DEVELOPMENT OF THE VERSION 8 NON-CO_2 GHG EMISSIONS DATASET

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Documentation Accompanying Dataset

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Supporting Files:
Version 8 Non-CO2 Emissions Dataset – GTP_NCO2_MMTCEQ_v8.har
Comparison of Versions 6, 7, and 8 - GTP_NCO2_V6V7V8.har

1. Introduction

This document describes the methods used to develop the non-CO_2 greenhouse gas (GHG) emissions dataset for the year 2007 for use with the GTAP Version 8 economic dataset.[1] Emissions by region and economic sector, as well as emissions driver, for three major non-CO_2 gases (or groups of gases) are provided in the dataset - CH_4, N_2O, and the group of fluorinated gases (F-gases), including CF_4, HFCs, and SF_6.

The report is organized as follows. Section 2 describes the methodology used in the construction of the Version 8 dataset of non-CO_2 emissions. Section 3 presents some results from the Version 8 emissions dataset in comparison to Versions 6 and 7.

2. Methodology

Global emissions of non-CO_2 greenhouse gases (GHG) have been assembled for use with Versions 6 and 7 of the GTAP Dataset[2], and have been documented in Rose and Lee (2009) and Rose et al. (2010a), which have 2001 and 2004 as base years, respectively. Detailed emissions data for 2001 were the primary source of information for both of these releases (see Rose et al., 2010b). The dataset in Rose et al. (2010b) is a highly detailed dataset of 2001 emissions developed from reported Annex 1 and non-Annex 1 country inventories, and estimated emissions for non-Annex 1 countries. The detailed data readily lends itself to cleaner mappings to economic activity. These 2001 data were also based on official reported country emissions as much as possible, rather than estimates based on standardized emissions estimation approaches applied to all countries and sectors. However, building the detailed 2001 dataset was resource intensive, and the effort has not been updated since for subsequent years consistent with the GTAP dataset releases. Instead emissions growth approaches have been used—for Version 7, and now for Version 8. The methodology used for Version 8 is a growth rate approach that takes advantage of the detailed 2001 raw input data of Rose et al. (2010b), and applies growth rates derived from two recently released global emissions datasets. Specifically, a modified version of the methodology used for the Version 7 emissions dataset (Rose et al., 2010a)[3] is used to extrapolate Rose et al. (2010b) using growth rates derived from country and source level emissions estimates for methane (CH_4), nitrous oxide (N_2O), and fluorinated gases (F-gases) from the EDGAR Version 4.2 (2011) dataset for non-agricultural emissions activities, and from the new FAO GHG emissions dataset for agricultural emissions activities.[4]

Our rationale for applying growth rate estimates to the 2001 raw emissions data, instead of the Version 7 emissions dataset, is twofold: (1) we can work with the highly disaggregated emissions data of Rose et al. (2010b) level for more direct association with economic activity data, and (2) Version 7 was created with a different growth rate approach and extrapolating off Version 7 would conflate approaches and be inappropriate. The Version 7 emissions dataset was developed

[1] Narayanan et al. (2012)
[2] Dimaranan (2006), and Narayanan and Walmsley (2008)
[3] Augmenting the GEMPACK programs authored by Misak Avetisyan, and helpfully shared for this exercise.
[4] The Center for Global Trade Analysis is grateful to the FAO's Francisco Tubiello and the Mitigation in Climate Change and Agriculture (MICCA) Program for early access to this dataset.

by extrapolating the Rose et al. (2010b) detailed data to 2004 using CH_4 and N_2O emissions growth rates derived from EPA (2006) projections; and, in the case of F-gases, economic output growth rates derived from Versions 6 and 7 of the GTAP economic activity datasets.

