Supplement of Earth Syst. Sci. Data, 17, 5915–5950, 2025
https://doi.org/10.5194/essd-17-5915-2025-supplement

Open Access Earth System Science Data

Supplement of

The HTAP_v3.2 emission mosaic: merging regional and global monthly emissions (2000–2020) to support air quality modelling and policies

Diego Guizzardi et al.

Correspondence to: Monica Crippa (monica.crippa@ec.europa.eu)

S1 - Matching tables between inventory providers and HTAP_v3 sectors and regions

Table S1 – Sector matching table between inventory providers and HTAP_v3 sectors

	REASv3.2.1	CAPSS-KU	JAPAN	US EPA	ECCC	CAMS-REGv6.1	MEICv1.4
HTAP_1: International Shipping	-	-	-	-	-	-	-
HTAP_2.1: Domestic Aviation		SCC Level3 domestic airport traffic	1.A.3.a.i.(i) Civil aviation (domestic, landing/take-off (LTO))	1A3aii_Domestic-aviation	Landing & Takeoff 1A3ai(i) and 1A3aii(i)	H_Aviation, O_AviCruise	-
HTAP_2.2: International Aviation	-	-	-	-	-	-	-
HTAP_3: Energy	POWER_PLANTS_POINT POWER_PLANTS_NON-POINT	SCC Level1 Energy Industry (Power Generation)	1.A.1.a Public electricity and heat production	1A1a_Public-Electricity 1A1a_Industrial-Electricity	1A1a_Public-Electricity 1A1a_Industrial-Electricity	A_PublicPower	Power
HTAP_4.1: Industry	INDUSTRY	SCC Level1 Combustion in manufacturing industry SCC Level1 Industrial processes	1.A.2 All components 2.A Mineral products 2.B Chemical industry 2.C Metal production 2.H Other industry production	1A2 All components 2 All components (excluding 2D) 6A_Other-commertial	1A2 All components, excluding Fugitive 2 All components (excluding 2D & excluding Fugitive)	B_Industry	Industry
HTAP_4.2: Fugitive	EXTRACTION	SCC Level1 Energy storage and distribution SCC Level2	1.A.1.c Manufacture of solid fuels and other energy industries 1.A.1.b Petroleum	1B2 All components 1A1b_Pet-refining 1A1c_Coke-ovens	Fugitive components of 1A2 1B2 All	D_Fugitive	Fugitive

		charcoal manufacturing	refining 1.B Fugitive emissions from fuels	1A1g_Other-energy-transf	components 2A5		
HTAP_4.3: Solvents	SOLVENT	SCC Level1 Solvent use	2.D Other solvent and product use	2D All components	Solvent portions of 1A2, 1B2, 2D and 2L	E_Solvents	Solvents
HTAP_5.1: Road Transport	ROAD_TRANSPORT	on-road mobile	1.A.3.b.i, ii, iii, iv, v Road transport	1A3bii_Road (combustion)	1A3bi – iv	F_RoadTransport (excluding resuspension)	Road_transport
HTAP_5.2: Brake and Tyre wear	-	SCC Level2 paved road SCC Level2 unpaved road SCC Level2 tire wear	1.A.3.b.vi, vii Road transport	1A3b_Road-noncomb	1A3bv – vii 6A Road Dust	F_RoadTransport (resuspension only)	-
HTAP_5.3: Domestic shipping	-	SCC Level2 Inland waterways SCC Level3 national sea traffic within EMEP area	-	1A3dii_Domestic-navigation (shipping) 1A5_Recreational-Equipment-Marine	1A3dii	G_Shipping	Domestic_shipping
HTAP_5.4: Other ground transport	OTHER_TRANSPORT	SCC Level2 Railways	1.A.3.c Railways	1A3c_Rail 1A3eii_Other-unspecified-transp 1A5_Recreational-Equipment-Land	1A2gvii Off road 1A3c 1A3ei 1A4bii	I_Offroad	Other_ground_transport

HTAP_6: Residential	DOMESTIC	SCC Level1 Non-industrial combustion plants SCC Level2 Agriculture SCC Level2 construction machinery SCC Level2 fireplace	1.A.4 All components	1A4 All components	1A4 All components 2D3e Commercial residential 2H2 Meat grilling 6A cigarette smoking, Structural fires	C_OtherStationaryComb	Residential
HTAP_7: Waste	-	SCC Level1 Waste treatment and disposal SCC Level2 waste disposal	5. Waste	5 All components	5 All components	J_Waste	-
HTAP_8.1: Agricultural waste burning	-	SCC Level2 agricultural residue burning	3.F Field burning of agricultural residues	3F_Ag-res-on-field	6A Prescribed Burning (forest)	L_AgriOther (agricultural waste burning only)	-
HTAP_8.2: Agriculture_livestock	MANURE_MANAGEMENT	SCC Level2 Manure management SCC Level2 Stockbreeding activity	3.B Manure management	3B All components	3B All components	K_AgriLivestock	Agriculture_livestock
HTAP_8.3: Agriculture_crops	FERTILIZER	SCC Level2 Cultures with fertilizers (except animal manure) SCC Level2 Agriculture activity	3.D Crop production and agricultural soils	3Da1_Inorganic-N-fertilizers 3Df_Use-of-pesticides	3D All components	L_AgriOther (excluding agricultural waste burning)	Agriculture_crops

Table S2 – Country mapping to inventory providers and regional belonging to IPCC AR6 regions.

Data provider	Country code ISO_A3	Country name	IPCC AR6 regional grouping
CAMS-REG-v6.1	ALB	Albania	Europe
CAMS-REG-v6.1	AUT	Austria	Europe
CAMS-REG-v6.1	BEL	Belgium	Europe
CAMS-REG-v6.1	BGR	Bulgaria	Europe
CAMS-REG-v6.1	BIH	Bosnia and Herzegovina	Europe
CAMS-REG-v6.1	BLR	Belarus	Eastern Europe and West-Central Asia
CAMS-REG-v6.1	CHE	Switzerland	Europe
CAMS-REG-v6.1	CYP	Cyprus	Europe
CAMS-REG-v6.1	CZE	Czech Republic	Europe
CAMS-REG-v6.1	DEU	Germany	Europe
CAMS-REG-v6.1	DNK	Denmark	Europe
CAMS-REG-v6.1	ESP	Spain	Europe
CAMS-REG-v6.1	EST	Estonia	Europe
CAMS-REG-v6.1	FIN	Finland	Europe
CAMS-REG-v6.1	FRA	France	Europe
CAMS-REG-v6.1	GBR	United Kingdom	Europe
CAMS-REG-v6.1	GRC	Greece	Europe
CAMS-REG-v6.1	HRV	Croatia	Europe
CAMS-REG-v6.1	HUN	Hungary	Europe
CAMS-REG-v6.1	IRL	Ireland	Europe
CAMS-REG-v6.1	ISL	Iceland	Europe
CAMS-REG-v6.1	ITA	Italy	Europe
CAMS-REG-v6.1	LTU	Lithuania	Europe

CAMS-REG-v6.1	LUX	Luxembourg	Europe
CAMS-REG-v6.1	LVA	Latvia	Europe
CAMS-REG-v6.1	MDA	Moldova, Republic of	Eastern Europe and West-Central Asia
CAMS-REG-v6.1	MKD	Macedonia, the former Yugoslav Republic of	Europe
CAMS-REG-v6.1	MLT	Malta	Europe
CAMS-REG-v6.1	MNE	Montenegro	Europe
CAMS-REG-v6.1	NLD	Netherlands	Europe
CAMS-REG-v6.1	NOR	Norway	Europe
CAMS-REG-v6.1	POL	Poland	Europe
CAMS-REG-v6.1	PRT	Portugal	Europe
CAMS-REG-v6.1	ROU	Romania	Europe
CAMS-REG-v6.1	SRB	Serbia	Europe
CAMS-REG-v6.1	SVK	Slovakia	Europe
CAMS-REG-v6.1	SVN	Slovenia	Europe
CAMS-REG-v6.1	SWE	Sweden	Europe
CAMS-REG-v6.1	TUR	Turkey	Europe
CAMS-REG-v6.1	UKR	Ukraine	Eastern Europe and West-Central Asia
CAMS-REG-v6.1	KOS	Kosovo	Europe
CAPSS-KU	KOR	Korea, Republic of	Eastern Asia
ECCC	CAN	Canada	North America
EDGARv8.1	ABW	Aruba	Latin America and Caribbean
EDGARv8.1	AGO	Angola	Africa
EDGARv8.1	AIA	Anguilla	Latin America and Caribbean
EDGARv8.1	AIR	Int. Aviation	Int. Aviation
EDGARv8.1	ANT	Netherlands Antilles	Latin America and Caribbean
EDGARv8.1	ARE	United Arab Emirates	Middle East
EDGARv8.1	ARG	Argentina	Latin America and Caribbean
EDGARv8.1	ARM	Armenia	Eastern Europe and West-Central Asia

EDGARv8.1	ASM	American Samoa	South-East Asia and Pacific
EDGARv8.1	ATG	Antigua and Barbuda	Latin America and Caribbean
EDGARv8.1	AUS	Australia	Australia, Japan, and New Zealand
EDGARv8.1	AZE	Azerbaijan	Eastern Europe and West-Central Asia
EDGARv8.1	BDI	Burundi	Africa
EDGARv8.1	BEN	Benin	Africa
EDGARv8.1	BFA	Burkina Faso	Africa
EDGARv8.1	BHR	Bahrain	Middle East
EDGARv8.1	BHS	Bahamas	Latin America and Caribbean
EDGARv8.1	BLZ	Belize	Latin America and Caribbean
EDGARv8.1	BMU	Bermuda	Latin America and Caribbean
EDGARv8.1	BOL	Bolivia	Latin America and Caribbean
EDGARv8.1	BRA	Brazil	Latin America and Caribbean
EDGARv8.1	BRB	Barbados	Latin America and Caribbean
EDGARv8.1	BWA	Botswana	Africa
EDGARv8.1	CAF	Central African Republic	Africa
EDGARv8.1	CHL	Chile	Latin America and Caribbean
EDGARv8.1	CIV	Cote d'Ivoire	Africa
EDGARv8.1	CMR	Cameroon	Africa
EDGARv8.1	COD	Congo, the Democratic Republic of the	Africa
EDGARv8.1	COG	Congo	Africa
EDGARv8.1	COK	Cook Islands	South-East Asia and Pacific
EDGARv8.1	COL	Colombia	Latin America and Caribbean
EDGARv8.1	COM	Comoros	Africa
EDGARv8.1	CPV	Cape Verde	Africa
EDGARv8.1	CRI	Costa Rica	Latin America and Caribbean
EDGARv8.1	CUB	Cuba	Latin America and Caribbean
EDGARv8.1	CYM	Cayman Islands	Latin America and Caribbean
EDGARv8.1	DJI	Djibouti	Africa
EDGARv8.1	DMA	Dominica	Latin America and Caribbean
EDGARv8.1	DOM	Dominican Republic	Latin America and Caribbean

EDGARv8.1	DZA	Algeria	Africa
EDGARv8.1	ECU	Ecuador	Latin America and Caribbean
EDGARv8.1	EGY	Egypt	Africa
EDGARv8.1	ERI	Eritrea	Africa
EDGARv8.1	ESH	Western Sahara	Africa
EDGARv8.1	ETH	Ethiopia	Africa
EDGARv8.1	FJI	Fiji	South-East Asia and Pacific
EDGARv8.1	FLK	Falkland Islands (Malvinas)	Latin America and Caribbean
EDGARv8.1	FRO	Faroe Islands	Europe
EDGARv8.1	FSM	Micronesia, Federated States of	South-East Asia and Pacific
EDGARv8.1	GAB	Gabon	Africa
EDGARv8.1	GEO	Georgia	Eastern Europe and West-Central Asia
EDGARv8.1	GHA	Ghana	Africa
EDGARv8.1	GIB	Gibraltar	Europe
EDGARv8.1	GIN	Guinea	Africa
EDGARv8.1	GLP	Guadeloupe	Latin America and Caribbean
EDGARv8.1	GMB	Gambia	Africa
EDGARv8.1	GNB	Guinea-Bissau	Africa
EDGARv8.1	GNQ	Equatorial Guinea	Africa
EDGARv8.1	GRD	Grenada	Latin America and Caribbean
EDGARv8.1	GRL	Greenland	Europe
EDGARv8.1	GTM	Guatemala	Latin America and Caribbean
EDGARv8.1	GUF	French Guiana	Latin America and Caribbean
EDGARv8.1	GUM	Guam	South-East Asia and Pacific
EDGARv8.1	GUY	Guyana	Latin America and Caribbean
EDGARv8.1	HKG	Hong Kong	Eastern Asia
EDGARv8.1	HND	Honduras	Latin America and Caribbean
EDGARv8.1	HTI	Haiti	Latin America and Caribbean
EDGARv8.1	IRN	Iran, Islamic Republic of	Middle East
EDGARv8.1	IRQ	Iraq	Middle East
EDGARv8.1	ISR	Israel	Middle East
EDGARv8.1	JAM	Jamaica	Latin America and Caribbean
EDGARv8.1	JOR	Jordan	Middle East
EDGARv8.1	KAZ	Kazakhstan	Eastern Europe and West-Central Asia

EDGARv8.1	KEN	Kenya	Africa
EDGARv8.1	KGZ	Kyrgyzstan	Eastern Europe and West-Central Asia
EDGARv8.1	KIR	Kiribati	South-East Asia and Pacific
EDGARv8.1	KNA	Saint Kitts and Nevis	Latin America and Caribbean
EDGARv8.1	KWT	Kuwait	Middle East
EDGARv8.1	LBN	Lebanon	Middle East
EDGARv8.1	LBR	Liberia	Africa
EDGARv8.1	LBY	Libyan Arab Jamahiriya	Africa
EDGARv8.1	LCA	Saint Lucia	Latin America and Caribbean
EDGARv8.1	LSO	Lesotho	Africa
EDGARv8.1	MAC	Macao	Eastern Asia
EDGARv8.1	MAR	Morocco	Africa
EDGARv8.1	MDG	Madagascar	Africa
EDGARv8.1	MEX	Mexico	Latin America and Caribbean
EDGARv8.1	MLI	Mali	Africa
EDGARv8.1	MOZ	Mozambique	Africa
EDGARv8.1	MRT	Mauritania	Africa
EDGARv8.1	MSR	Montserrat	Latin America and Caribbean
EDGARv8.1	MTQ	Martinique	Latin America and Caribbean
EDGARv8.1	MUS	Mauritius	Africa
EDGARv8.1	MWI	Malawi	Africa
EDGARv8.1	MYT	Mayotte	Africa
EDGARv8.1	NAM	Namibia	Africa
EDGARv8.1	NCL	New Caledonia	South-East Asia and Pacific
EDGARv8.1	NER	Niger	Africa
EDGARv8.1	NGA	Nigeria	Africa
EDGARv8.1	NIC	Nicaragua	Latin America and Caribbean
EDGARv8.1	NIU	Niue	South-East Asia and Pacific
EDGARv8.1	NZL	New Zealand	Australia, Japan, and New Zealand
EDGARv8.1	OMN	Oman	Middle East
EDGARv8.1	PAN	Panama	Latin America and Caribbean
EDGARv8.1	PER	Peru	Latin America and Caribbean
EDGARv8.1	PLW	Palau	South-East Asia and Pacific
EDGARv8.1	PNG	Papua New Guinea	South-East Asia and Pacific
EDGARv8.1	PRY	Paraguay	Latin America and Caribbean

EDGARv8.1	PYF	French Polynesia	South-East Asia and Pacific
EDGARv8.1	QAT	Qatar	Middle East
EDGARv8.1	REU	Reunion	Africa
EDGARv8.1	RUS	Russian Federation	Eastern Europe and West-Central Asia
EDGARv8.1	RWA	Rwanda	Africa
EDGARv8.1	SAU	Saudi Arabia	Middle East
EDGARv8.1	SDN	Sudan	Africa
EDGARv8.1	SEA	Int. Shipping	Int. Shipping
EDGARv8.1	SEN	Senegal	Africa
EDGARv8.1	SHN	Saint Helena	Africa
EDGARv8.1	SLB	Solomon Islands	South-East Asia and Pacific
EDGARv8.1	SLE	Sierra Leone	Africa
EDGARv8.1	SLV	El Salvador	Latin America and Caribbean
EDGARv8.1	SOM	Somalia	Africa
EDGARv8.1	SPM	Saint Pierre and Miquelon	North America
EDGARv8.1	STP	Sao Tome and Principe	Africa
EDGARv8.1	SUR	Suriname	Latin America and Caribbean
EDGARv8.1	SWZ	Swaziland	Africa
EDGARv8.1	SYC	Seychelles	Africa
EDGARv8.1	SYR	Syrian Arab Republic	Middle East
EDGARv8.1	TCA	Turks and Caicos Islands	Latin America and Caribbean
EDGARv8.1	TCD	Chad	Africa
EDGARv8.1	TGO	Togo	Africa
EDGARv8.1	TJK	Tajikistan	Eastern Europe and West-Central Asia
EDGARv8.1	TKL	Tokelau	South-East Asia and Pacific
EDGARv8.1	TKM	Turkmenistan	Eastern Europe and West-Central Asia
EDGARv8.1	TLS	Timor-Leste	South-East Asia and Pacific
EDGARv8.1	TON	Tonga	South-East Asia and Pacific
EDGARv8.1	TTO	Trinidad and Tobago	Latin America and Caribbean
EDGARv8.1	TUN	Tunisia	Africa
EDGARv8.1	TZA	Tanzania, United Republic of	Africa
EDGARv8.1	UGA	Uganda	Africa
EDGARv8.1	URY	Uruguay	Latin America and Caribbean
EDGARv8.1	UZB	Uzbekistan	Eastern Europe and West-Central Asia
EDGARv8.1	VCT	Saint Vincent and the Grenadines	Latin America and Caribbean

EDGARv8.1	VEN	Venezuela	Latin America and Caribbean
EDGARv8.1	VGB	Virgin Islands, British	Latin America and Caribbean
EDGARv8.1	VUT	Vanuatu	South-East Asia and Pacific
EDGARv8.1	WLF	Wallis and Futuna	South-East Asia and Pacific
EDGARv8.1	WSM	Samoa	South-East Asia and Pacific
EDGARv8.1	YEM	Yemen	Middle East
EDGARv8.1	ZAF	South Africa	Africa
EDGARv8.1	ZMB	Zambia	Africa
EDGARv8.1	ZWE	Zimbabwe	Africa
JAPAN	JPN	Japan	Australia, Japan, and New Zealand
MEICv.14	CHN	China	Eastern Asia
REAS	AFG	Afghanistan	Southern Asia
REAS	BGD	Bangladesh	Southern Asia
REAS	BRN	Brunei Darussalam	South-East Asia and Pacific
REAS	BTN	Bhutan	Southern Asia
REAS	IDN	Indonesia	South-East Asia and Pacific
REAS	IND	India	Southern Asia
REAS	KHM	Cambodia	South-East Asia and Pacific
REAS	LAO	Lao People's Democratic Republic	South-East Asia and Pacific
REAS	LKA	Sri Lanka	Southern Asia
REAS	MDV	Maldives	Southern Asia
REAS	MMR	Myanmar	South-East Asia and Pacific
REAS	MNG	Mongolia	Eastern Asia
REAS	MYS	Malaysia	South-East Asia and Pacific
REAS	NPL	Nepal	Southern Asia
REAS	PAK	Pakistan	Southern Asia
REAS	PHL	Philippines	South-East Asia and Pacific
REAS	PRK	Korea, Democratic People's Republic of	Eastern Asia
REAS	SGP	Singapore	South-East Asia and Pacific
REAS	THA	Thailand	South-East Asia and Pacific
REAS	TWN	Taiwan, Province of China	Eastern Asia
REAS	VNM	Viet Nam	South-East Asia and Pacific
US EPA	PRI	Puerto Rico	North America
US EPA	USA	United States	North America
US EPA	VIR	Virgin Islands, USA	North America

S2 – Comparison of HTAP_v3.2 emission mosaic vs. regional and global inventories

In this section, the comparison between the HTAP_v3.2 mosaic emission time series by pollutant and region and the corresponding emissions from other inventories is presented (Figures S1-S5). We also included the emission estimates provided by the HTAPv3 mosaic to highlight changes and improvements of HTAP_v3.2 compared to the previous version of the mosaic. In particular, we compare HTAP_v3.2 against CEDS_v2025_03_18 (Hoesly et al., 2025), EDGARv8.1 (which is used in HTAP_v3.2 as gapfilling inventory, https://edgar.jrc.ec.europa.eu/dataset_ap81), country inventories, GAINS_(ECLIPSE_v6b_CLE) (Klimont et al., 2017), and REAS_v3.2.1 (Kurokawa and Ohara, 2020) including the latest updates available at https://www.nies.go.jp/REAS/. In a few instances (Canada, China) multiple versions of the country inventories are available and the older version is plotted as "Old National inventory" in the first figure in each set below.

