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Comparing aerosol emission estimates using different approaches and emission factor datasets in EDGAR

G. Janssens-Maenhout, M. Muntean, A.Hjadu, J. Olivier, R. Petrescu, V. Pagilari, F. Dentener, J. Wilson, E. Vignati

ABSTRACT

Much of the uncertainty in estimates of aerosol effects on climate change is due to the continuing large uncertainties in black or elemental (BC or EC) and organic (OC) carbon emission inventories. We have derived EC emission inventories by combining source profiles with both particulate matter (PM) emission factor and sector-specific mass fractions for EC, and technology-specific combustion models to that directly estimate EC emission factors. Differences between both approaches are evaluated by comparing sector- and country-specific emission trends of EC inventories applying the Bond or GAINS approach. The resulting gridmaps using Bond approach for USA and GAINS approach for Europe and China were assessed for different sectors by comparing these with the EDGAR-HTAP patchwork of officially accepted EC emission inventories.

COMPARISON of DATASETS

EOLO platform

EDGARv4 =ADxEF

Technology-based calculations

EDGARv4.0: for 1970-2005:
CO_2, CH_4, N_2O, HFCs, PFCs, SF_6
http://edgar.jrc.ec.europa.eu, May '09

EDGARv4.1: for 1970-2005: v4.0 GHG corrected + CO, SO_2,NO_x, NMVOC, NH_3
http://jrc.ec.europa.eu, July '10

EDGARv4.2: 1970-2008: v4.1 GHG&AP corrected + aerosols (PM10, PM2.5) to be released

EDGAR-HTAP =ΣEM_i

Collection of official inventories

HTAP_V0: for 2000-2005:
CH4, SO2, NOx, CO, NMVOC, NH3, PM10, PM2.5, BC, OC (2000-2005)
http://edgar.jrc.it/eolo, May '10

HTAP_V1: for 2000-2005: V0 CH4 & AP & aerosols corrected w/o Savannah burning & pave dust
http://edgar.jrc.it/eolo (passwd)
aggregated maps for HTAP, Streets et al., HTAP, Ch. 3 (2010)

An inventory for ozone precursors and particulate matter was constructed for the Task Force on Hemispheric Transport of Air Pollution at the EOLO-web-server, with EMEP-data (2009), UNFCCC (2009) - data for CH4, GAINS (2008) for China, REAS (2007) for East-Asia, gapfilled with EDGAR v4.1 and gridded with EDGAR's proxy data.
[Cfr. Dentener et al (2011)]

"Official" EDGAR-HTAPv1.1 versus "scientific" EDGARv4.2

The EDGAR-HTAPv1.1 inventory of man-made emissions covers for the time period from 2000 to 2005, the acidification and ozone precursors: CH_4, CO, NO_x, NMVOC, SO_2 and NH_3, and aerosols PM10, PM2.5, BC & OC. The 2000 emissions per world regions are in (Tg specie)/yr *[Cfr. Streets et al., HTAP report Ch.3, (2010)]* ***compared to the EDGARv4.2 emissions for the different world regions***

EMEP data (NFR08) communicated by TFEIP, R. Wankmueller (2009)
UNFCCC GHG inventories, nationally reported (2008)
US EPA data for USA, communicated in gridmaps by Battye (2008)
GAINS inventory for China, communicated by Klimont (2008)
REAS inventory of Ohara (2007) communicated by J. Kurokawa (2008)
REAS inventory gapfilled for agricultural sectors with EDGARv4.1
EDGAR v4.1 data as online since July 2010
EDGAR v4.2 preliminary version 2010

	CH4	CO	NOx	SO2	NMVOC	NH3	PM10	PM2.5	BC	OC
Europe+Canada +Iceland	29.806	44.224	15.342	13.942	15.324	5.561	5.841	2.549	0.364	0.901
Russia+ Moldova +Ukraine+Turkey	25.509	17.111	5.796	2.775	5.608	1.125	1.071	0.626	0.115	0.42
USA	25.112	90.588	20.372	15.507	17.831	3.915	13.198	4.457	0.157	0.296
Japan	2.107	3.018	2.017	0.044	2.117	0.44	0.254	0.167	0.067	0.044
Rest Annex I (Oceania)	6.437	4.918	1.832	2.997	0.957	0.762	0.305	0.151	0.024	0.073
China	56.03	144.384	16.926	31.528	23.876	12.545	17.883	12.725	1.366	2.812
Rest Eastern, Southern Asia	62.071	211.425	15.057	15.33	26.087	13.11	25.359	12.586	1.779	7.378
Rest Non-Annexl (Africa, Latin-America)	97.333	112.889	17.319	20.864	40.385	9.249	11.543	8.673	1.162	4.365
International bunkers	0.442	1.459	14.812	8.019	4.756	0	1.324	1.311	0.036	0.105
Total in 2000 Tg species	304.847	630.016	109.473	111.006	136.941	46.707	76.778	43.245	5.070	16.394