The EDGAR (2011) and FAO emissions datasets are based on globally standardized methods, not official government reported emissions. However, they are updated regularly and therefore provide estimates for both 2001 and 2007 from which emissions growth rates can be derived. The estimated growth rates are then applied to the detailed 2001 emissions data of Rose et al. (2010b). The first step is to map the Rose et al. (2010b) detailed input emissions categories to emissions categories in the EDGAR (2011) and FAOSTAT datasets. This mapping is provided in Table 1. There are 18 non-agricultural and 6 agricultural top-level emissions categories that are listed in the first column of Table 1. Rose et al. (2010b) consists of 29 non-CO_2 GHG emissions categories and 153 emissions subcategories, of which 24 categories and 119 subcategories are mapped into GTAP (Rose and Lee, 2009). The categories represent emission source and the type of GHG. The 119 subcategories are presented in the second column of Table 1 by category. The third column lists the related IPCC emissions inventory codes[5].

The last three columns in Table 1 show the growth rate source for each subcategory. Growth rates derived from "EDGAR" use country level emissions data on CH_4, N_2O, and fluorinated gases for 2001 and 2007 from the EDGAR Version 4.2 (2011) dataset. For instance, the growth rate for "Adipic acid production" subcategory emissions in the "Adipic Acid and Nitric Acid Production N_2O" category is calculated from the EDGAR Chemical Production N_2O emissions data ("2B" IPCC code). Notice that because of insufficient disaggregation in the EDGAR dataset, the same growth rate is used for all three subcategories of "Adipic Acid and Nitric Acid Production N_2O" category. On the other hand, there are cases where there is more than one relevant EDGAR emission category. For instance, for the "Combined stationary and mobile combustion" subcategory of the "Stationary and Mobile Combustion CH_4" category there are nine EDGAR categories: 1A1a, 1A1bc, 1A2, 1A3a, 1A3b, 1A3c, 1A3d, 1A3e, 1A4. In these cases, the growth rate for the sum of the EDGAR categories is used.

Growth rates derived from "FAO" use country level emissions data on CH_4, and N_2O for 2001 and 2007 from the new FAO GHG emissions dataset. The FAO dataset provides emissions by both livestock and crop types. The livestock related categories are "Livestock Enteric Fermentation CH_4", "Livestock Manure Management, both CH_4 and N_2O", and "Pasture, Range and Paddock N_2O" and these categories are disaggregated into twelve livestock subcategories. For the Enteric Fermentation and Manure Management categories, the grow rate of each subcategory is obtained from the corresponding livestock data. For Pasture, Range and Paddock N_2O category, we use an identical growth rate for all twelve subcategories because the data about emissions from soil manure are not disaggregated across livestock subcategories. Only available data on soil manure in the FAO dataset are the total of all livestock sectors.

The crop related categories in Version 8 dataset are "Cropland Soils N_2O" and "Rice Cultivation CH_4". The emissions growth rate for the Cropland Soils category is calculated from aggregation of the FAO "Synthetic Fertilizers" and "Cultivated Organic Soils" emissions data.

[5] Please see Table A2 in the appendix for the description of IPCC codes.

"Other" growth rates indicates subcategories without mappings to the EDGAR or FAO datasets. These include the following:

- "Mineral production"[6] and "Other non-classified"[7] subcategory emissions in the "Other Industrial Non-Agricultural Sources of CH_4" (INCH) category
- "Ferroalloys production and iron and steel production"[8] and "Other non-classified"[9] subcategory emissions in the "Other Industrial Non-Agricultural Sources of N_2O" (INN2) category
- "Fire extinguishing"[10] and "Solvents"[11] subcategory emissions in the "Ozone Depleting Substances Substitutes HFC-134a" (ODS) category.

For these subcategories, we have adopted the economic output growth approach used by Rose et al. (2010a) for F-gases. In this case, annual growth rates in regional output for the emitting sectors between 2001 and 2007 are computed, and then applied to the Version 6 raw input emissions data. This approach involves the following steps:

1. The version 8 base data are mapped from the 129 regions of Version 8 to the 87 regions of Version 6.
2. The 87 region aggregated Version 8 data are deflated to 2001 US dollars.
3. Annual average growth rates for 2001-2007 regional output for the relevant sectors are computed.
4. The growth rates for 87 regions are applied to the Version 6 raw input emissions data to create and estimate for 2007 emissions.