The country level inventories are from the US EPA (https://www.epa.gov/air-emissions-inventories/air-pollutant-emissions-trends-data; Version April 5, 2023), Environment and Climate Change Canada (https://pollution-waste.canada.ca/air-emission-inventory, downloaded August 2024), EMEP (https://www.ceip.at/, downloaded 2024), MEIC for China (Zheng et al 2018), Japan (PM2.5EI and J-STREAM), Korea (http://airemiss.nier.go.kr/; downloaded 2024) and Taiwan (http://teds.epa.gov.tw/).

For each emission species three graphs are shown. The first shows comparisons at the country level (and Eastern/western European regions) where we can compare HTAP_v3.2 with the country-level inventory data as processed for CEDS. Note that CEDS is calibrated to the country level data shown in this graph, which means CEDS will generally align with the country-level data except where gap filling has taken place (as noted below). The second graph in each set below compares the three global inventories and REAS with HTAP mosaics for world regions. A third figure is produced for countries in the Asian domain showing the comparison between the emission estimates of global inventories, national inventories and HTAP mosaics.

The graphs below exclude emissions from aviation, international shipping, and agricultural waste burning on fields. Note that, while we have attempted to harmonize geographic and sectoral coverage between the inventories, the correspondence is not always exact and this can lead to spurious differences. There are significant differences, for example, in how different inventories define the category "domestic shipping". We, therefore, focus on larger differences where this potentially impacts interpretation of the HTAP_v3.2 data.

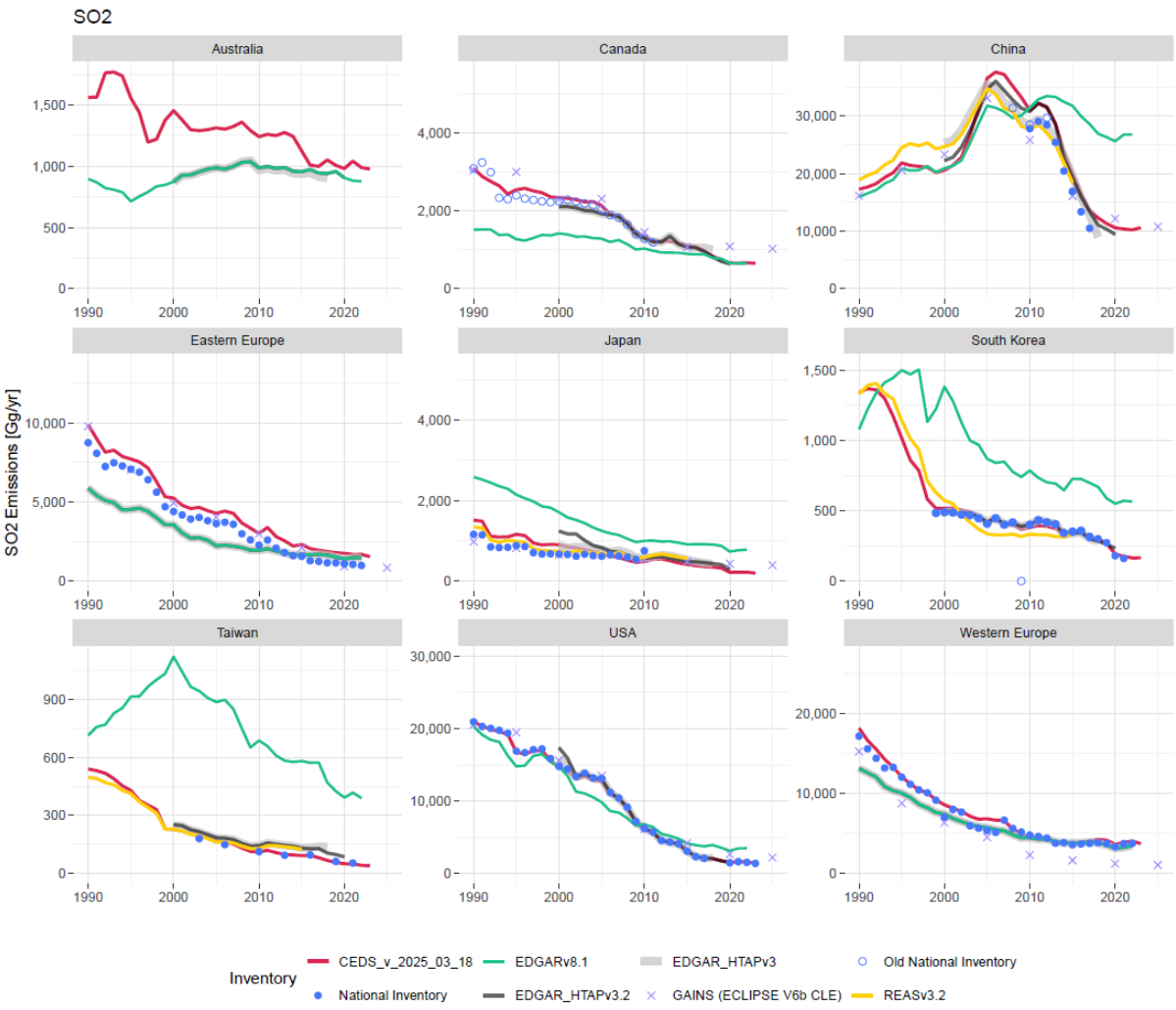
S2.1- Comparison of SO_2 emissions

Overall, HTAP_v3.2 compares well with the country level data for SO_2. The largest discrepancy is for Australia. The Australia National Pollutant Inventory (NPI; http://www.npi.gov.au/) provides annual data for point sources. For non-point sources, however, this only provides data for one representative year, which is also not necessarily consistent between states. For this reason, there is no consistent time series data available for total emissions from the NPI. The CEDS emission data uses default estimates for area sources, but calibrates emissions from power plants and industrial sources (for species where point sources dominate, such as SO_2 from metal smelters) to the Australia NPI data. HTAP_v3.2 is

based on EDGAR for Australia, as shown in the graph. While SO_2 values are similar by 2020, the NPI indicates that emissions were much higher than the HTAP_v3.2 values by 2000.

There is also a small difference between inventories for China. While CEDS is calibrated to MEIC, CEDS also contains bottom-up estimates for metal smelting SO_2 emissions that are not included in MEIC which increases total emissions in the mid to late 2000's. The difference becomes small by the end of the time series as increased penetration of acid production plants and pollution control devices is assumed to have substantially decreased SO_2 emissions from metal smelting.

At a regional level the largest differences between inventories, where the CEDS inventory has higher emissions than EDGAR (and HTAP_v3.2) or GAINS, are in Latin America from metal smelting (derived from bottom-up mass balance estimates plus some country data in CEDS), and the Middle East, where CEDS has higher emissions from oil and gas operations (derived from OMI satellite measurements). Differences in SO_2 emissions between HTAP_v3.2 and EDGAR_v8.1 for the Islands[1] regional grouping is associated with the emissions from Maldives which are provided by the REAS inventory and not by EDGAR.



[1]In this comparison, 'Islands' includes emissions from: Cook Islands, Faeroe Islands, Maldives, Martinique, Niue, French Polynesia, Saint Pierre and Miquelon.


SO2
Africa
Asia
Eastern Europe
FSU
Latin America
Middle East
OtherOECD90
Western Europe
World
SO2 Emissions [Gg/yr]
Inventory
CEDS_v_2025_03_18
EDGAR_HTAPv3.2
GAINS (ECLIPSE V6b CLE)
EDGARv8.1
EDGAR_HTAPv3
REASv3.2

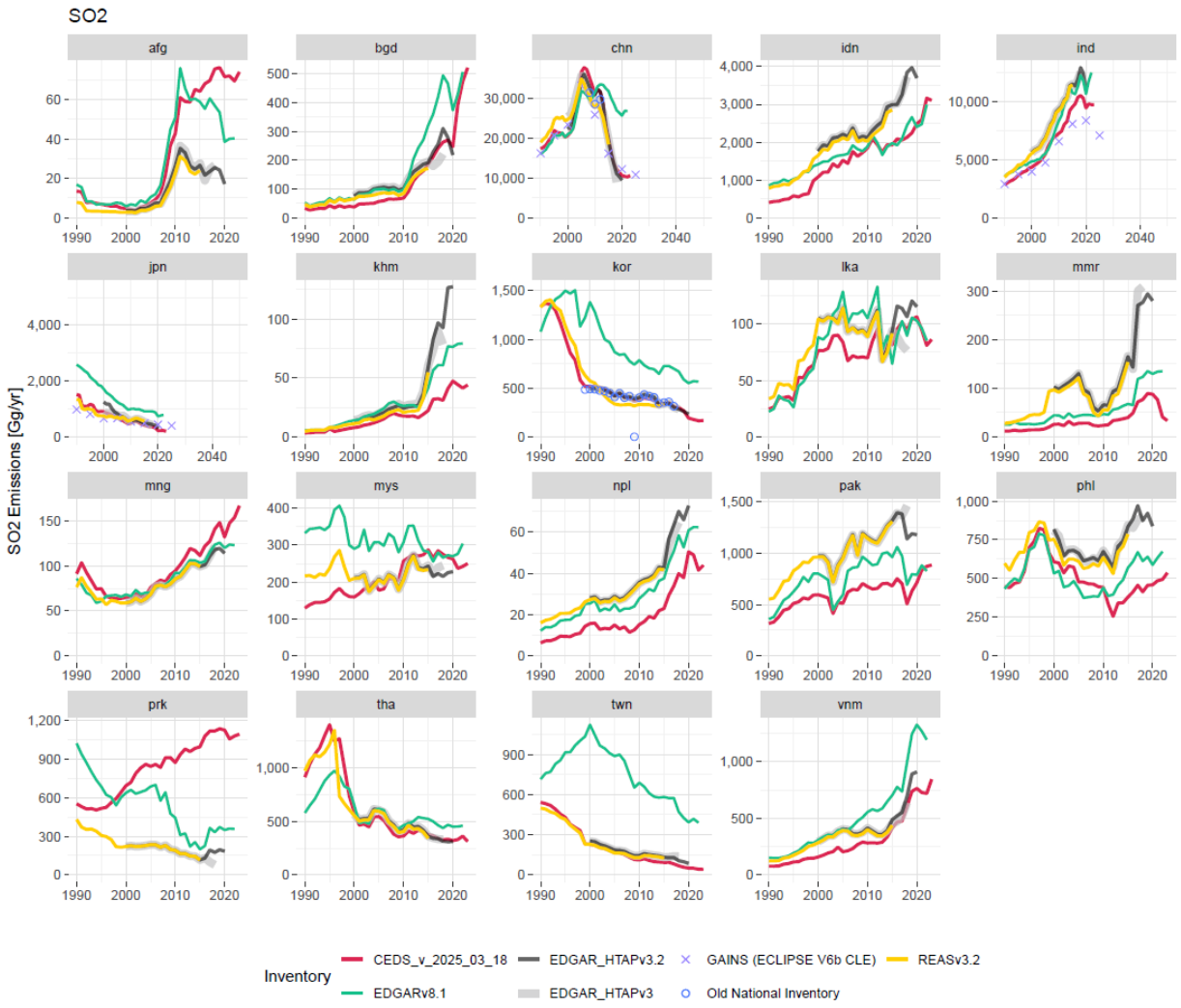
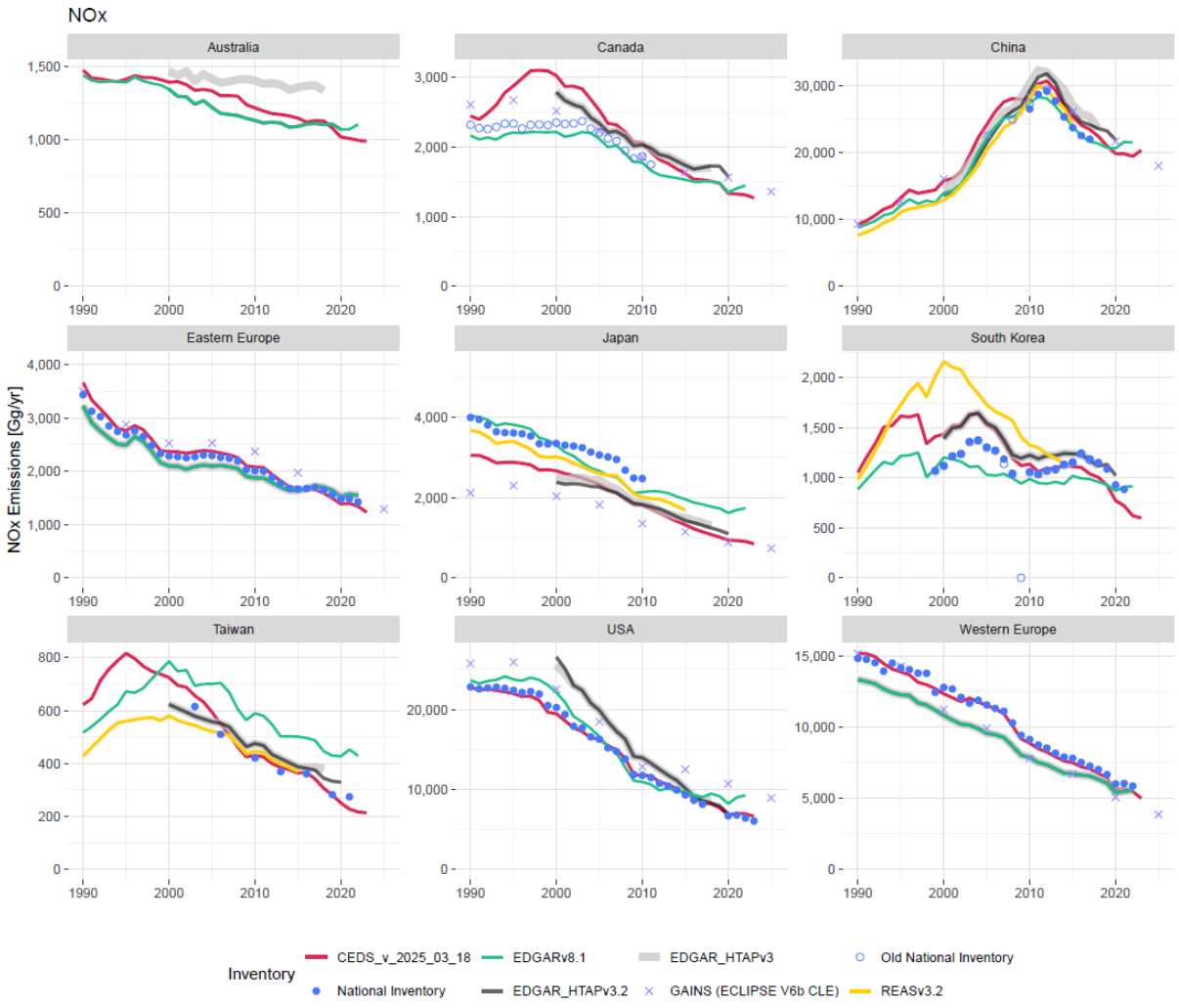
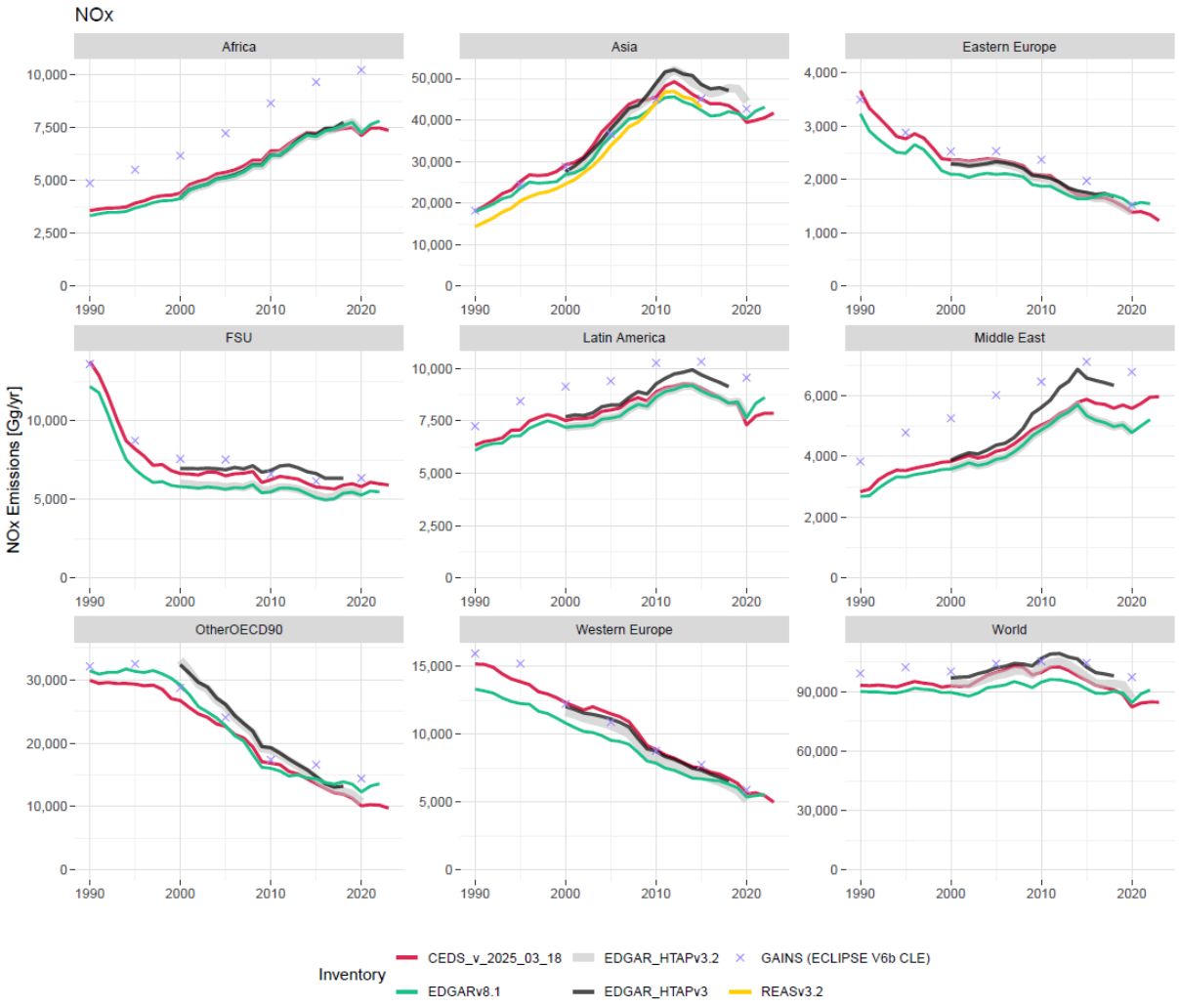


Figure S1 – SO_2 emission time series comparison by world region as provided by different inventories and HTAP_v3.2. For country codes refer to Table S2.

S2.2- Comparison of NOx emissions

Overall, HTAP_v3.2 compares well with the country level data for NOx with general agreement between the inventories for most regions. Trends in Australia are particularly uncertain, however, since there is no country-level time series information for mobile sources, which are a major driver of trends in NOx emissions. The figure illustrates how different assumptions impact the estimated trends, which differ between EDGAR v8.1 (on which HTAP_v3.2 is based), and CEDS (which uses emission factors from GAINS for mobile sources). The inventories also show different emission magnitudes for Japan. Possible drivers of differences include different assumptions about industrial sector emissions and the treatment of domestic shipping emissions, which are both significant contributors to emission totals in Japan. Similarly to SO_2, also differences in NOx emissions between HTAP_v3.2 and EDGAR_v8.1 for the Islands regional grouping is associated with the emissions from Maldives which are provided by the REAS inventory and not by EDGAR.