EDGARv4.2 /EDGAR-HTAPv1.1	CH4	CO	NOx	SO2	NMVOC	NH3	PM10	PM2.5	BC	OC
Europe+Canada +Iceland	1.11	1.11	0.86	0.86	1.19	1.10	0.48	0.17	1.06	1.03
Russia+ Moldova +Ukraine+Turkey	1.12	2.51	1.15	2.87	1.88	2.19	4.31	3.79	2.75	4.57
USA	1.05	1.02	0.89	0.78	0.80	0.85	0.14	0.10	1.37	1.99
Japan	1.07	3.69	1.29	3.59	1.70	0.86	1.33	0.11	0.46	1.09
Rest Annex I (Oceania)	1.13	5.55	1.23	0.87	2.45	1.39	11.03	12.81	7.82	17.80
China	0.88	0.54	0.73	0.63	1.09	0.70	0.37	0.02	0.79	1.04
Rest Eastern, Southern Asia	0.79	0.50	0.71	0.82	0.89	0.50	0.46	0.12	0.65	0.63
Rest Non-Annexl (Africa, Latin-America)	0.75	2.96	1.02	0.62	1.12	1.15	3.22	2.12	2.12	3.26
International bunkers	1.00	1.00	1.00	1.00	1.00		0.86		0.86	0.86
global	**0.88**	**1.18**	**0.88**	**0.80**	**1.05**	**0.84**	**0.90**	**0.59**	**1.16**	**1.63**

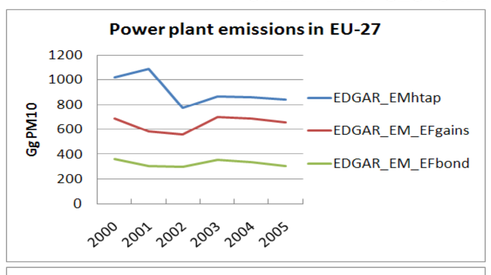
Differences for PM are noticed because:

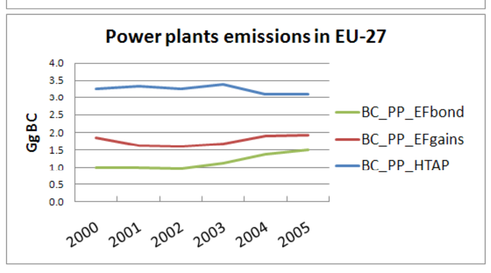
1. ***Depend on technology & end-of-pipe***
2. ***Few non-standard plants using non-standard fuel (e.g. lignite instead of bituminous pop up***
3. ***High uncertainty of real removal efficiency depending on plant operation/ maintenance***

CASE STUDY: IMPACT OF REGION-SPECIFIC UNCONTROLLED PM EMISSION FACTORS FOR DIFFERENT POWER PLANT TECHNOLOGIES IN EU27

How does the total PM10 emissions for the Power Plants in Europe compare, using (1) EDGARv4.2 database with Corinair based emission factors and EDGAR PP controlled technology, (2) GAINS uncontrolled emission factors *(Kupiainen & Klimont, 2007)* combined with EDGAR's controlled technology, and (3) AP-42 *(Bond et al., 2007)* uncontrolled emission factors with the same EDGAR specifications ?

POWER PLANT SECTOR: well-known but very differentiated in technology and end-of-pipe





OC emissions from HTAP/ GAINS/ Bond differ a factor 10.

