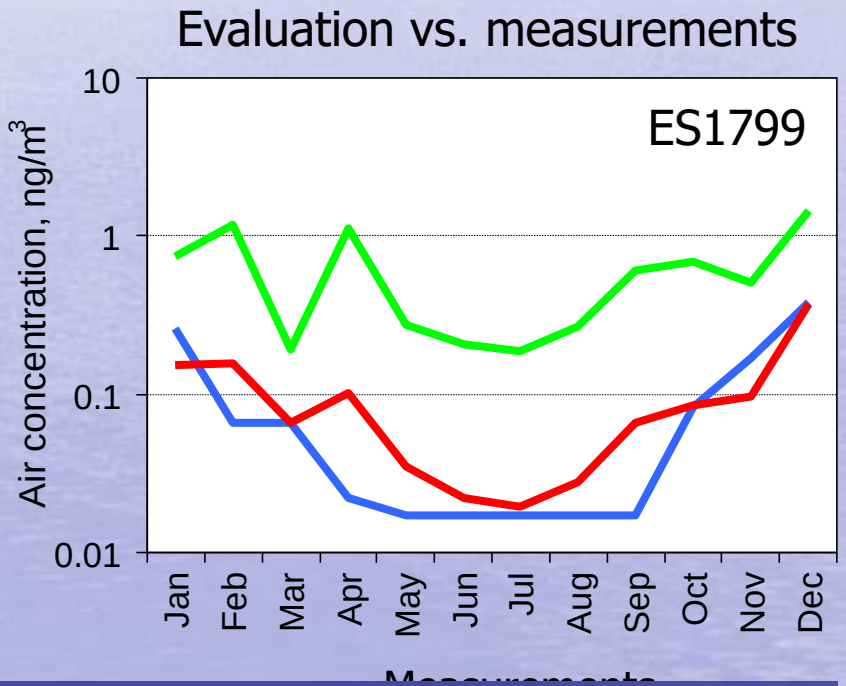


Model evaluation

Simulations of B(a)P in Spain based on scenario emissions (2014)

B(a)P concentration (annual)





Emissions of B(a)P from field burning in agriculture are largely overestimated in southern Spain

Further case studies for B(a)P

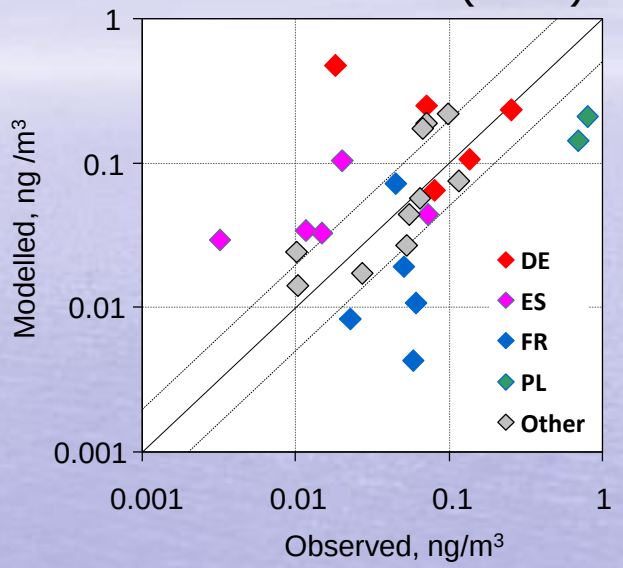
Spain and France (ongoing):

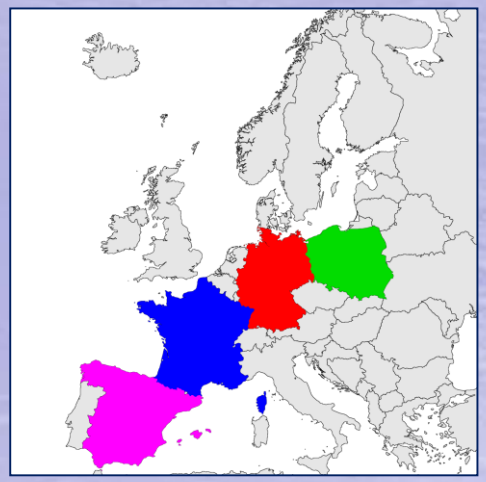
- Analysis of national emissions and measurements
- Modelling for Spain and France using GLEMOS and CHIMERE models
- Analysis of sensitivity of model results to changes of national emissions
- Analysis of factors affecting B(a)P transport: interaction with aerosols, reactants
- Refinement of parameterizations for physical and chemical processes

Poland and Germany (proposed):

- Proposal to perform country-specific assessment to refine estimates of B(a)P pollution

Modelled vs. measured B(a)P concentrations (2016)





Recommendations

Emissions reporting:

- Chemical composition of emissions is critical for Hg, PCDD/Fs, and PCB modelling and requires update and refinement (possible co-operation with UN Env., Minamata and Stockholm Conventions)
- B(a)P is a priority pollutant and needs particular attention in terms of sectoral composition and spatial distribution of emissions data

Evaluation of emission data:

- Model evaluation of emission estimates can be relevant, particularly, on a national scale
- It can be applied on a regular basis for evaluation of national emissions, e. g. as a part of the emissions review process