NOx
Australia
Canada
China
Eastern Europe
Japan
South Korea
Taiwan
USA
Western Europe
NOx Emissions [Gg/yr]
Inventory
CEDS_v_2025_03_18
EDGARv8.1
EDGAR_HTAPv3
Old National Inventory
National Inventory
EDGAR_HTAPv3.2
GAINS (ECLIPSE V6b CLE)
REASv3.2


NOx
Africa
Asia
Eastern Europe
FSU
Latin America
Middle East
OtherOECD90
Western Europe
World
NOx Emissions [Gg/yr]
Inventory
CEDS_v_2025_03_18
EDGAR_HTAPv3.2
GAINS (ECLIPSE V6b CLE)
EDGARv8.1
EDGAR_HTAPv3
REASv3.2

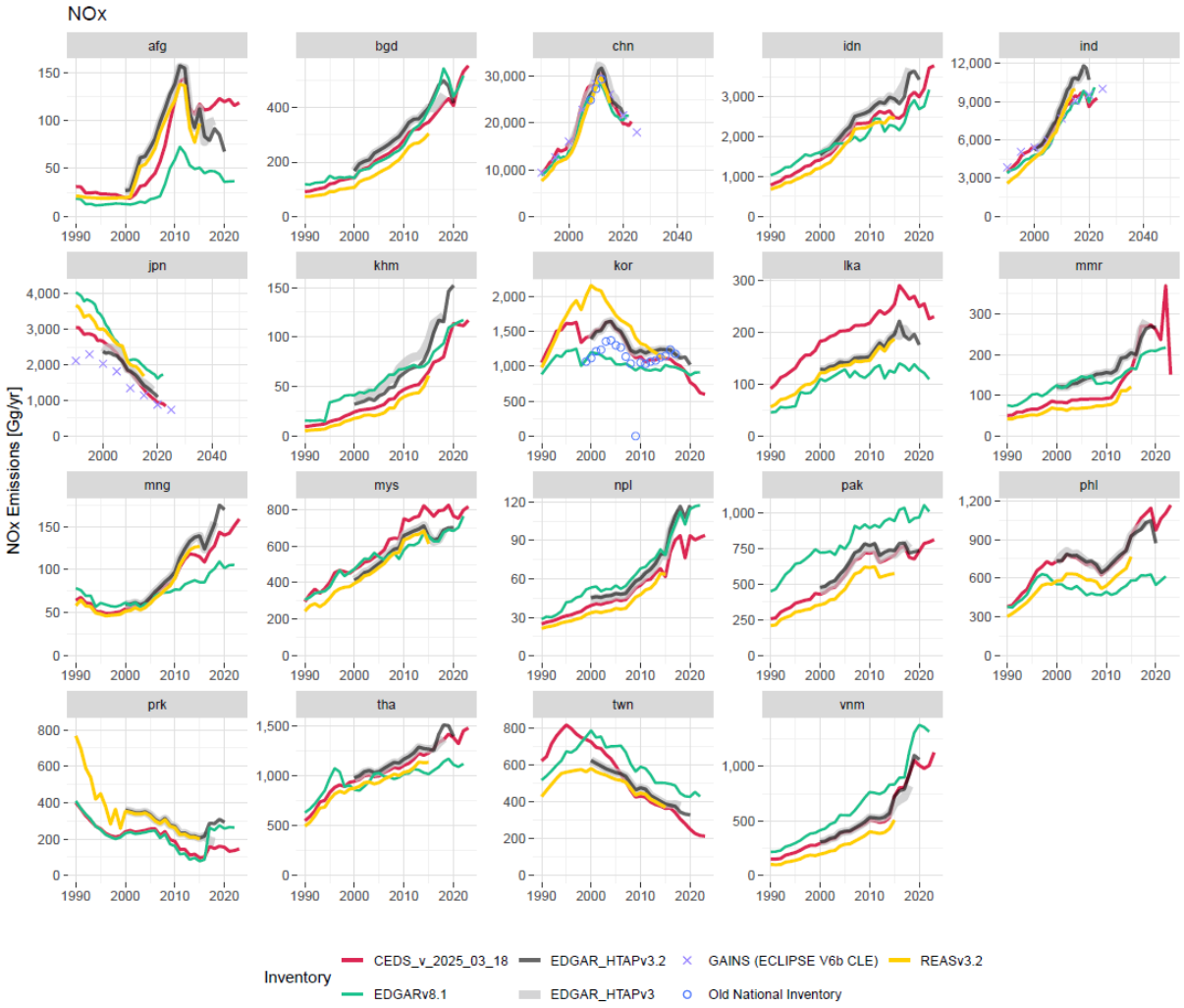
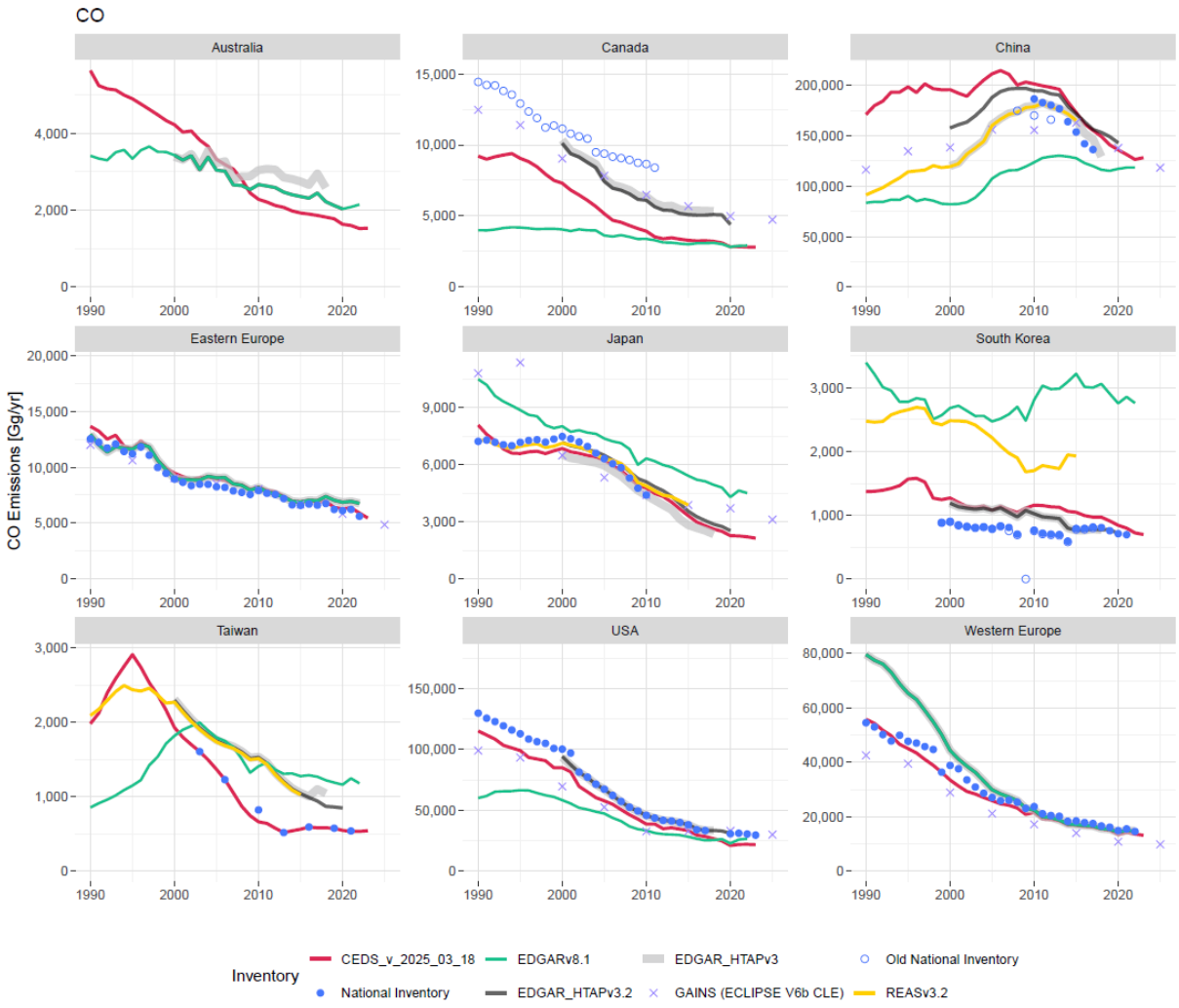


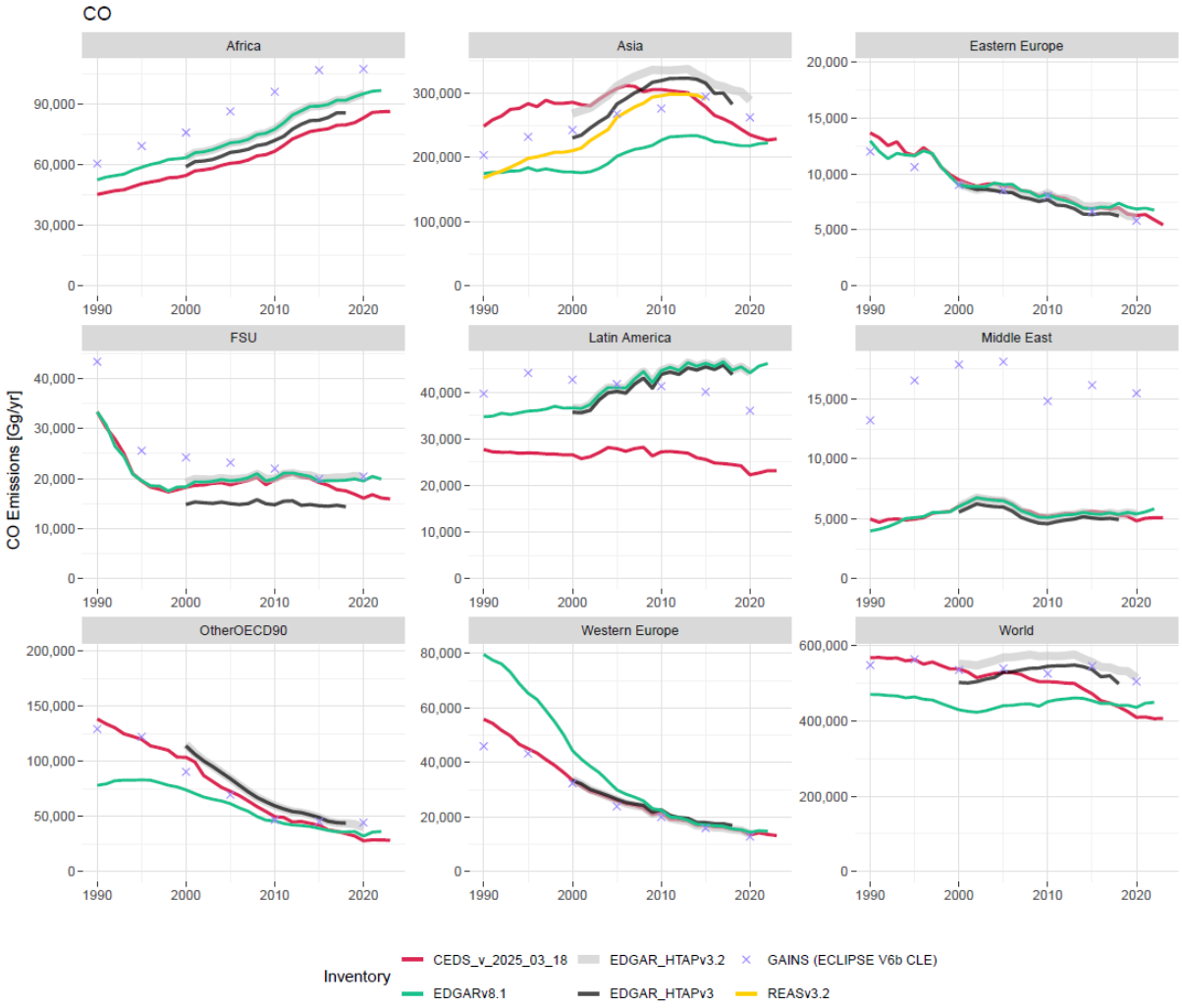
Figure S2 – NOx emission time series comparison by world region as provided by different inventories and HTAP_v3.2. For country codes refer to Table S2.

S2.3- Comparison of CO emissions

While HTAP_v3.2 compares well with the country level data for CO, there is a large variation overall between the different global inventories. CO emission factors depend heavily on combustion process details which are difficult to capture with default regional emission factor assumptions. An example of this is shown for Canada, where CO emission estimates appear to have changed significantly in more recent versions of the inventory.

There is a particularly large difference in China by 2000, where HTAP_v3.2 has CO emissions that peak around 2010, whereas CEDS has CO emissions peaking earlier and at a higher value, and EDGAR has no prominent peak in CO emissions. The difference is largely in the residential sector, with HTAP_v3.2 residential CO emissions decreasing when going back from 2005 to 2000, whereas residential sector CO emissions increase in CEDS driven by increases in residential biomass combustion when going back from 2005 to 2000.


CO
Australia
Canada
China
Eastern Europe
Japan
South Korea
Taiwan
USA
Western Europe
CO Emissions [Gg/yr]
Inventory
CEDS_v_2025_03_18
EDGARv8.1
EDGAR_HTAPv3
Old National Inventory
National Inventory
EDGAR_HTAPv3.2
GAINS (ECLIPSE V6b CLE)
REASv3.2


CO
Africa
Asia
Eastern Europe
FSU
Latin America
Middle East
OtherOECD90
Western Europe
World
CO Emissions [Gg/yr]
Inventory
CEDS_v_2025_03_18
EDGAR_HTAPv3.2
GAINS (ECLIPSE V6b CLE)
EDGARv8.1
EDGAR_HTAPv3
REASv3.2

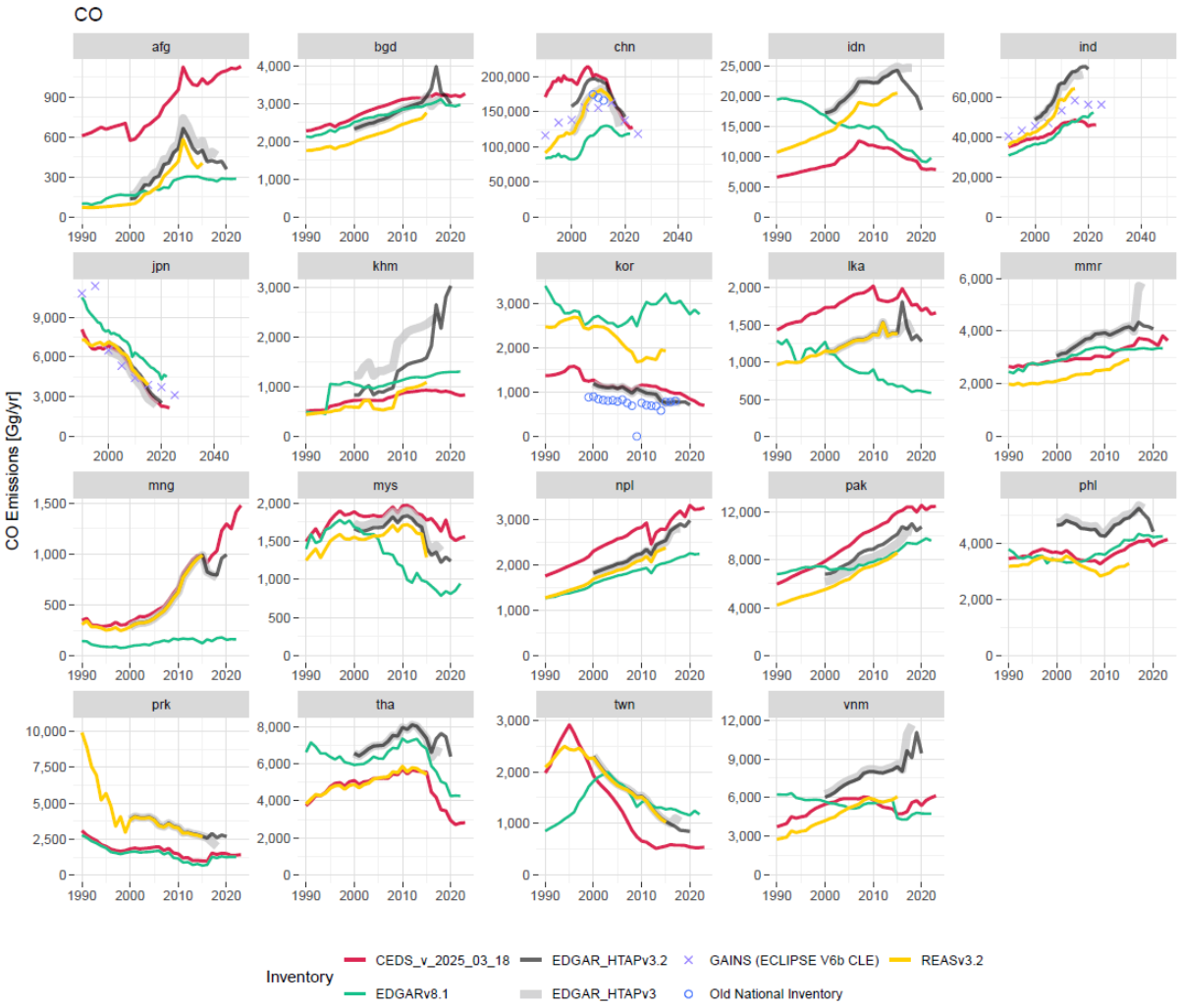
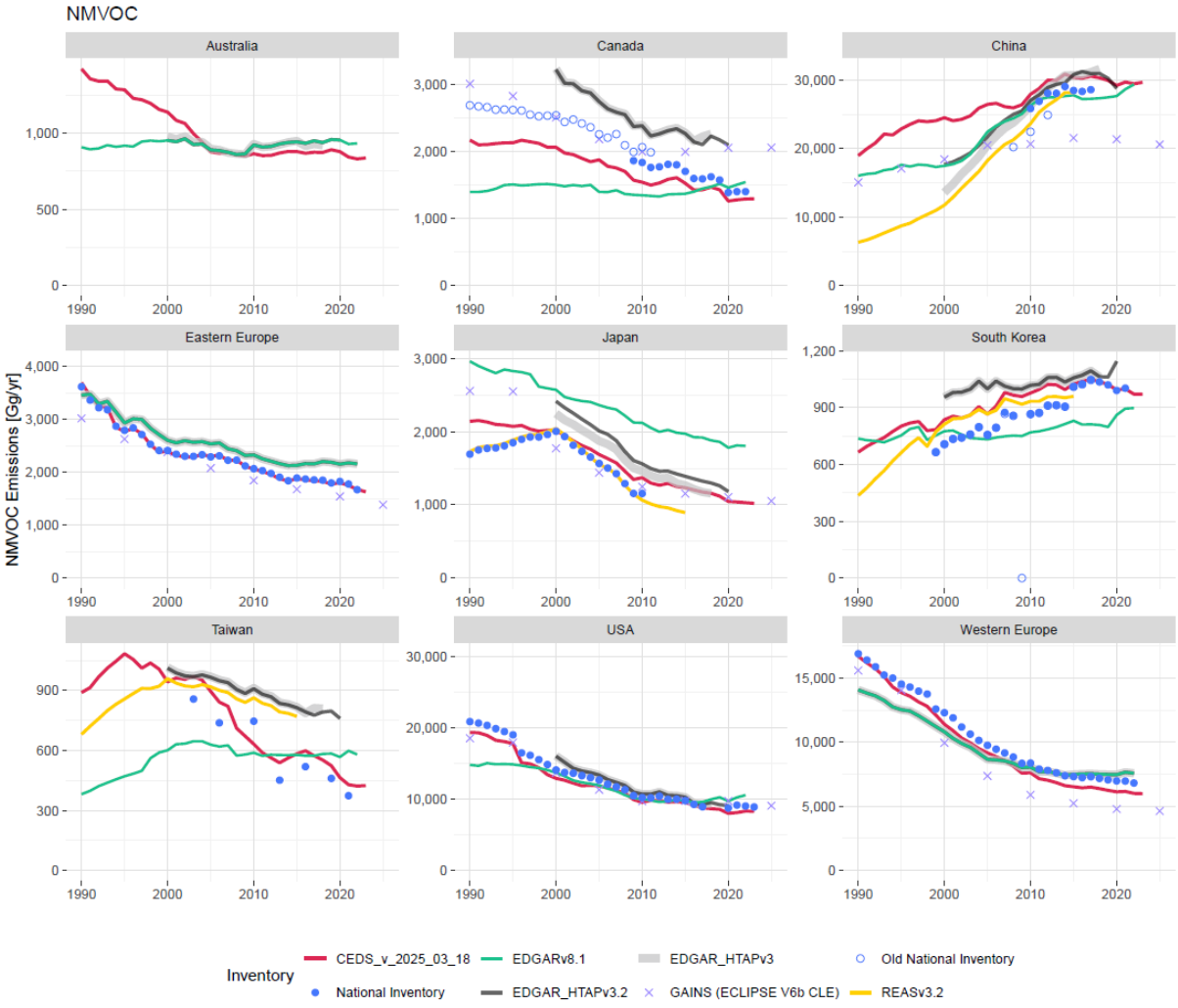
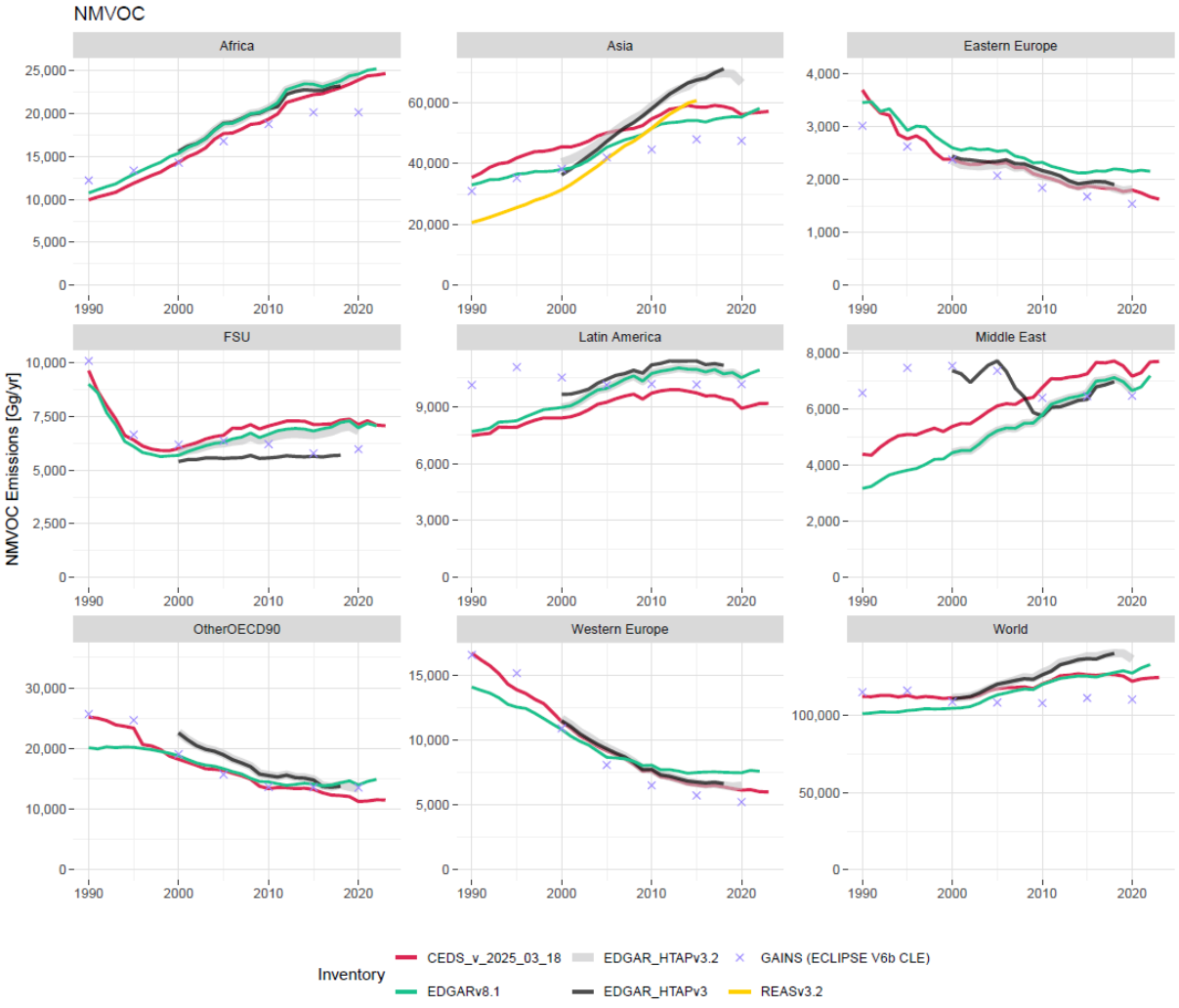


Figure S3 – CO emission time series comparison by world region as provided by different inventories and HTAP_v3.2. For country codes refer to Table S2.