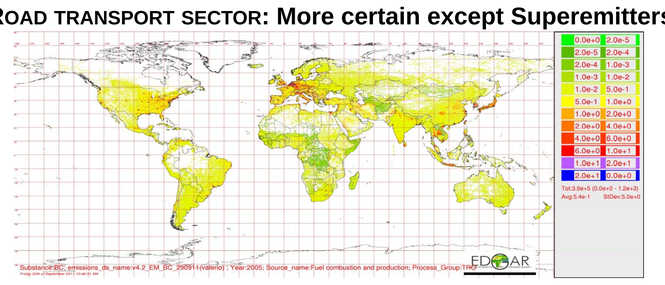
EDGAR-HTAPv1.1	2000	2001	2002	2003	2004	2005
Austria	0.018	0.020	0.014	0.018	0.019	0.018
Belgium	0.039	0.047	0.040	0.053	0.062	0.064
Bulgaria	0.322	0.368	0.333	0.366	0.359	0.371
Cyprus	0.030	0.030	0.031	0.036	0.035	0.038
Czech Republic	0.105	0.061	0.083	0.075	0.078	0.072
Germany	0.150	0.152	0.140	0.130	0.148	0.192
Danmark	0.053	0.055	0.056	0.053	0.051	0.051
Spain	0.275	0.332	0.363	0.325	0.268	0.279
Estonia	0.130	0.128	0.125	0.149	0.148	0.140
Finland	0.125	0.160	0.134	0.173	0.154	0.132
France	0.204	0.190	0.186	0.193	0.197	0.254
UK	0.089	0.106	0.064	0.066	0.073	0.075
Greece	0.098	0.093	0.098	0.138	0.132	0.134
Hungary	0.063	0.060	0.038	0.038	0.037	0.049
Ireland	0.048	0.057	0.041	0.032	0.036	0.038
Italy	0.701	0.631	0.686	0.655	0.503	0.412
Lithuania	0.018	0.022	0.021	0.017	0.017	0.016
Luxembourg	0.002	0.002	0.002	0.002	0.002	0.002
Latvia	0.024	0.021	0.023	0.024	0.023	0.021
Malta	0.014	0.017	0.015	0.016	0.017	0.017
The Netherlands	0.037	0.037	0.035	0.038	0.035	0.023
Poland	0.180	0.163	0.166	0.212	0.191	0.186
Portugal	0.088	0.078	0.092	0.055	0.050	0.075
Roumania	0.393	0.447	0.431	0.457	0.433	0.400
Slovakia	0.020	0.020	0.016	0.019	0.017	0.018
Slovenia	0.007	0.008	0.008	0.008	0.009	0.008
Sweden	0.024	0.029	0.032	0.036	0.030	0.028
Totals (Gg)	3.257	3.333	3.276	3.383	3.125	3.112

HTAP /EFgains	2005
Austria	4.233281
Belgium	2.479071
Bulgaria	3.379378
Cyprus	96.13875
Czech Republic	2.67913
Germany	1.147613
Danmark	0.634255
Spain	1.102816
Estonia	19.668
Finland	2.399032
France	1.645795
UK	0.350136
Greece	2.337388
Hungary	0.95057
Ireland	3.27171
Italy	3.861436
Lithuania	1.808312
Luxembourg	4.195726
Latvia	2.359951
Malta	2.898482
The Netherlands	1.155393
Poland	0.380674
Portugal	11.71686
Roumania	81.84747
Slovakia	0.499695
Slovenia	1.468672
Sweden	1.783757
global ratio	**1.615117**

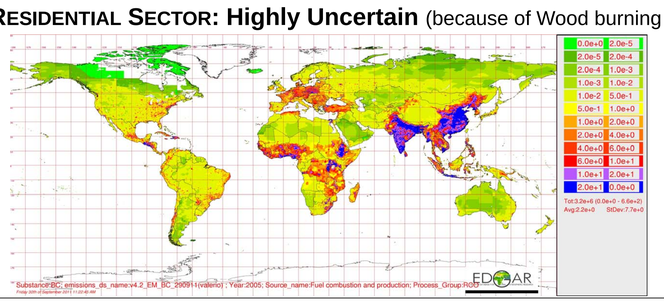
Efgains /EFbond	2005
Austria	2.384994
Belgium	1.097224
Bulgaria	0.609347
Cyprus	1.381739
Czech Republic	1.841369
Germany	1.133021
Danmark	0.591364
Spain	0.231
Estonia	4.6779
Finland	2.437117
France	0.665024
UK	0.523712
Greece	0.996541
Hungary	0.967416
Ireland	1.048474
Italy	0.700214
Lithuania	2.117562
Luxembourg	0.307134
Latvia	2.155808
Malta	0.214169
The Netherlands	1.480083
Poland	0.561245
Portugal	0.609176
Roumania	13.33099
Slovakia	0.327128
Slovenia	1.121229
Sweden	2.102887
global ratio	**0.772673**