Table 1: Input Emissions Categories and Their Subcategories

GTAP Input Data Category (Rose et al. 2010b)			**Growth rate source**		
Category	**Subcategory**	**IPCC Code**	**EDGAR ***	**FAO**	**Other**
Adipic Acid and Nitric Acid Production N_2O	Adipic acid production	2B3	2B		
	Adipic acid and nitric acid production (combined)	2B2 & 2B3	2B		
	Nitric acid production	2B2	2B		
Aluminum Production CF_4	Aluminum production	2C4	2C		
Biomass Burning CH_4	Agricultural residue burning	4F	4F		
	Savanna burning	4E	4E		

[6] "2A" category in EDGAR dataset is zero for all 2007 GHG emissions and all countries.
[7] "2G" category in EDGAR does not exist.
[8] "2C" category in EDGAR dataset is zero for 2007 N_2O emissions and all countries.
[9] See footnote 7.
[10] "2F3" category in EDGAR dataset is zero for all 2007 GHG emissions and all countries.
[11] "2F5" category in EDGAR dataset is zero for all 2007 GHG emissions and all countries.

Biomass Burning N_2O	Agricultural residue burning	4F	4F		
	Savanna burning	4E	4E		
Cropland Soils N_2O	Soil			"Synthetic Fertilizer" & "Cultivated Organic Soil"	
Electrical Transmission and Distribution SF_6	Electrical transmission and distribution	2F7	2F7		
Fugitives from Coal Mining Activities CH_4	Fugitives from coal mining activities	1B1	1B1		
Fugitives from Oil and Natural Gas Systems CH_4	Natural gas - distribution	1B2b*ii*	1B2		
	Natural gas - exploration	1B2b	1B2		
	Natural gas - flaring	1B2c*ii*	1B2		
	Natural gas - leakage	1B2b*iii*	1B2		
	Natural gas - leakage at industrial plants and power stations	1B2b*iii*	1B2		
	Natural gas - leakage at residential and commercial sectors	1B2b*iii*	1B2		
	Natural gas - production/processing	1B2b*i*	1B2		
	Natural gas - transmission	1B2b*ii*	1B2		
	Natural gas - venting	1B2c	1B2		
	Oil - distribution of products	1B2a*v*	1B2		
	Oil - exploration	1B2a*i*	1B2		
	Oil - flaring	1B2c*i*	1B2		
	Oil - other	1B2a*vi*	1B2		
	Oil - production	1B2a*ii*	1B2		
	Oil - refining and storage	1B2a*iv*	1B2		
	Oil - transport	1B2a*iii*	1B2		
	Oil - venting	1B2c*i*	1B2		
	Fugitives from Oil and Natural Gas Systems	1B2	1B2		
	Oil & Natural Gas - flaring	1B2c*iii*	1B2		
	Oil & Natural Gas - venting	1B2c*iii*	1B2		
HCFC-22 Production HFC-23	HCFC-22 production	2E1	2E		
Human Sewage N_2O	Human Sewage	6B	6B		
Landfilling of Solid Waste CH_4	Landfilling of solid waste	6A	6A		