S2.4- Comparison of NMVOC emissions

While HTAP_v3.2 compares well with the country level data for NMVOC, there is a large variation overall between the different global inventories. HTAP_v3.2 NMVOC emissions are shifted higher than the country level inventories used in CEDS for a number of countries/regions. The reason for this difference is not clear, but may be due to more recent country data used in EDGAR-HTAP_v3.2 or differences in sectoral coverage.


NMVOC
Australia
Canada
China
Eastern Europe
Japan
South Korea
Taiwan
USA
Western Europe
NMVOC Emissions [Gg/yr]
Inventory
CEDS_v_2025_03_18
EDGARv8.1
EDGAR_HTAPv3
Old National Inventory
National Inventory
EDGAR_HTAPv3.2
GAINS (ECLIPSE V6b CLE)
REASv3.2


NMVOC
Africa
Asia
Eastern Europe
FSU
Latin America
Middle East
OtherOECD90
Western Europe
World
NMVOC Emissions [Gg/yr]
Inventory
CEDS_v_2025_03_18
EDGAR_HTAPv3.2
GAINS (ECLIPSE V6b CLE)
EDGARv8.1
EDGAR_HTAPv3
REASv3.2

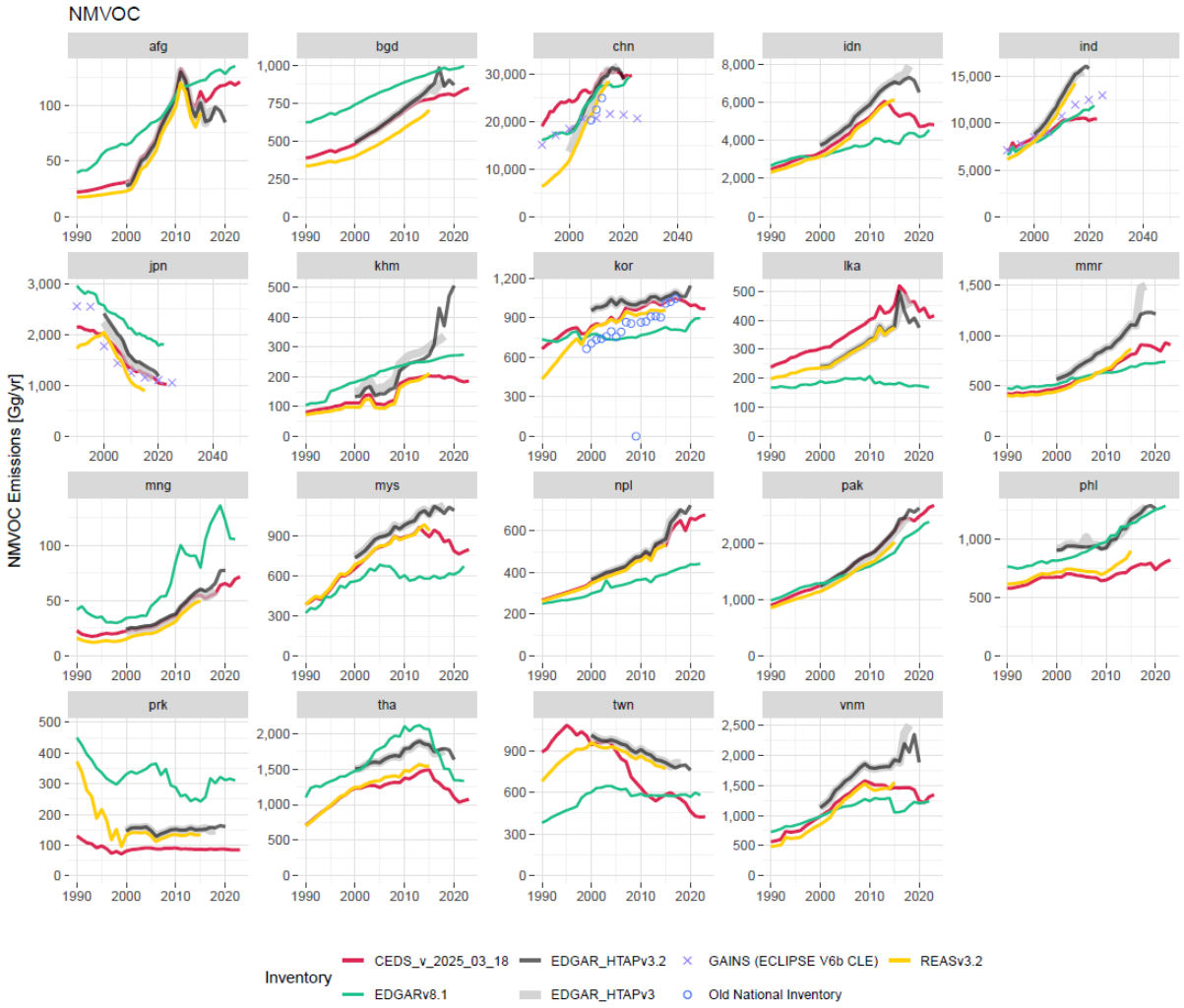
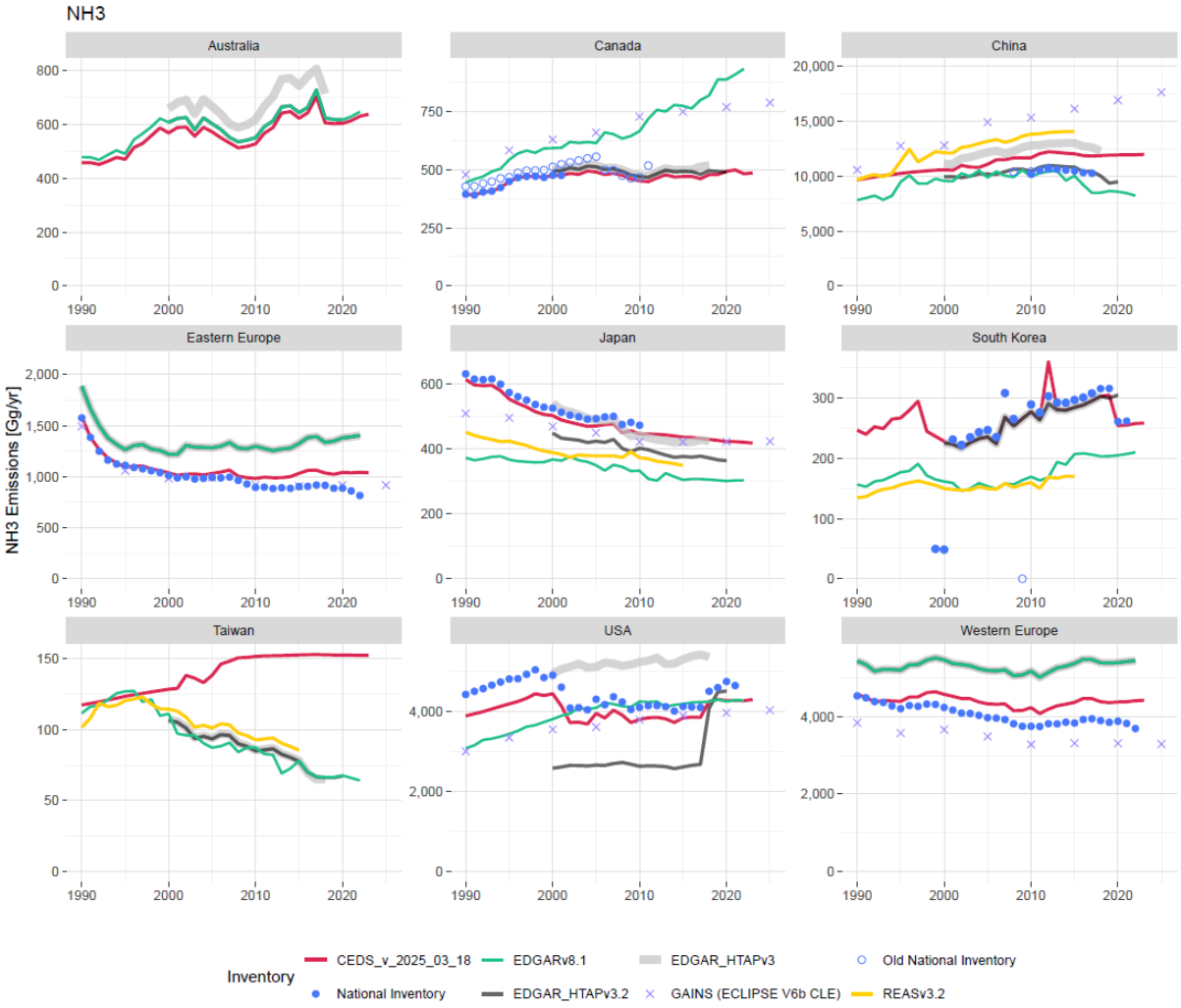
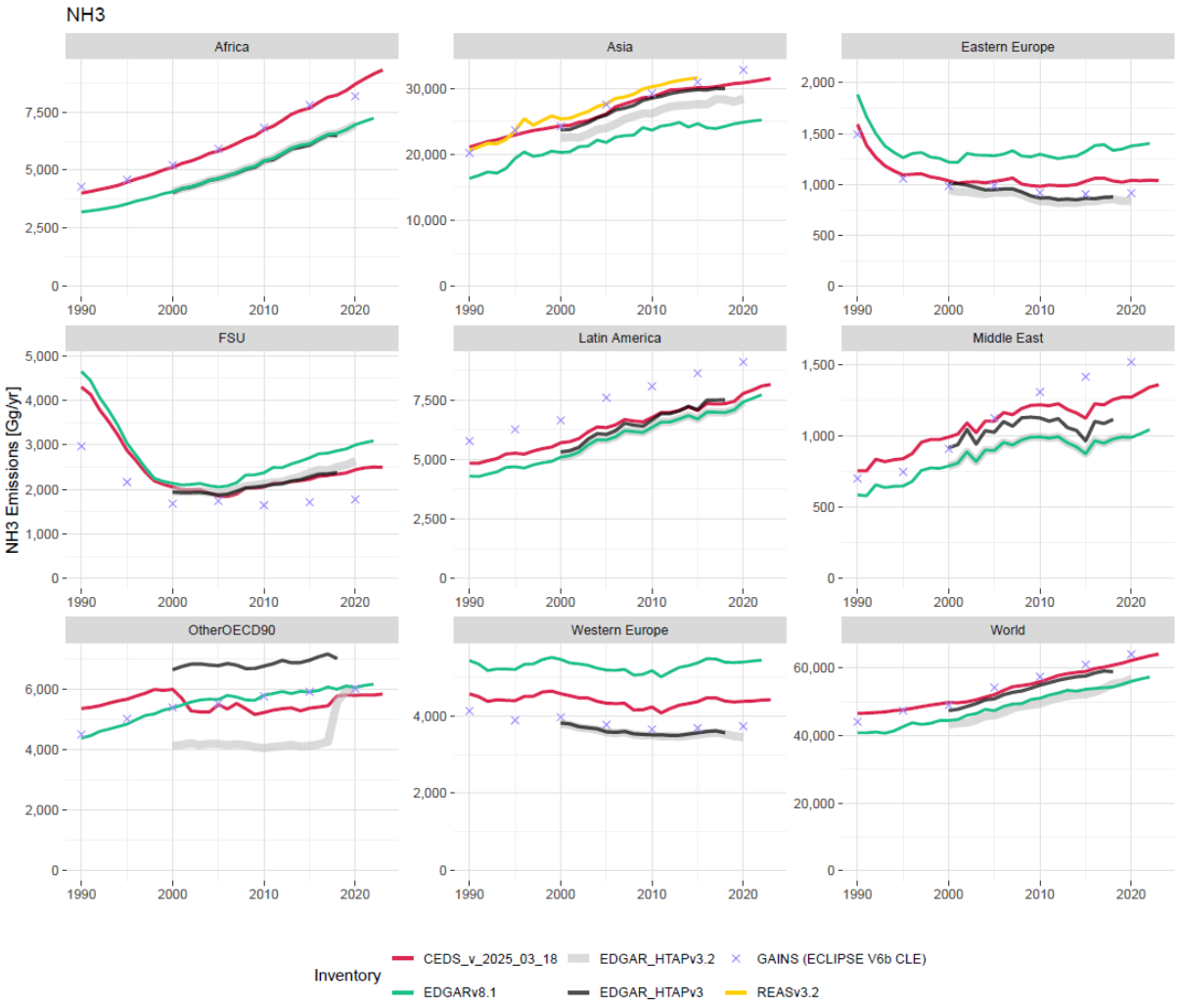


Figure S4 – NMVOC emission time series comparison by world region as provided by different inventories and HTAP_v3.2. For country codes refer to Table S2.

S2.5- Comparison of NH_3 emissions

While HTAP_v3.2 compares well with the country level data for NH_3 in most cases, there is also a large variation overall between the different global inventories. In some cases, such as the USA, gridded NH_3 emissions in some key agricultural sectors was not available so these emissions were gap filled from EDGAR estimates.


NH3
Australia
Canada
China
Eastern Europe
Japan
South Korea
Taiwan
USA
Western Europe
NH3 Emissions [Gg/yr]
Inventory
CEDS_v_2025_03_18
EDGARv8.1
EDGAR_HTAPv3
Old National Inventory
National Inventory
EDGAR_HTAPv3.2
GAINS (ECLIPSE V6b CLE)
REASv3.2


NH3
Africa
Asia
Eastern Europe
FSU
Latin America
Middle East
OtherOECD90
Western Europe
World
NH3 Emissions [Gg/yr]
Inventory
CEDS_v_2025_03_18
EDGAR_HTAPv3.2
GAINS (ECLIPSE V6b CLE)
EDGARv8.1
EDGAR_HTAPv3
REASv3.2

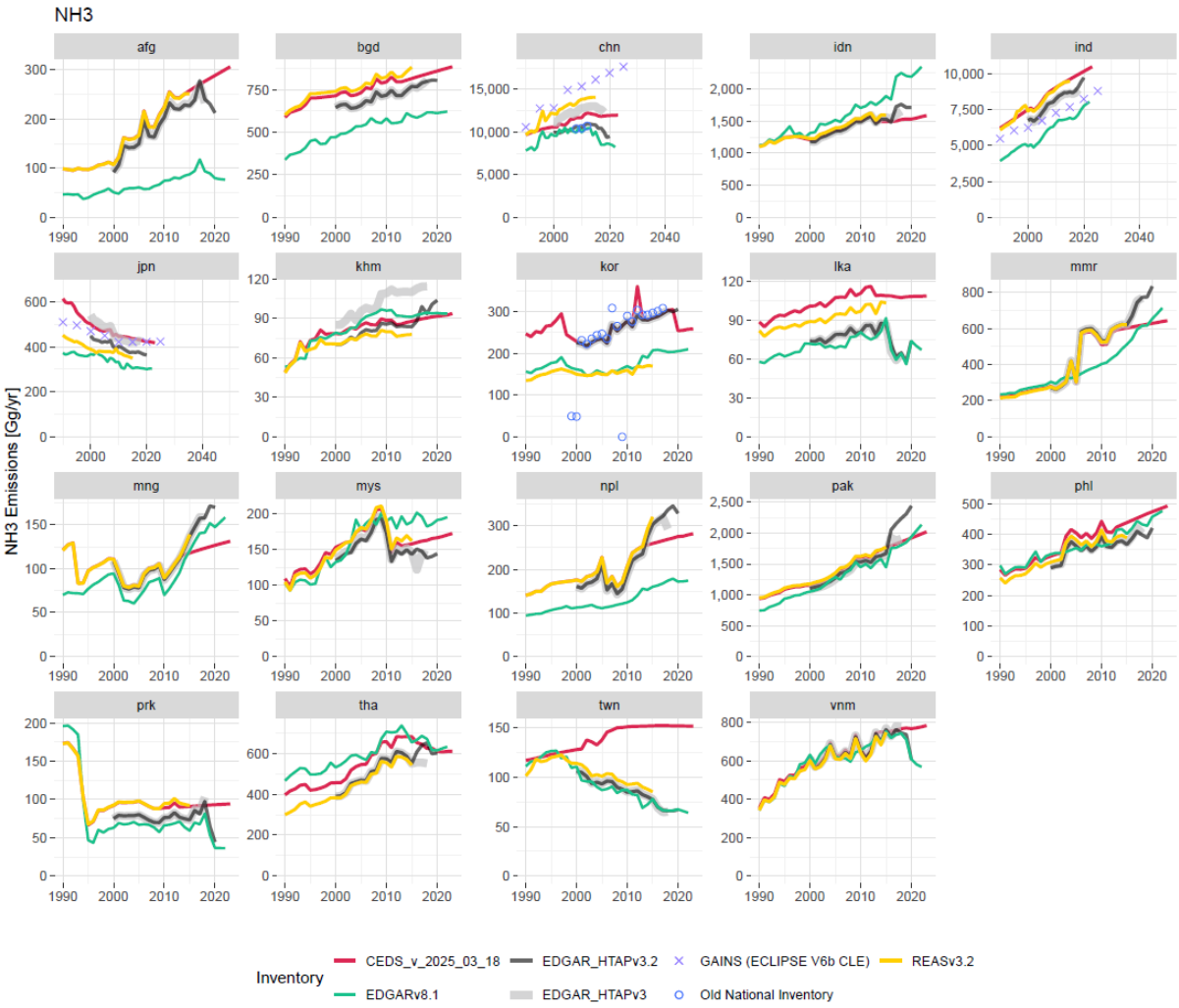


Figure S5 – NH_3 emission time series comparison by world region as provided by different inventories and HTAP_v3.2. For country codes refer to Table S2.

Figures S6-S17 show the comparison between HTAP_v3 and HTAP_v3.2 emissions by aggregated world regions, highlighting changes and improvements between the 2 versions of the mosaic. For example, for Eastern Asia, the comparison figure reflects the different emission estimates in particular for China between REAS (used in HTAP_v3) and MEIC (used in HTAP_v3.2). The improvement of the EDGAR data between version 6.1 (used in HTAP_v3) and 8.1 (used in HTAP_v3.2) appears in the figures of international shipping and aviation, Africa, Latin America and the Caribbean, Middle East (Figs S7-S11), while the improvements of the input data by regional inventory providers is shown for all other world regions (Figs S12-S17).