Comparison of powerplant BC emissions for each EU member state

ROAD TRANSPORT SECTOR: More certain except Superemitters

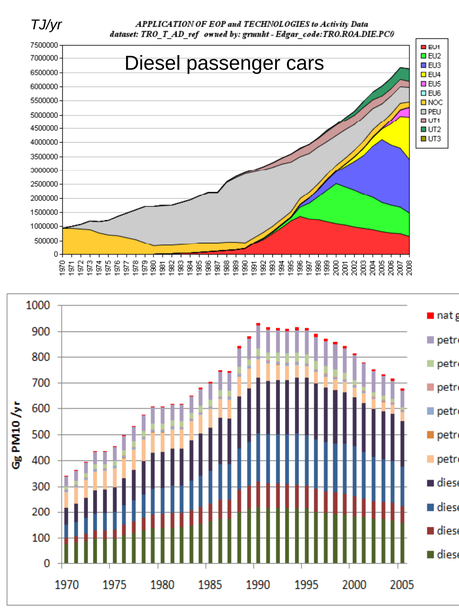


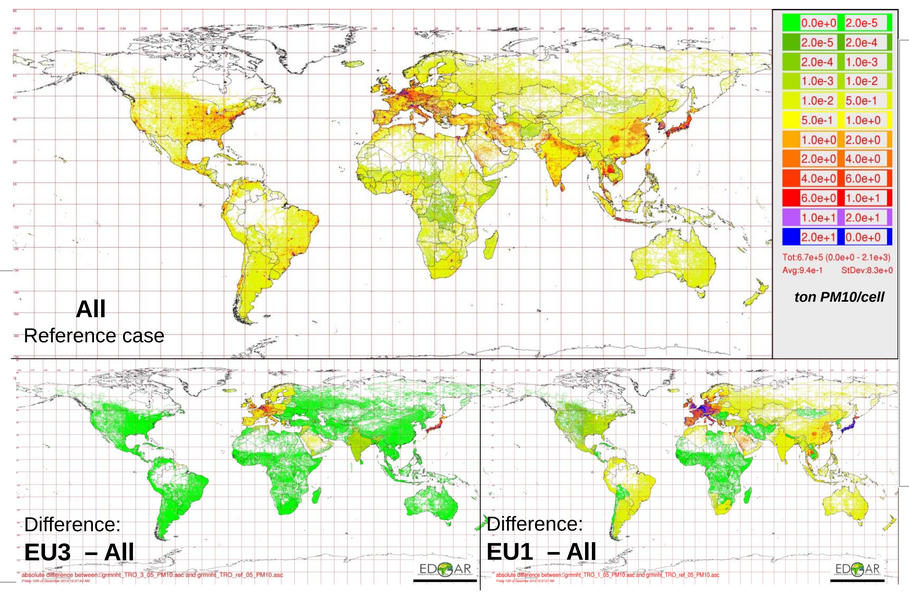
RESIDENTIAL SECTOR: Highly Uncertain (because of Wood burning etc.)

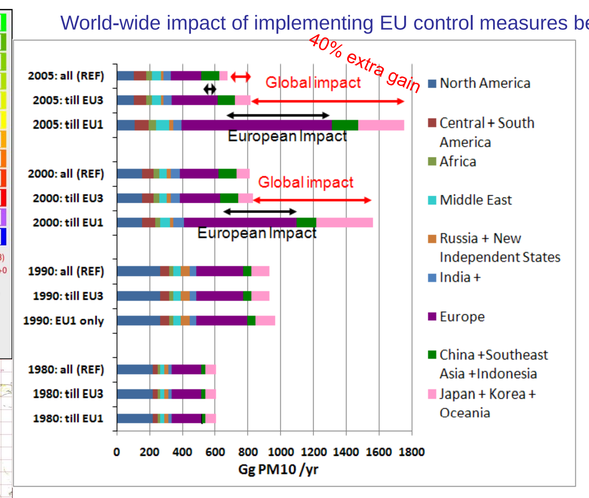


CASE STUDY: IMPACT OF TECHNOLOGICAL EU STANDARDS ON WORLD-WIDE ROAD TRANSPORT EMISSIONS OF PM10

What would have been road transport emissions in 2005 if the technological development of EU standards stagnated at Euro level 1 or at level 3 in Europe and elsewhere?







Reference scenario
All : All EU conrol measures implemented

Scenario1:
EU1 stagnation

Scenario 2:
EU3 stagnation

Conclusion: By 2000 much of the world was effectively meeting "Euro3"

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EDGAR Project team:
G. Janssens-Maenhout, M. Muntean, A. Hajdu, V. Pagliari, A.M.R. Petrescu, R. Abad-Vinas, J. Wilson, D. Guizzardi, A. Orive-Meijide, J.J.G. Olivier (PBL), J.A.H. Peters (PBL)

Acknowledged: J. van Aardenne, U. Doering, S. Monni, B. Murphy, G. Oreggioni

Contact:
edgar-info@jrc.ec.europa.eu
EC • Joint Research Centre
Institute for Environment & Sustainability
Climate Change & Air Quality Unit

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