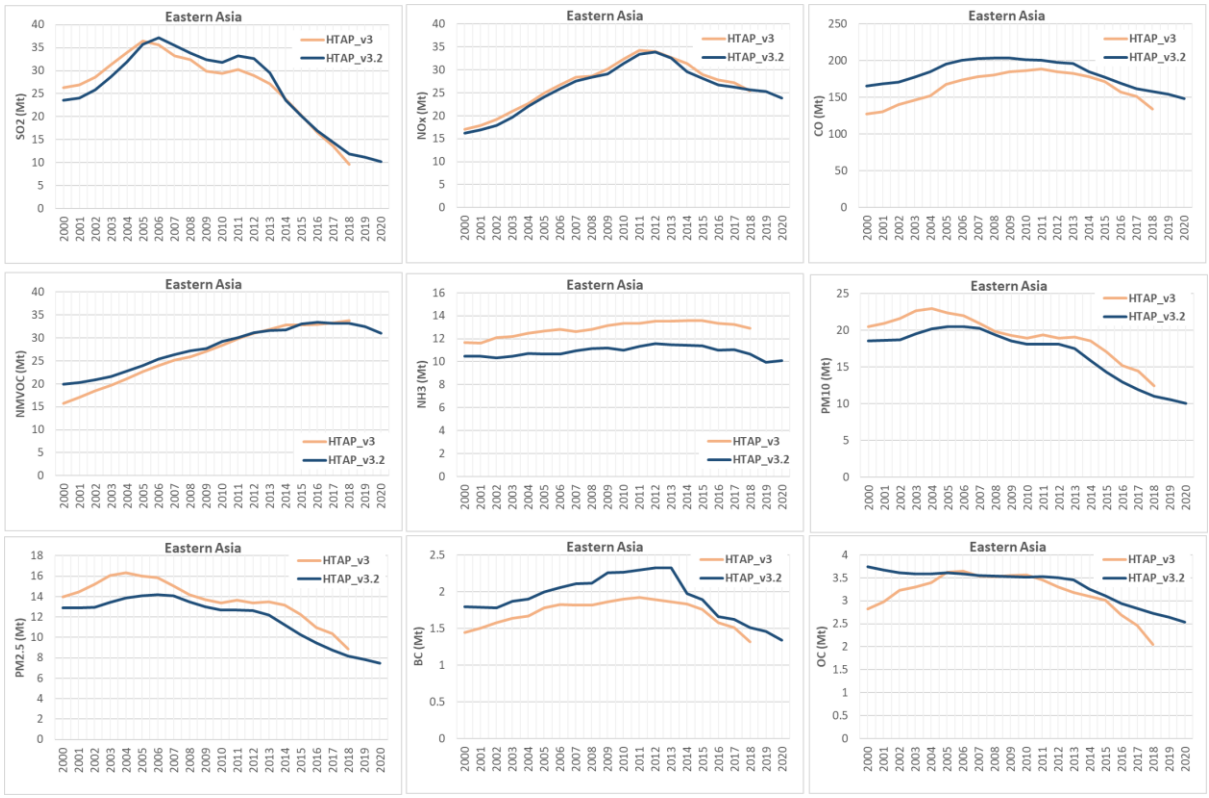


Figure S6 – Comparison of HTAP_v3 and HTAP_v3.2 emissions for Eastern Asia.

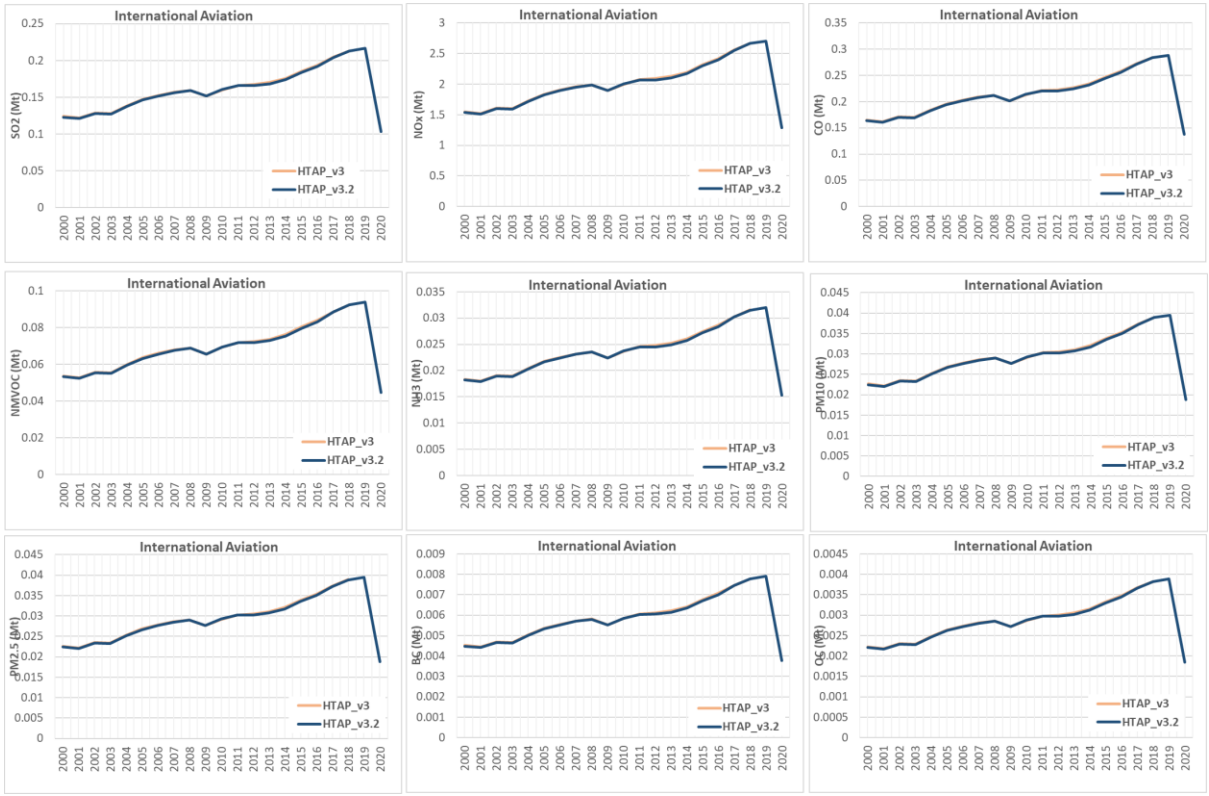


Figure S7 – Comparison of HTAP_v3 and HTAP_v3.2 emissions for international aviation.

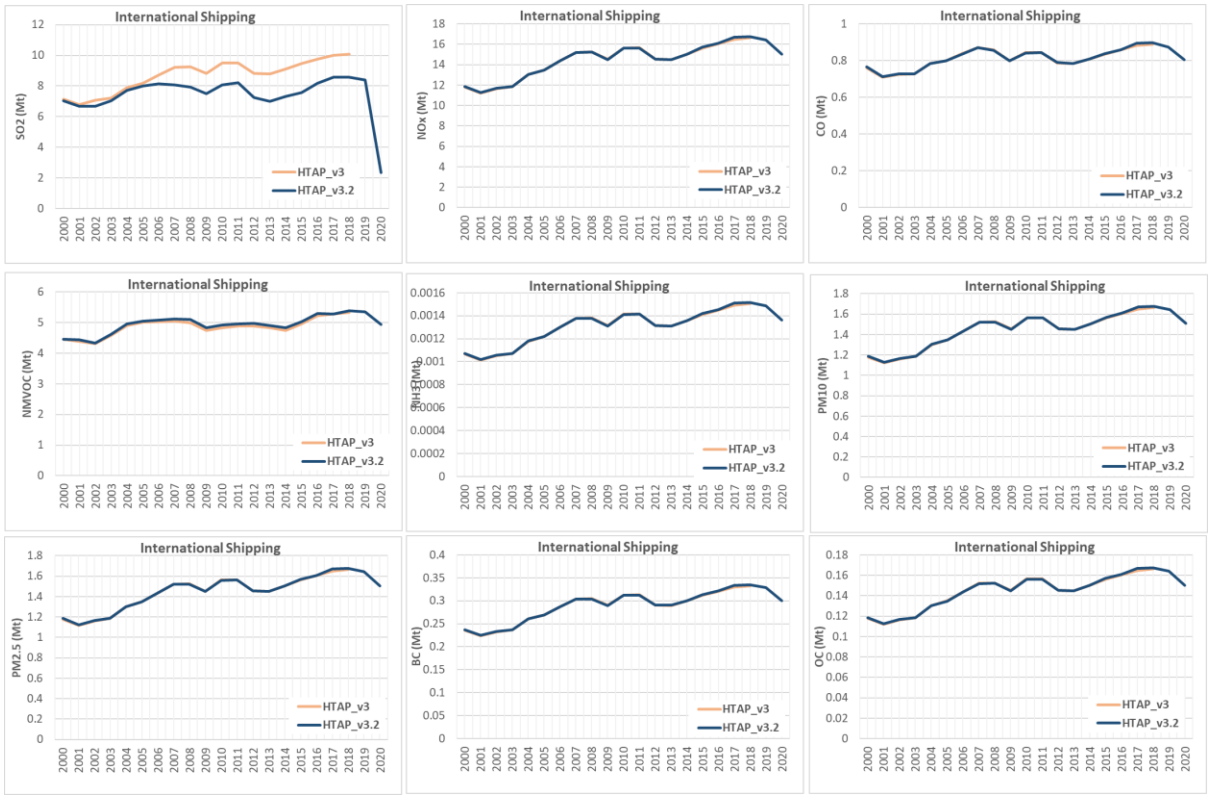


Figure S8 – Comparison of HTAP_v3 and HTAP_v3.2 emissions for international shipping.

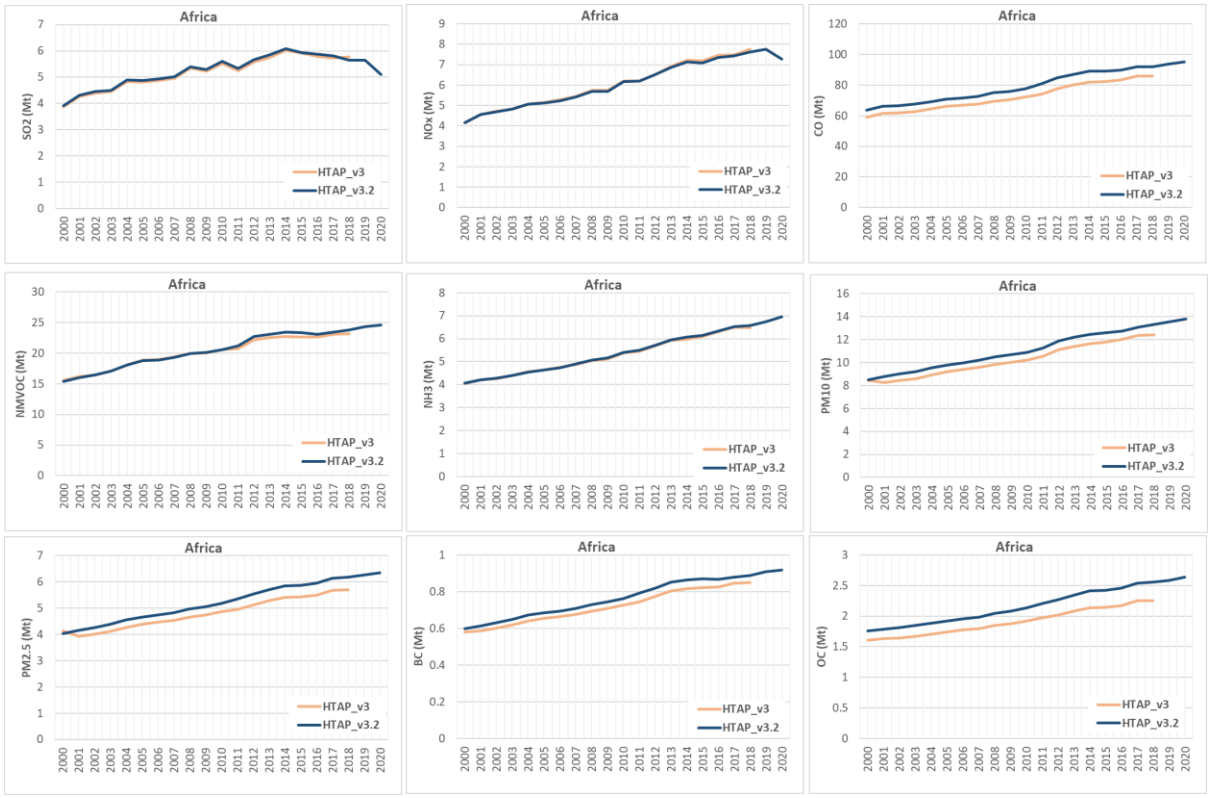


Figure S9 – Comparison of HTAP_v3 and HTAP_v3.2 emissions for Africa.

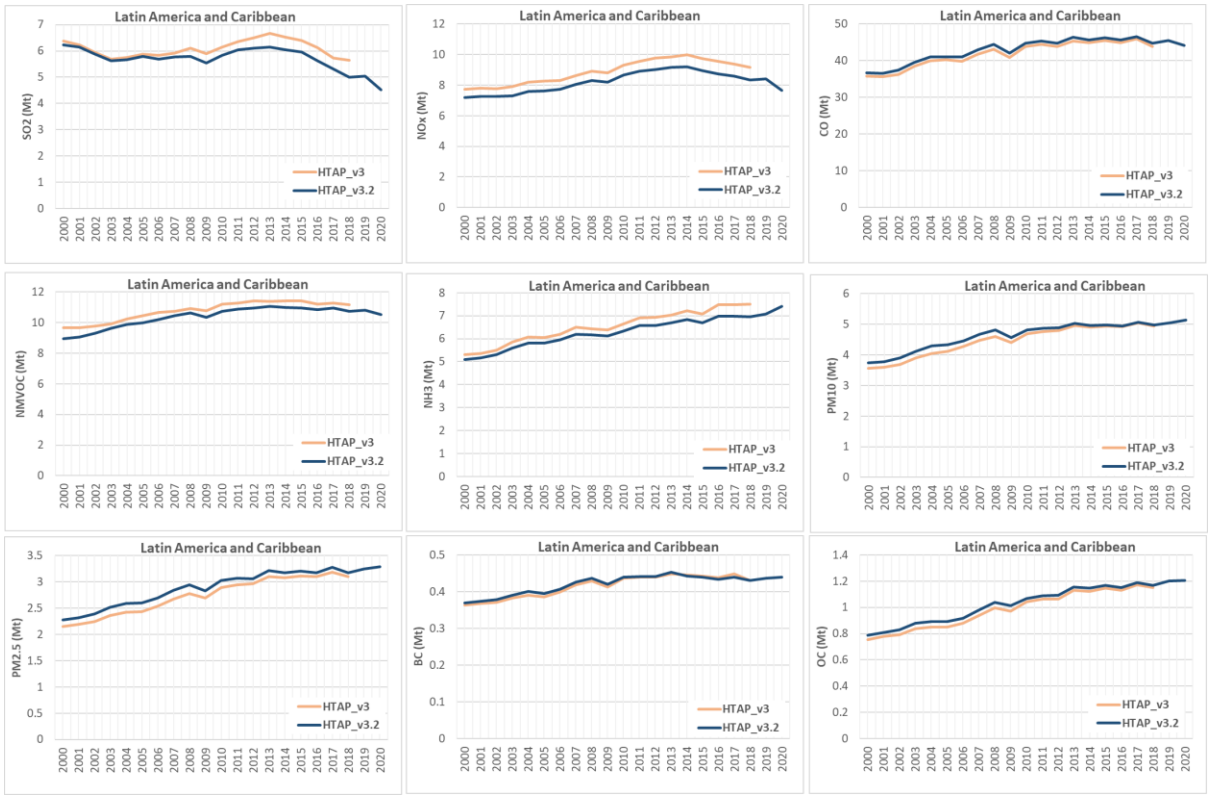


Figure S10 – Comparison of HTAP_v3 and HTAP_v3.2 emissions for Latin America and the Caribbean.

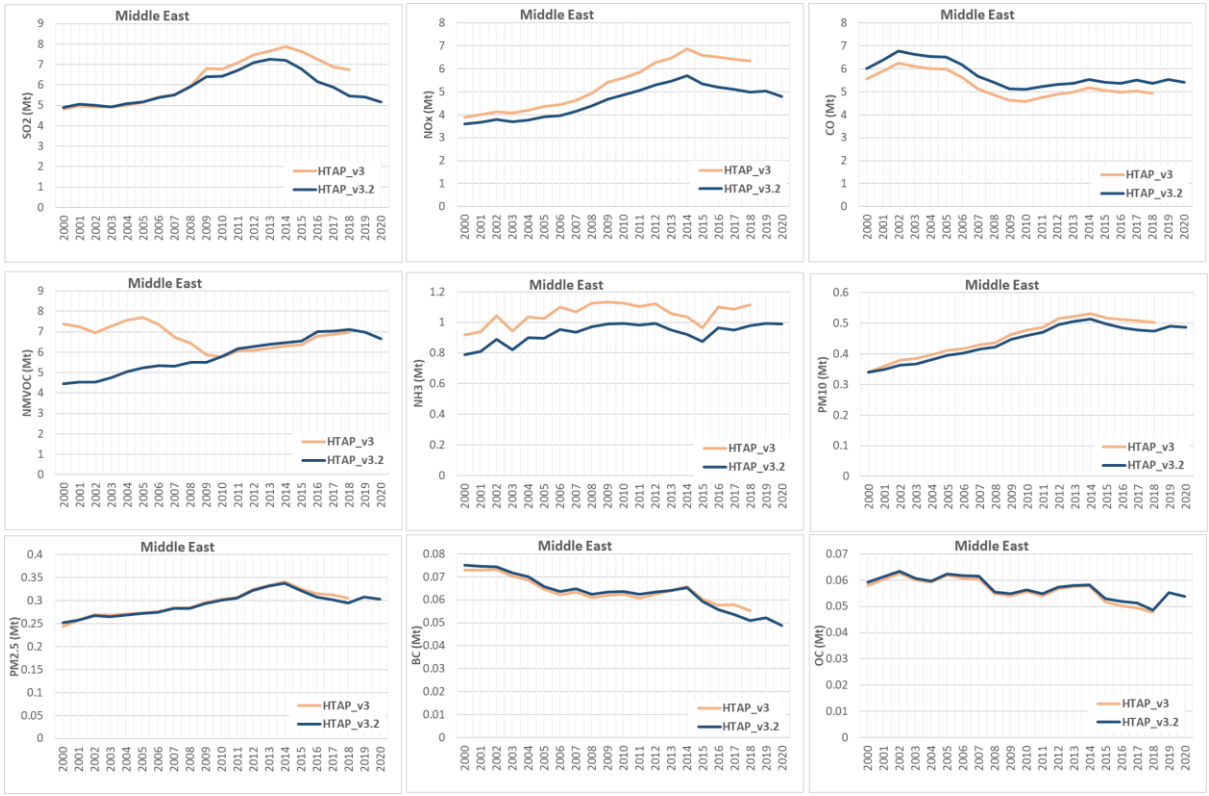


Figure S11 – Comparison of HTAP_v3 and HTAP_v3.2 emissions for Middle East.

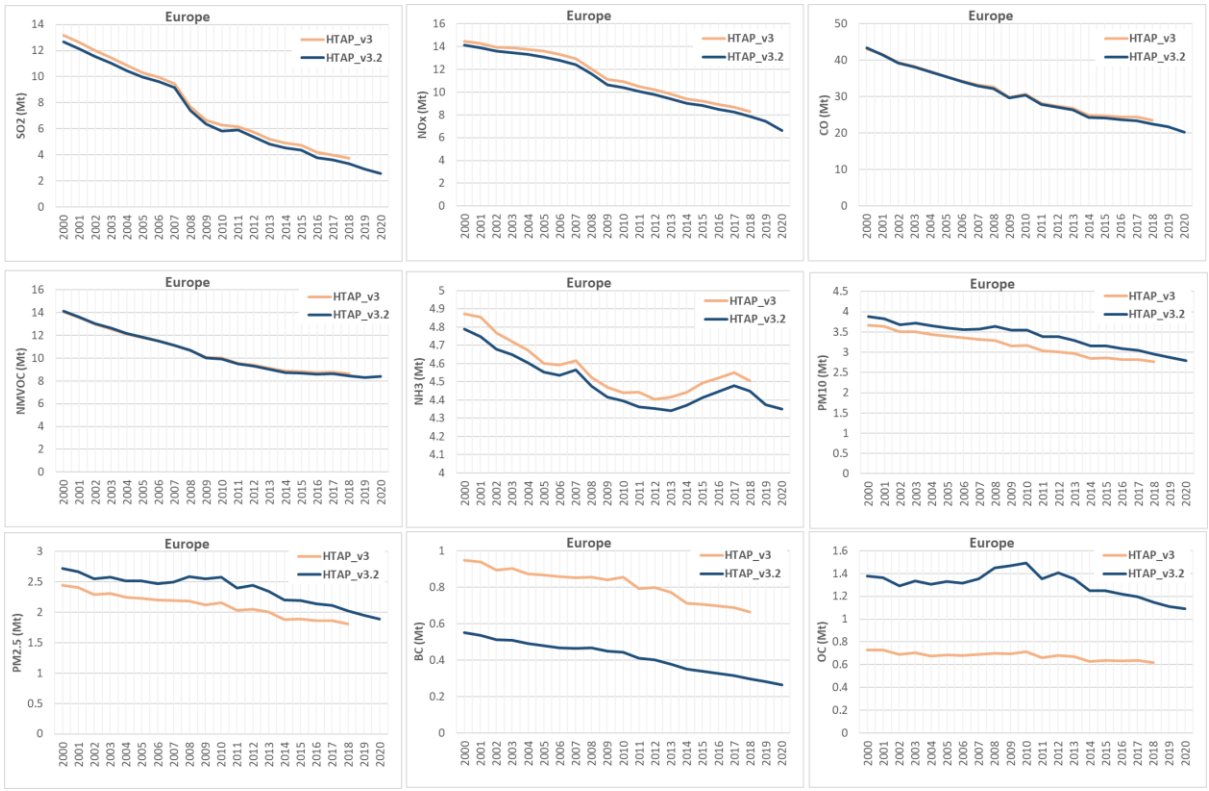


Figure S12 – Comparison of HTAP_v3 and HTAP_v3.2 emissions for Europe.

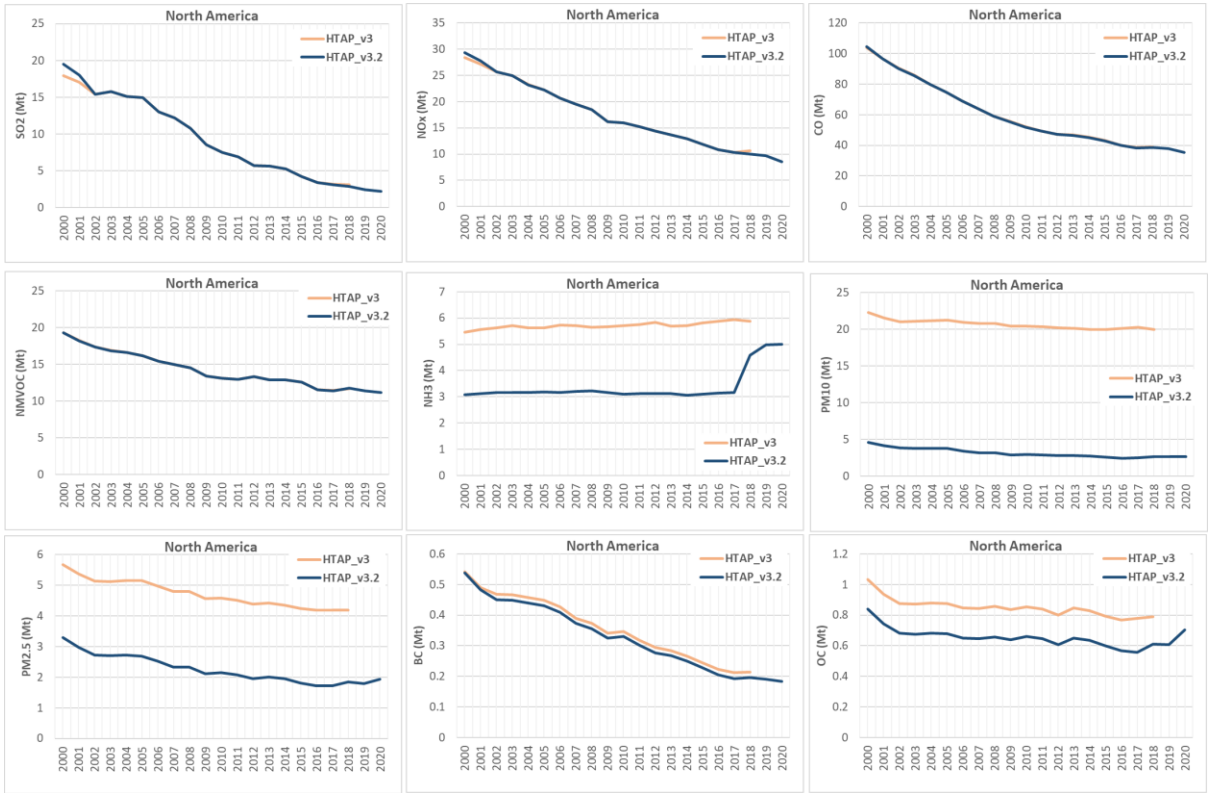


Figure S13 – Comparison of HTAP_v3 and HTAP_v3.2 emissions for North America.

Figure S14 – Comparison of HTAP_v3 and HTAP_v3.2 emissions for Eastern Europe and West-Central Asia.

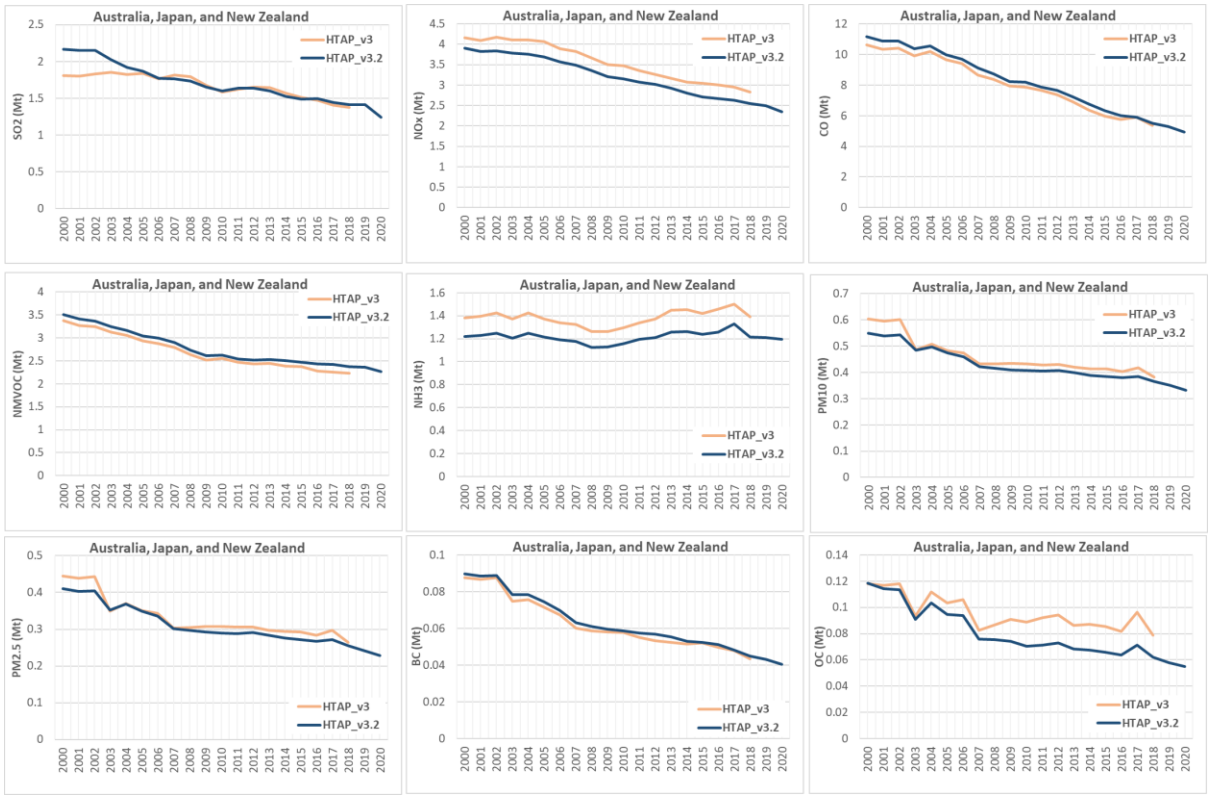


Figure S15 – Comparison of HTAP_v3 and HTAP_v3.2 emissions for Australia, Japan and New Zealand.

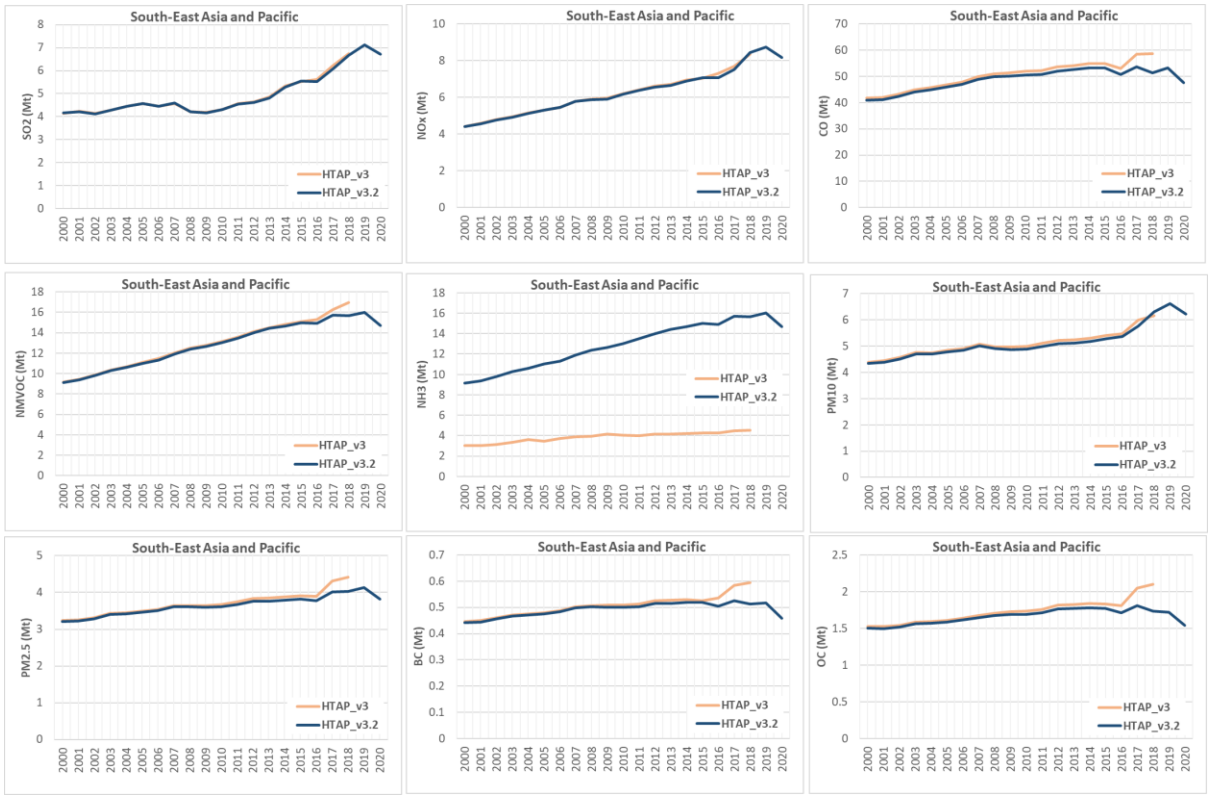


Figure S16 – Comparison of HTAP_v3 and HTAP_v3.2 emissions for South-East Asia and Pacific.

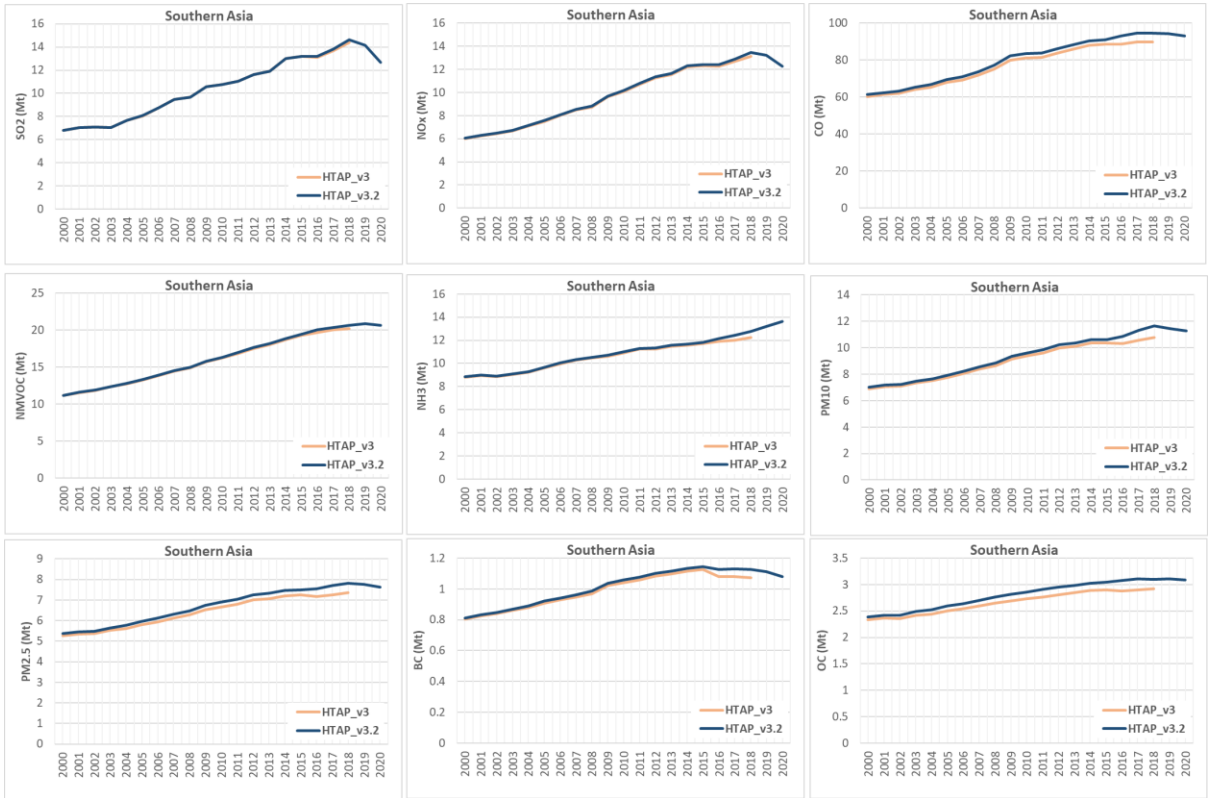


Figure S17 – Comparison of HTAP_v3 and HTAP_v3.2 emissions for Southern Asia.

S3 – Monthly variability of the emissions

Figures S18, S19 and S20 show the monthly contribution of the emissions of CO, NMVOC and SO_2 in 2015 for world regions. The largest variability is found for the residential sector and agriculture, while smaller variation is present for energy, industry and transport.

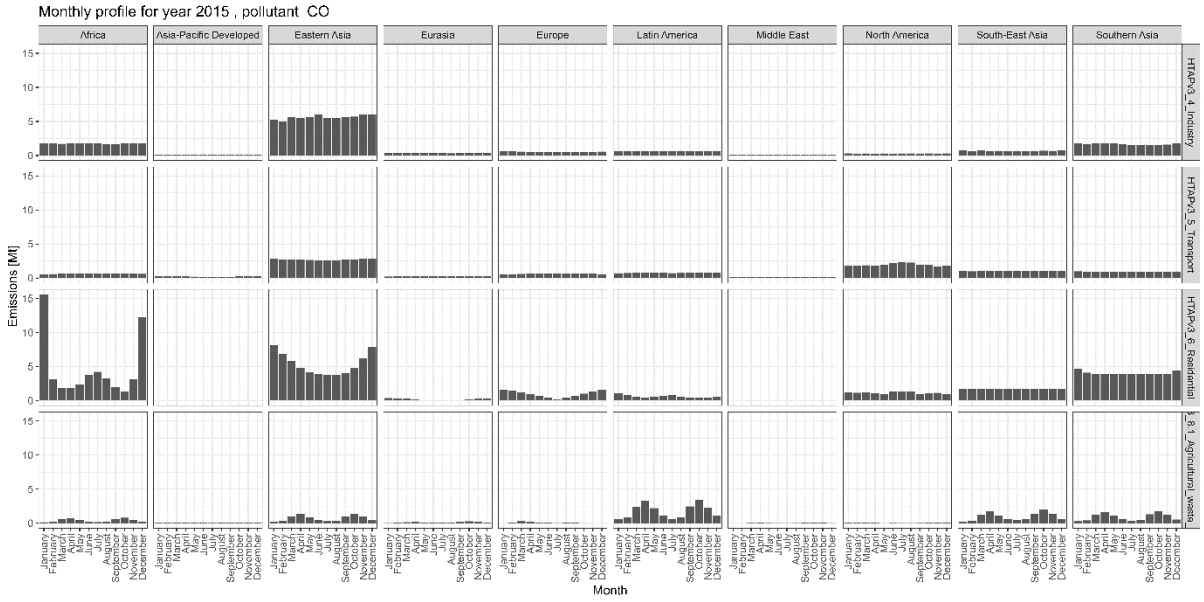


Figure S18 – Monthly variability of CO emissions for relevant emission sectors for the different world regions in 2015.

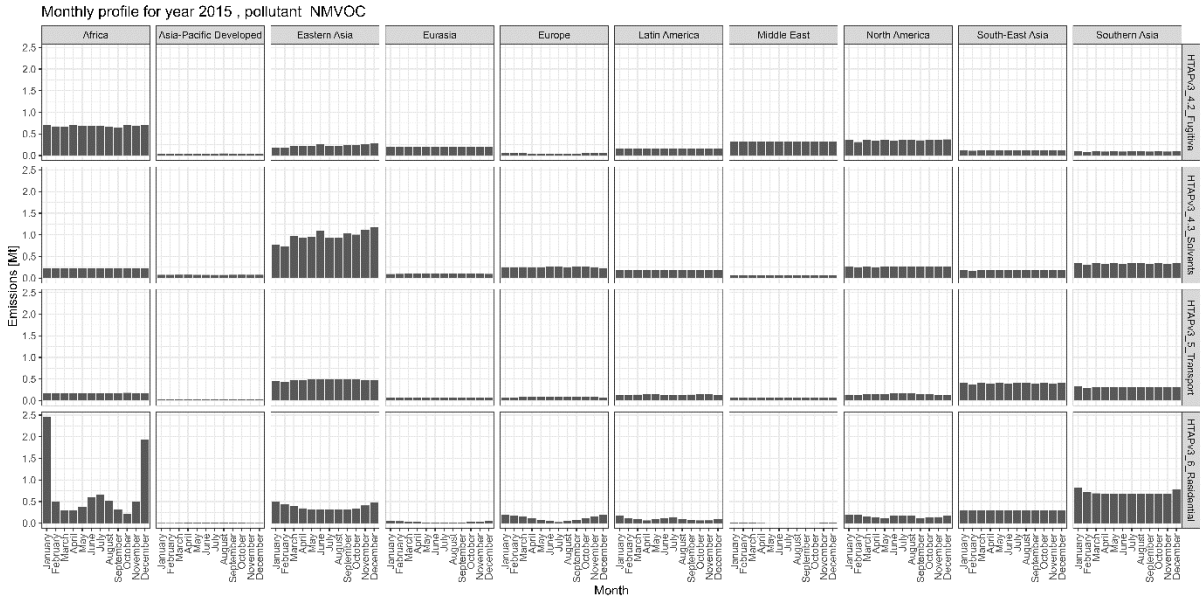


Figure S19 – Monthly variability of NMVOC emissions for relevant emission sectors for the different world regions in 2015.

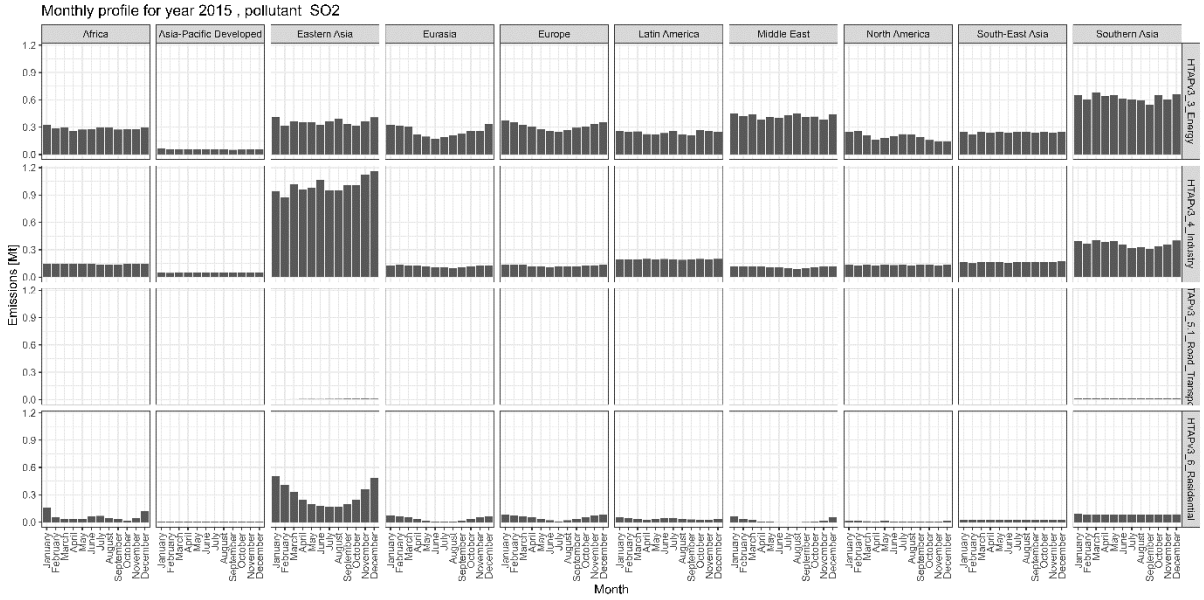


Figure S20 – Monthly variability of SO_2 emissions for relevant emission sectors for the different world regions in 2015.

Figures S21-S26 show the monthly mean profiles for the different pollutants and relevant emission sectors. The mean profile over the years 2002-2015, which is the period covered by all data providers, for each region is represented together with the 10° and 90° percentiles. With the exception of few data providers (EDGAR and ECCC), no inter-annual variability of the monthly profiles is found.

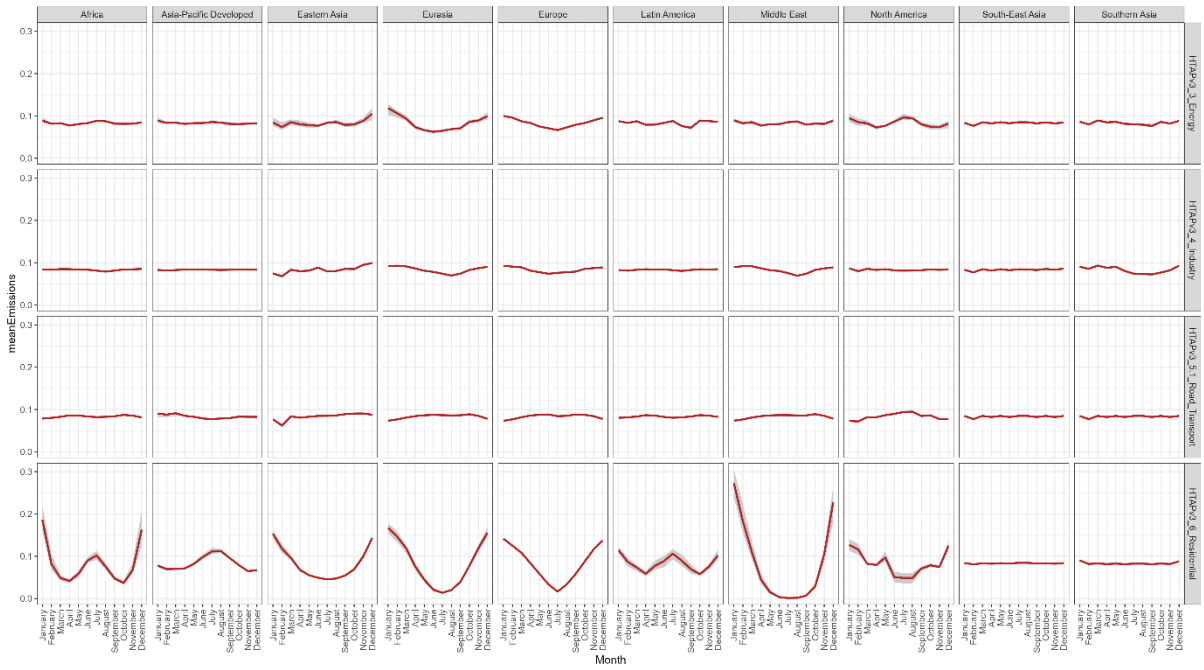


Figure S21 – Monthly mean profile of SO_2 emissions for relevant emission sectors for the different world regions. The mean profile over the years 2002-2015, which is the period covered by all data providers, for each region is represented together with the 10° and 90° percentiles, in grey.

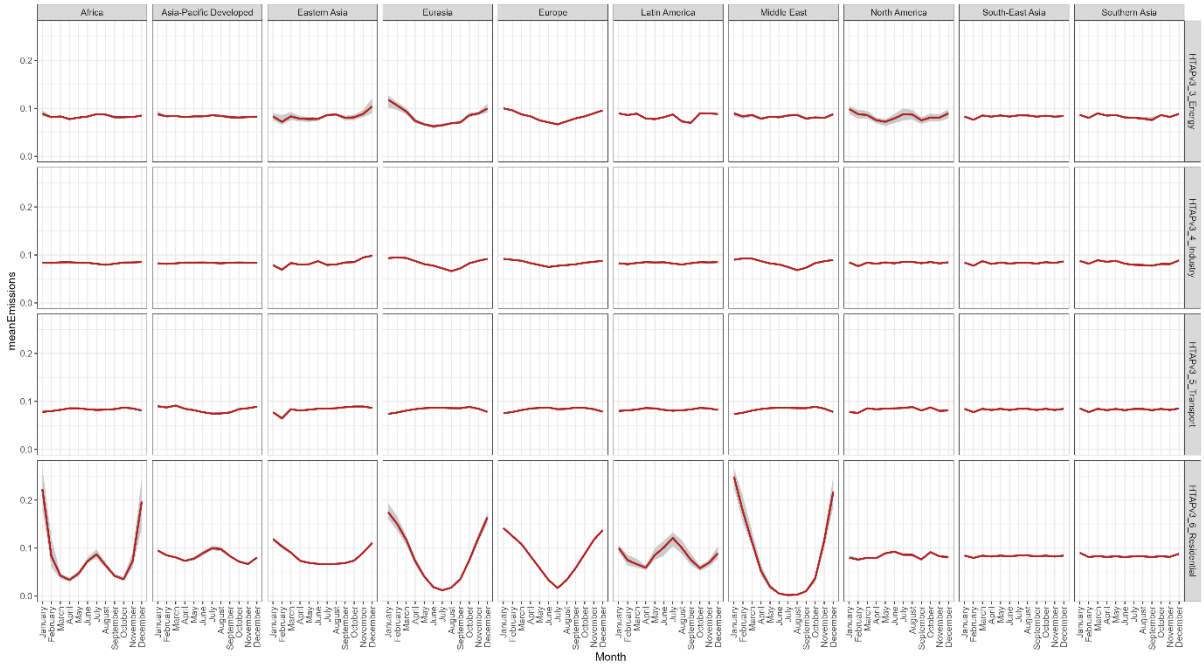


Figure S22 – Monthly mean profile of NOx emissions for relevant emission sectors for the different world regions. The mean profile over the years 2002-2015, which is the period covered by all data providers, for each region is represented together with the 10° and 90° percentiles.

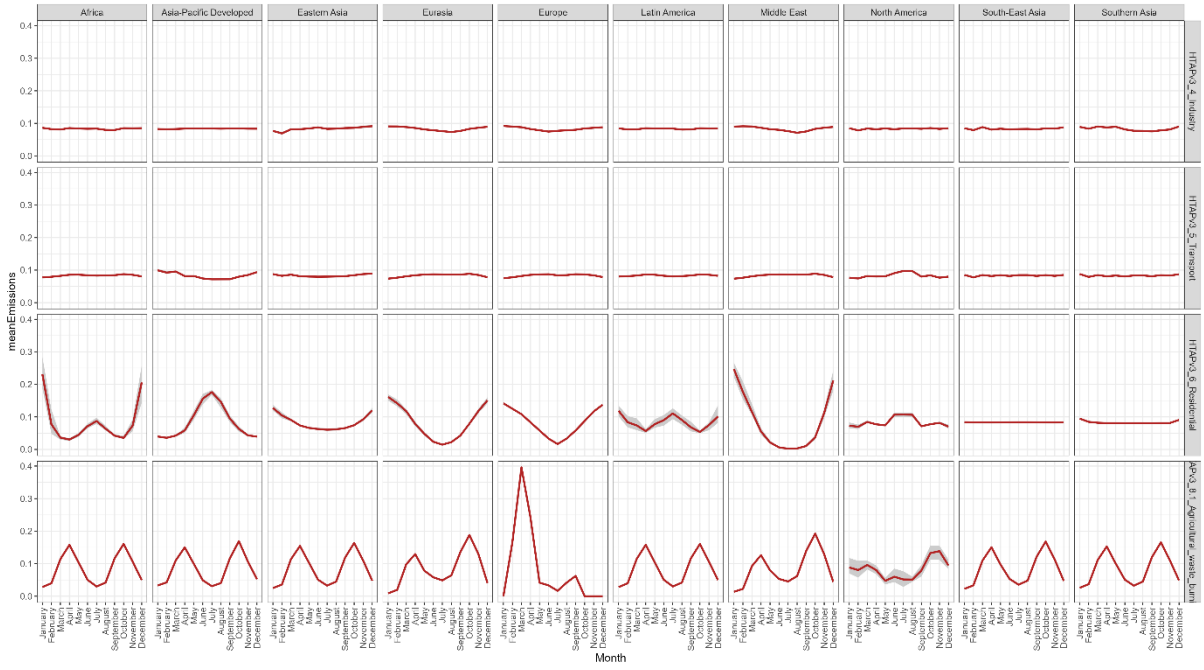


Figure S23 – Monthly mean profile of CO emissions for relevant emission sectors for the different world regions. The mean profile over the years 2002-2015, which is the period covered by all data providers, for each region is represented together with the 10° and 90° percentiles.

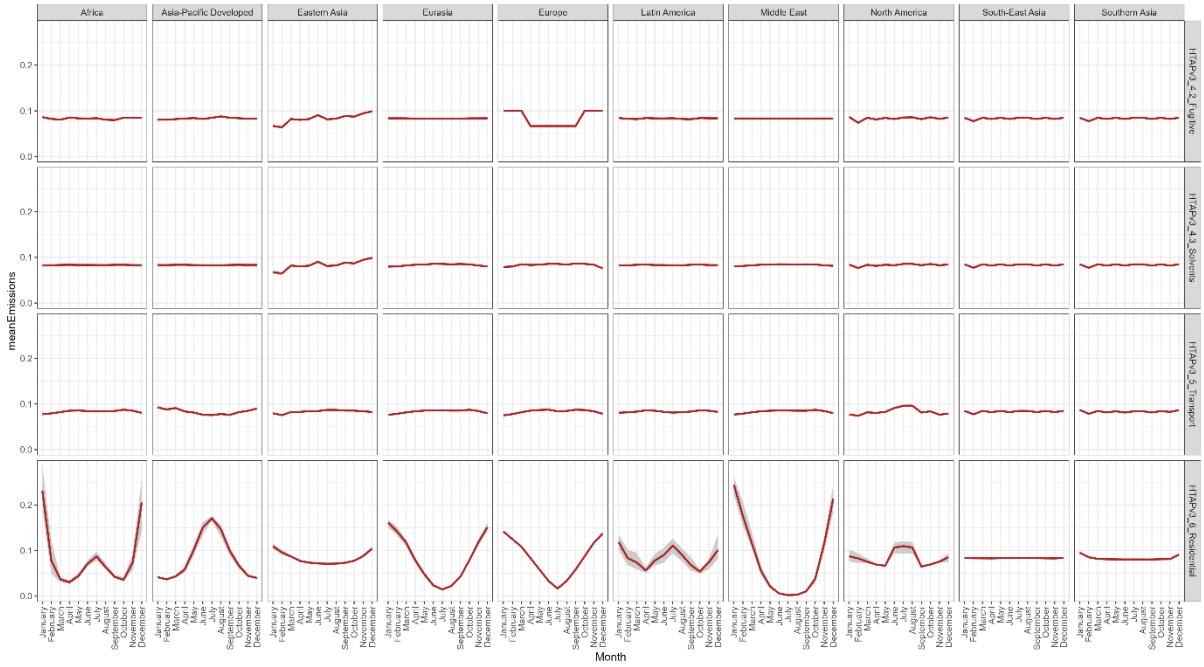


Figure S24 – Monthly mean profile of NMVOC emissions for relevant emission sectors for the different world regions. The mean profile over the years 2002-2015, which is the period covered by all data providers, for each region is represented together with the 10° and 90° percentiles.

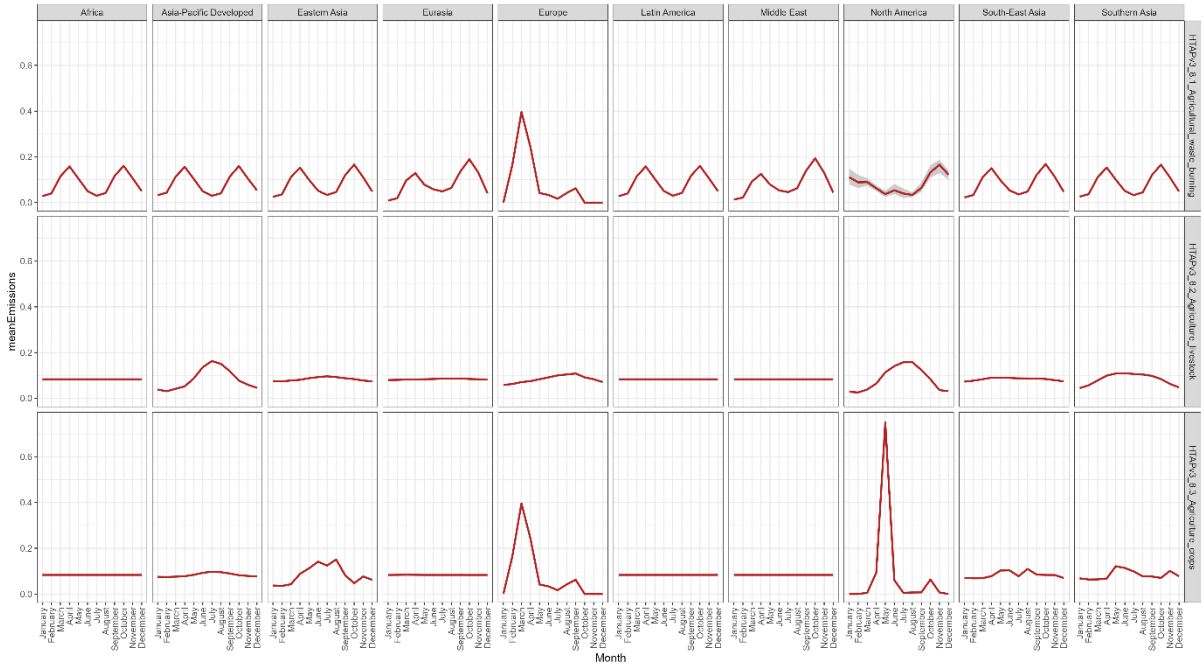


Figure S25 – Monthly mean profile of NH_3 emissions for relevant emission sectors for the different world regions. The mean profile over the years 2002-2015, which is the period covered by all data providers, for each region is represented together with the 10° and 90° percentiles.

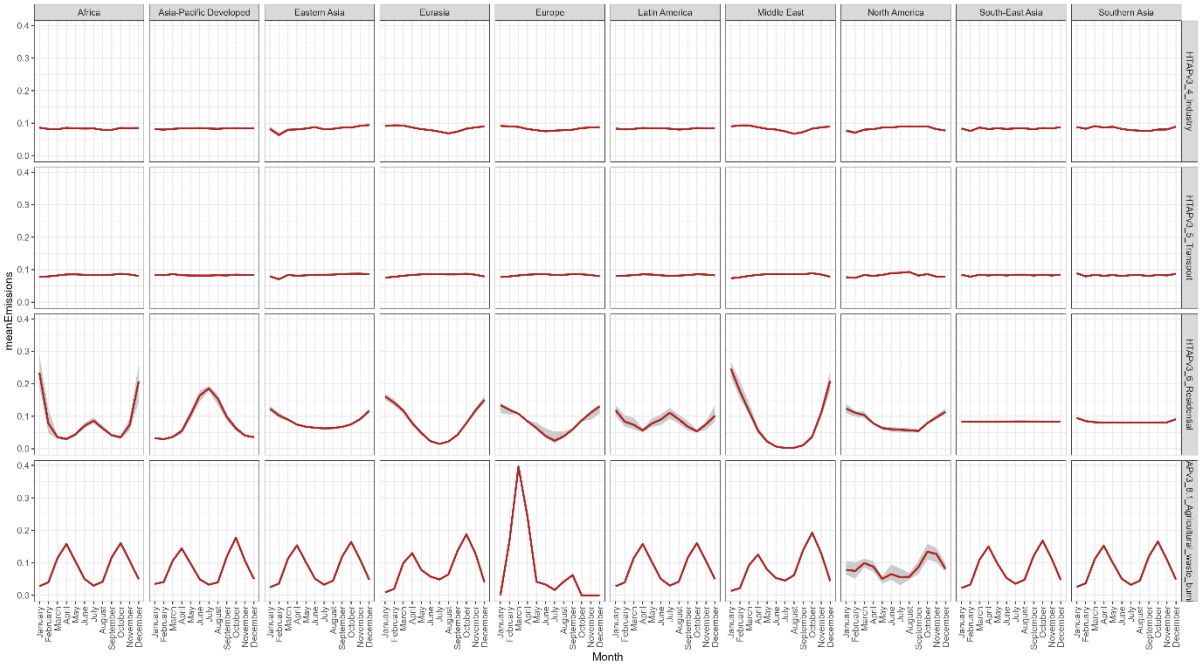


Figure S26 – Monthly mean profile of PM_{10} emissions for relevant emission sectors for the different world regions. The mean profile over the years 2002-2015, which is the period covered by all data providers, for each region is represented together with the 10° and 90° percentiles.

S4 NMVOC speciation

Table S3 provides the list of Global Emissions InitiAtive (GEIA) 25 NMVOC groups included in HTAP_v3.2 with the corresponding molecular formula.

Table S3 – List of NMVOC species included in HTAP_v3.2. R and R' denote functional groups. Where general formulae are not appropriate, the simplest molecular formula representing the group is provided. NA = not available

GEIA ID	GEIA group	Molecular formula
voc1	Alkanols (alcohols)	$C_nH_{2n+1}OH$
voc2	Ethane	C_2H_6
voc3	Propane	C_3H_8
voc4	Butanes	C_4H_{10}
voc5	Pentanes	C_5H_{12}
voc6	Hexanes and higher alkanes	C_nH_{2n+2} ($n \geq 6$)
voc7	Ethene (ethylene)	C_2H_4
voc8	Propene	C_3H_6
voc9	Ethyne (acetylene)	C_2H_2
voc10	Isoprenes	C_5H_8
voc11	Monoterpenes	$C_{10}H_{16}$
voc12	Other alk(adi)enes/alkynes (olefines)	C_nH_{2n-2}
voc13	Benzene (benzol)	C_6H_6
voc14	Methylbenzene (toluene)	C_7H_8
voc15	Dimethylbenzenes (xylenes)	$C_6H_4(CH_3)_2$
voc16	Trimethylbenzenes	$C_6H_3(CH_3)_3$
voc17	Other aromatics	C_nH_{2n-6}
voc18	Esters	R-C(=O)O-R'
voc19	Ethers (alkoxy alkanes)	R-O-R'
voc20	Chlorinated hydrocarbons	CH_3Cl
voc21	Methanal (formaldehyde)	CH_2O
voc22	Other alkanals (aldehyedes)	R-CHO
voc23	Alkanones (ketones)	R-C(=O)-R'
voc24	Acids (alkanoic)	$R\text{-}C_nH_nCOOH$
voc25	Other NMVOC (HCFCs, nitriles, etc.)	NA

Table S4 - Regional mapping to be applied for NMVOC speciation

Country code	Country name	Regional VOC grouping	Region definition
ABW	Aruba	OT	Other
AFG	Afghanistan	AS	Asia
AGO	Angola	OT	Other
AIA	Anguilla	OT	Other
AIR	Int. Aviation	OT	Other
ALA	Åland Islands	EU	Europe
ALB	Albania	EU	Europe
AND	Andorra	EU	Europe
ANT	Netherlands Antilles	OT	Other
ARE	United Arab Emirates	OT	Other
ARG	Argentina	OT	Other
ARM	Armenia	EU	Europe
ASM	American Samoa	OT	Other
ATA	Antarctica	OT	Other
ATF	French Southern Territories	OT	Other
ATG	Antigua and Barbuda	OT	Other
AUS	Australia	OT	Other
AUT	Austria	EU	Europe
AZE	Azerbaijan	EU	Europe
BDI	Burundi	OT	Other
BEL	Belgium	EU	Europe
BEN	Benin	OT	Other
BFA	Burkina Faso	OT	Other
BGD	Bangladesh	AS	Asia
BGR	Bulgaria	EU	Europe
BHR	Bahrain	OT	Other
BHS	Bahamas	OT	Other
BIH	Bosnia and Herzegovina	EU	Europe
BLR	Belarus	EU	Europe
BLZ	Belize	OT	Other
BMU	Bermuda	OT	Other
BOL	Bolivia	OT	Other
BRA	Brazil	OT	Other
BRB	Barbados	OT	Other
BRN	Brunei Darussalam	AS	Asia
BTN	Bhutan	AS	Asia
BVT	Bouvet Island	OT	Other
BWA	Botswana	OT	Other
CAF	Central African Republic	OT	Other
CAN	Canada	NA	North America
CCK	Cocos (Keeling) Islands	OT	Other
CHE	Switzerland	EU	Europe
CHL	Chile	OT	Other

CHN	China	AS	Asia
CIV	Cote d'Ivoire	OT	Other
CMR	Cameroon	OT	Other
COD	Congo, the Democratic Republic of the	OT	Other
COG	Congo	OT	Other
COK	Cook Islands	OT	Other
COL	Colombia	OT	Other
COM	Comoros	OT	Other
CPV	Cape Verde	OT	Other
CRI	Costa Rica	OT	Other
CUB	Cuba	OT	Other
CXR	Christmas Island	OT	Other
CYM	Cayman Islands	OT	Other
CYP	Cyprus	EU	Europe
CZE	Czech Republic	EU	Europe
DEU	Germany	EU	Europe
DJI	Djibouti	OT	Other
DMA	Dominica	OT	Other
DNK	Denmark	EU	Europe
DOM	Dominican Republic	OT	Other
DZA	Algeria	OT	Other
E27	Europe - 27 MS	EU	Europe
ECU	Ecuador	OT	Other
EGY	Egypt	OT	Other
ERI	Eritrea	OT	Other
ESH	Western Sahara	OT	Other
ESP	Spain	EU	Europe
EST	Estonia	EU	Europe
ETH	Ethiopia	OT	Other
FIN	Finland	EU	Europe
FJI	Fiji	OT	Other
FLK	Falkland Islands (Malvinas)	OT	Other
FRA	France	EU	Europe
FRO	Faroe Islands	EU	Europe
FSM	Micronesia, Federated States of	OT	Other
GAB	Gabon	OT	Other
GBR	United Kingdom	EU	Europe
GEO	Georgia	EU	Europe
GGY	Guernsey	EU	Europe
GHA	Ghana	OT	Other
GIB	Gibraltar	EU	Europe
GIN	Guinea	OT	Other
GLP	Guadeloupe	OT	Other
GMB	Gambia	OT	Other
GNB	Guinea-Bissau	OT	Other
GNQ	Equatorial Guinea	OT	Other

GRC	Greece	EU	Europe
GRD	Grenada	OT	Other
GRL	Greenland	EU	Europe
GTM	Guatemala	OT	Other
GUF	French Guiana	OT	Other
GUM	Guam	OT	Other
GUY	Guyana	OT	Other
HKG	Hong Kong	AS	Asia
HMD	Heard Island and McDonald Islands	OT	Other
HND	Honduras	OT	Other
HRV	Croatia	EU	Europe
HTI	Haiti	OT	Other
HUN	Hungary	EU	Europe
IDN	Indonesia	AS	Asia
IMN	Isle of Man	EU	Europe
IND	India	AS	Asia
IOT	British Indian Ocean Territory	AS	Asia
IRL	Ireland	EU	Europe
IRN	Iran, Islamic Republic of	OT	Other
IRQ	Iraq	OT	Other
ISL	Iceland	EU	Europe
ISR	Israel	OT	Other
ITA	Italy	EU	Europe
JAM	Jamaica	OT	Other
JEY	Jersey	EU	Europe
JOR	Jordan	OT	Other
JPN	Japan	AS	Asia
KAZ	Kazakhstan	AS	Asia
KEN	Kenya	OT	Other
KGZ	Kyrgyzstan	AS	Asia
KHM	Cambodia	AS	Asia
KIR	Kiribati	OT	Other
KNA	Saint Kitts and Nevis	OT	Other
KOR	Korea, Republic of	AS	Asia
KWT	Kuwait	OT	Other
LAO	Lao People's Democratic Republic	AS	Asia
LBN	Lebanon	OT	Other
LBR	Liberia	OT	Other
LBY	Libyan Arab Jamahiriya	OT	Other
LCA	Saint Lucia	OT	Other
LIE	Liechtenstein	EU	Europe
LKA	Sri Lanka	AS	Asia
LSO	Lesotho	OT	Other
LTU	Lithuania	EU	Europe
LUX	Luxembourg	EU	Europe
LVA	Latvia	EU	Europe

MAC	Macao	AS	Asia
MAR	Morocco	OT	Other
MCO	Monaco	EU	Europe
MDA	Moldova, Republic of	EU	Europe
MDG	Madagascar	OT	Other
MDV	Maldives	AS	Asia
MEX	Mexico	OT	Other
MHL	Marshall Islands	OT	Other
MKD	Macedonia, the former Yugoslav Republic of	EU	Europe
MLI	Mali	OT	Other
MLT	Malta	EU	Europe
MMR	Myanmar	AS	Asia
MNE	Montenegro	EU	Europe
MNG	Mongolia	AS	Asia
MNP	Northern Mariana Islands	OT	Other
MOZ	Mozambique	OT	Other
MRT	Mauritania	OT	Other
MSR	Montserrat	OT	Other
MTQ	Martinique	OT	Other
MUS	Mauritius	OT	Other
MWI	Malawi	OT	Other
MYS	Malaysia	AS	Asia
MYT	Mayotte	OT	Other
NAM	Namibia	OT	Other
NCL	New Caledonia	OT	Other
NER	Niger	OT	Other
NFK	Norfolk Island	OT	Other
NGA	Nigeria	OT	Other
NIC	Nicaragua	OT	Other
NIU	Niue	OT	Other
NLD	Netherlands	EU	Europe
NOR	Norway	EU	Europe
NPL	Nepal	AS	Asia
NRU	Nauru	OT	Other
NZL	New Zealand	OT	Other
OMN	Oman	OT	Other
PAK	Pakistan	AS	Asia
PAN	Panama	OT	Other
PCN	Pitcairn	OT	Other
PER	Peru	OT	Other
PHL	Philippines	AS	Asia
PLW	Palau	OT	Other
PNG	Papua New Guinea	AS	Asia
POL	Poland	EU	Europe
PRI	Puerto Rico	OT	Other

PRK	Korea, Democratic People's Republic of	AS	Asia
PRT	Portugal	EU	Europe
PRY	Paraguay	OT	Other
PSE	Palestinian Territory	OT	Other
PYF	French Polynesia	OT	Other
QAT	Qatar	OT	Other
REU	Reunion	OT	Other
ROU	Romania	EU	Europe
RUS	Russian Federation	EU	Europe
RWA	Rwanda	OT	Other
SAU	Saudi Arabia	OT	Other
SCG	Serbia and Montenegro	EU	Europe
SDN	Sudan	OT	Other
SEA	Int. Shipping	OT	Other
SEN	Senegal	OT	Other
SGP	Singapore	AS	Asia
SGS	South Georgia and the South Sandwich Islands	OT	Other
SHN	Saint Helena	OT	Other
SJM	Svalbard and Jan Mayen	EU	Europe
SLB	Solomon Islands	OT	Other
SLE	Sierra Leone	OT	Other
SLV	El Salvador	OT	Other
SMR	San Marino	EU	Europe
SOM	Somalia	OT	Other
SPM	Saint Pierre and Miquelon	NA	North America
SRB	Serbia	EU	Europe
STP	Sao Tome and Principe	OT	Other
SUR	Suriname	OT	Other
SVK	Slovakia	EU	Europe
SVN	Slovenia	EU	Europe
SWE	Sweden	EU	Europe
SWZ	Swaziland	OT	Other
SYC	Seychelles	OT	Other
SYR	Syrian Arab Republic	OT	Other
TCA	Turks and Caicos Islands	OT	Other
TCD	Chad	OT	Other
TGO	Togo	OT	Other
THA	Thailand	AS	Asia
TJK	Tajikistan	AS	Asia
TKL	Tokelau	OT	Other
TKM	Turkmenistan	AS	Asia
TLS	Timor-Leste	AS	Asia
TON	Tonga	OT	Other
TTO	Trinidad and Tobago	OT	Other
TUN	Tunisia	OT	Other

TUR	Turkey	EU	Europe
TUV	Tuvalu	OT	Other
TWN	Taiwan, Province of China	AS	Asia
TZA	Tanzania, United Republic of	OT	Other
UGA	Uganda	OT	Other
UKR	Ukraine	EU	Europe
UMI	United States Minor Outlying Islands	NA	North America
URY	Uruguay	OT	Other
USA	United States	NA	North America
UZB	Uzbekistan	AS	Asia
VAT	Holy See (Vatican City State)	EU	Europe
VCT	Saint Vincent and the Grenadines	OT	Other
VEN	Venezuela	OT	Other
VGB	Virgin Islands, British	OT	Other
VIR	Virgin Islands, USA	OT	Other
VNM	Viet Nam	AS	Asia
VUT	Vanuatu	OT	Other
WLF	Wallis and Futuna	OT	Other
WSM	Samoa	OT	Other
YEM	Yemen	OT	Other
ZAF	South Africa	OT	Other
ZMB	Zambia	OT	Other
ZWE	Zimbabwe	OT	Other

S5 Qualitative uncertainty estimates of global emissions

A qualitative indication of the emission variability at global level is reported in Table S5 and it is calculated as the relative difference between EDGARv8.1 and HTAP_v3.2 emissions by sector and pollutant. Further explanations are provided in section 3.5.2 of the manuscript.

Table S5 – Variability of global emission estimates by sector and pollutant, calculated as the relative difference between HTAP_v3.2 emissions and the EDGARv8.1 estimates. Variability ranges are based on the qualitative classes defined in the EMEP/EEA Guidebook 2019 as low (L), low medium (LM), upper medium (UM), high (H).

Emission sector	Substance	Global variability, year 2000	Global variability, year 2018	Global variability, year 2020	Variability range, year 2000	Variability range, year 2018	Variability range, year 2020
3_Energy	BC	3.9%	42.9%	52.6%	L	LM	UM
3_Energy	CO	-1.9%	77.8%	9.8%	L	UM	L
3_Energy	NH_3	-0.3%	44.5%	-44.0%	L	LM	LM
3_Energy	NMVOC	15.8%	24.4%	38.0%	LM	LM	LM
3_Energy	NOx	22.3%	20.7%	4.5%	LM	LM	L
3_Energy	OC	34.9%	15.5%	171.5%	LM	LM	H
3_Energy	PM_{10}	-16.4%	-1.2%	-48.6%	LM	L	LM
3_Energy	$PM_{2.5}$	-17.2%	-2.7%	-4.4%	LM	L	L
3_Energy	SO_2	-1.9%	-39.5%	18.1%	L	LM	LM
4.1_Industry	BC	59.3%	96.4%	42.4%	UM	UM	LM
4.1_Industry	CO	-15.8%	85.5%	10.5%	LM	UM	L
4.1_Industry	NH_3	-24.0%	50.3%	-35.1%	LM	UM	LM
4.1_Industry	NMVOC	-3.7%	47.8%	48.9%	L	LM	LM
4.1_Industry	NOx	-46.6%	40.2%	9.8%	LM	LM	L
4.1_Industry	OC	-1.6%	21.5%	23.7%	L	LM	LM
4.1_Industry	PM_{10}	-60.3%	-0.5%	5.3%	UM	L	L
4.1_Industry	$PM_{2.5}$	-25.8%	-2.6%	31.5%	LM	L	LM
4.1_Industry	SO_2	-53.7%	-54.2%	85.1%	UM	UM	UM
4.2_Fugitive	BC	53.5%	64.1%	1.0%	UM	UM	L
4.2_Fugitive	CO	31.1%	52.7%	16.3%	LM	UM	LM
4.2_Fugitive	NH_3	36.7%	50.2%	18.4%	LM	UM	LM
4.2_Fugitive	NMVOC	30.2%	19.4%	19.8%	LM	LM	LM
4.2_Fugitive	NOx	10.7%	13.4%	-6.1%	L	L	L
4.2_Fugitive	OC	29.9%	8.9%	-16.6%	LM	L	LM
4.2_Fugitive	PM_{10}	-0.6%	0.9%	10.9%	L	L	L
4.2_Fugitive	$PM_{2.5}$	-29.0%	-23.0%	3.6%	LM	LM	L
4.2_Fugitive	SO_2	-65.0%	-51.1%	-8.6%	UM	UM	L
4.3_Solvents	NH_3	2.2%	-25.2%	-99.3%	L	LM	UM
4.3_Solvents	NMVOC	-69.8%	-60.2%	-15.9%	UM	UM	LM
4.3_Solvents	PM_{10}	-74.5%	-67.6%	26.0%	UM	UM	LM
4.3_Solvents	$PM_{2.5}$	-99.8%	-99.6%	37.6%	UM	UM	LM
5.1_Road_Transport	BC	52.3%	80.2%	-48.5%	UM	UM	LM
5.1_Road_Transport	CO	-4.2%	-16.4%	-46.2%	L	LM	LM
5.1_Road_Transport	NH_3	-21.3%	-47.0%	93.8%	LM	LM	UM

5.1_Road_Transport	NMVOC	-36.2%	-51.1%	-52.6%	LM	UM	UM
5.1_Road_Transport	NOx	-11.0%	-58.1%	-11.9%	L	UM	L
5.1_Road_Transport	OC	-48.3%	-60.5%	-29.8%	LM	UM	LM
5.1_Road_Transport	PM_{10}	-63.2%	-74.5%	-48.4%	UM	UM	LM
5.1_Road_Transport	$PM_{2.5}$	-53.1%	-81.2%	-47.5%	UM	UM	LM
5.1_Road_Transport	SO_2	-90.3%	-93.8%	-73.1%	UM	UM	UM
5.2_Brake_and_Tyre_wear	BC	26.1%	19.1%	24.9%	LM	LM	LM
5.2_Brake_and_Tyre_wear	OC	-33.5%	-25.6%	-25.5%	LM	LM	LM
5.2_Brake_and_Tyre_wear	PM_{10}	-57.1%	-48.0%	-80.3%	UM	LM	UM
5.2_Brake_and_Tyre_wear	$PM_{2.5}$	-84.9%	-80.0%	-49.8%	UM	UM	LM
5.3_Domestic_shipping	BC	249.9%	191.3%	160.7%	H	H	H
5.3_Domestic_shipping	CO	221.2%	188.7%	355.7%	H	H	H
5.3_Domestic_shipping	NH_3	-5.5%	13.7%	-15.1%	L	L	LM
5.3_Domestic_shipping	NMVOC	11.4%	13.6%	274.6%	L	L	H
5.3_Domestic_shipping	NOx	11.1%	13.5%	97.2%	L	L	UM
5.3_Domestic_shipping	OC	5.2%	11.3%	138.9%	L	L	H
5.3_Domestic_shipping	PM_{10}	6.3%	6.0%	204.7%	L	L	H
5.3_Domestic_shipping	$PM_{2.5}$	-5.2%	3.3%	206.2%	L	L	H
5.3_Domestic_shipping	SO_2	-41.5%	-20.9%	204.0%	LM	LM	H
5.4_Other_ground_transport	BC	-34.5%	8.9%	-88.1%	LM	L	UM
5.4_Other_ground_transport	CO	-13.8%	-17.4%	-85.2%	L	LM	UM
5.4_Other_ground_transport	NH_3	-55.5%	-33.1%	-2.2%	UM	LM	L
5.4_Other_ground_transport	NMVOC	-47.7%	-37.7%	-67.8%	LM	LM	UM
5.4_Other_ground_transport	NOx	-71.8%	-41.7%	-53.5%	UM	LM	UM
5.4_Other_ground_transport	OC	-80.8%	-64.6%	-68.2%	UM	UM	UM
5.4_Other_ground_transport	PM_{10}	-86.0%	-73.3%	-41.0%	UM	UM	LM
5.4_Other_ground_transport	$PM_{2.5}$	-82.6%	-82.3%	-37.3%	UM	UM	LM
5.4_Other_ground_transport	SO_2	-83.8%	-84.0%	-40.9%	UM	UM	LM
6_Residential	BC	30.2%	18.2%	-31.0%	LM	LM	LM
6_Residential	CO	15.0%	4.9%	-28.3%	LM	L	LM
6_Residential	NH_3	-8.0%	3.9%	2.0%	L	L	L
6_Residential	NMVOC	-7.4%	-9.5%	-21.5%	L	L	LM
6_Residential	NOx	-17.0%	-18.3%	-24.5%	LM	LM	LM
6_Residential	OC	-16.5%	-20.5%	-28.2%	LM	LM	LM
6_Residential	PM_{10}	-20.6%	-20.5%	8.6%	LM	LM	L
6_Residential	$PM_{2.5}$	-39.0%	-28.8%	-13.6%	LM	LM	L
6_Residential	SO_2	-41.6%	-40.3%	-6.7%	LM	LM	L
7_Waste	BC	78.1%	54.9%	-74.2%	UM	UM	UM
7_Waste	CO	9.2%	7.4%	-96.1%	L	L	UM
7_Waste	NH_3	-34.5%	-13.3%	-30.9%	LM	L	LM
7_Waste	NMVOC	-60.8%	-48.6%	59.2%	UM	LM	UM
7_Waste	NOx	-50.5%	-57.3%	-54.8%	UM	UM	UM

7_Waste	OC	-70.5%	-58.4%	-82.6%	UM	UM	UM
7_Waste	PM_{10}	-81.2%	-74.0%	-49.6%	UM	UM	LM
7_Waste	$PM_{2.5}$	-89.9%	-82.7%	-59.3%	UM	UM	UM
7_Waste	SO_2	-95.7%	-95.8%	0.5%	UM	UM	L
8.1_Agricultural_waste_burning	BC	7.5%	6.7%	-2.6%	L	L	L
8.1_Agricultural_waste_burning	CO	6.6%	6.1%	-0.1%	L	L	L
8.1_Agricultural_waste_burning	NH_3	7.0%	5.8%	-5.2%	L	L	L
8.1_Agricultural_waste_burning	NMVOC	5.6%	5.4%	-3.9%	L	L	L
8.1_Agricultural_waste_burning	NOx	5.6%	5.1%	-0.5%	L	L	L
8.1_Agricultural_waste_burning	OC	5.4%	4.9%	0.4%	L	L	L
8.1_Agricultural_waste_burning	PM_{10}	3.8%	4.0%	-1.2%	L	L	L
8.1_Agricultural_waste_burning	$PM_{2.5}$	1.0%	2.7%	-0.5%	L	L	L
8.1_Agricultural_waste_burning	SO_2	-1.1%	0.3%	-1.6%	L	L	L
8.2_Agriculture_livestock	NH_3	11.5%	10.7%	-31.7%	L	L	LM
8.2_Agriculture_livestock	NMVOC	-14.7%	-9.4%	-11.4%	L	L	L
8.2_Agriculture_livestock	NOx	-25.2%	-20.9%	10.5%	LM	LM	L
8.2_Agriculture_livestock	PM_{10}	-33.8%	-26.7%	22.2%	LM	LM	LM
8.2_Agriculture_livestock	$PM_{2.5}$	-34.8%	-27.8%	23.8%	LM	LM	LM
8.3_Agriculture_crops	NH_3	13.1%	11.7%	17.3%	L	L	LM
8.3_Agriculture_crops	NMVOC	16.6%	8.7%	-2.6%	LM	L	L
8.3_Agriculture_crops	NOx	6.9%	6.8%	11.2%	L	L	L
8.3_Agriculture_crops	PM_{10}	-82.1%	-77.8%	-66.5%	UM	UM	UM
8.3_Agriculture_crops	$PM_{2.5}$	-92.6%	-91.6%	-43.5%	UM	UM	LM

References

Hoesly, R., Smith, S., Ahsan, H., Prime, N., O'Rourke, P., Crippa, M., Klimont, Z., Guizzardi, D., Feng, L., Harkins, C., MCDONALD, B., & Wang, S. (2025). CEDS v_2025_04_18 Gridded Emissions Data 0.5 degree (v_2025_03_18) [Data set]. Zenodo. https://doi.org/10.5281/zenodo.15127477.

Klimont, Z., Kupiainen, K., Heyes, C., Purohit, P., Cofala, J., Rafaj, P., Borken-Kleefeld, J., and Schöpp, W.: Global anthropogenic emissions of particulate matter including black carbon, Atmos. Chem. Phys., 17, 8681-8723, 10.5194/acp-17-8681-2017, 2017.

Kurokawa, J. and Ohara, T.: Long-term historical trends in air pollutant emissions in Asia: Regional Emission inventory in ASia (REAS) version 3, Atmospheric Chemistry and Physics, 20, 12761-12793, https://doi.org/10.5194/acp-20-12761-2020, 2020.

O'Rourke, P. R., Smith, S. J., Mott, A., Ahsan, H., McDuffie, E. E., Crippa, M., Klimont, S., McDonald, B., Z., Wang, Nicholson, M. B, Feng, L., and Hoesly, R. M.: Community Emissions Data System (Version 04-21-2021), Zenodo. https://doi.org/10.5281/zenodo.4737769 2021.

Oreggioni, G. D., Mahiques, O., Monforti-Ferrario, F., Schaaf, E., Muntean, M., Guizzardi, D., Vignati, E., and Crippa, M.: The impacts of technological changes and regulatory frameworks on global air

pollutant emissions from the energy industry and road transport, Energy Policy, 168, 113021, https://doi.org/10.1016/j.enpol.2022.113021, 2022.