Livestock Enteric Fermentation CH_4	BUFFALO	4A		Enteric Fermentation, Buffaloes	
	CAMEL_LLAMA			Enteric Fermentation, Camels&Llamas	
	DAIRY_CTL			Enteric Fermentation, Dairy Cattle	
	GOAT			Enteric Fermentation, Goats	
	HORSE			Enteric Fermentation, Horses	
	MULE_ASS			Enteric Fermentation, Mules&Assses	
	NONDAIRY_CTL			Enteric Fermentation, Non-dairy cattle	
	OTHER			Enteric Fermentation, all	
	POULTRY			Enteric Fermentation, all	
	SHEEP_LAMB			Enteric Fermentation, Sheep	
	SWINE			Enteric Fermentation, Pigs	
	UKNOWN			Enteric Fermentation, all	
Livestock Manure Management CH_4	BUFFALO	4B		"Emissions (CH_4)(ManureManagement), Buffaloes	
	CAMEL_LLAMA			"Emissions (CH_4)(ManureManagement), Camels&llamas	
	DAIRY_CTL			"Emissions (CH_4)(ManureManagement), Dairy cattle	
	GOAT			"Emissions (CH_4)(ManureManagement), Goats	

	HORSE			"Emissions (CH_4)(ManureManagement), Horses	
	MULE_ASS			"Emissions (CH_4)(ManureManagement), Mules&Assses	
	NONDAIRY_CTL			"Emissions (CH_4)(ManureManagement), Non-Dairy cattle	
	OTHER			"Emissions (CH_4)(ManureManagement), all	
	POULTRY			"Emissions (CH_4)(ManureManagement), all	
	SHEEP_LAMB			"Emissions (CH_4)(ManureManagement), Sheep	
	SWINE			"Emissions (CH_4)(ManureManagement), Pigs	
	UKNOWN			"Emissions (CH_4)(ManureManagement), all	
Livestock Manure Management N_2O	BUFFALO	4B		"Emissions (N_2O)(ManureManagement), Buffaloes	
	CAMEL_LLAMA			"Emissions (N_2O)(ManureManagement), Camels&llamas	
	DAIRY_CTL			"Emissions (N_2O)(ManureManagement), Dairy cattle	
	GOAT			"Emissions (N_2O)(ManureManagement), Goats	
	HORSE			"Emissions (N_2O)(ManureManagement), Horses	
	MULE_ASS			"Emissions (N_2O)(ManureManagement), Mules&Assses	

	NONDAIRY_CTL			"Emissions (N_2O)(ManureManagement), Non-Dairy cattle	
	OTHER			"Emissions (N_2O)(ManureManagement), all	
	POULTRY			"Emissions (N_2O)(ManureManagement), all	
	SHEEP_LAMB			"Emissions (N_2O)(ManureManagement), Sheep	
	SWINE			"Emissions (N_2O)(ManureManagement), Pigs	
	UKNOWN			"Emissions (N_2O(ManureManagement), all	
Magnesium Manufacturing SF6	Magnesium manufacturing	2C4	2C		
ODS Substitutes HFC-134a	Aerosols (MDI)	2F4	2F4		
	Aerosols (Non-MDI)	2F4	2F4		
	Fire extinguishing	2F3			output growth rate
	Foams	2F2	2F2		
	Refrigeration/AC	2F1	2F1		
	Solvents	2F5			output growth rate
Other Industrial Non-Agricultural Sources CH_4	Metal production listed under “other”	2C5	2C		
	Aluminum production	2C3	2C		
	Chemical industry	2B	2B		
	Ferroalloys production and iron and steel production	2C1 & 2C2	2C		
	Mineral production	2A			output growth rate
	Other (not specified)	2G			output growth rate
Other Industrial Non-Agricultural Sources N_2O	Chemical industry	2B	2B		
	Ferroalloys production and iron and steel production	2C1 & 2C2			output growth rate **
	Other (not specified)	2G			output growth rate
Pasture, Range, and Paddock N_2O	BUFFALO			"Emissions(N_2O)(PastureManure)" &	
	CAMEL_LLAMA				

	DAIRY_CTL			"Emissions(N_2O)(SoilManure)"	
	GOAT				
	HORSE				
	MULE_ASS				
	NONDAIRY_CTL				
	OTHER				
	POULTRY				
	SHEEP_LAMB				
	SWINE				
	UKNOWN				
Rice Cultivation CH_4	Rice Cultivation			"Rice Cultivation"	
Stationary and Mobile Combustion CH_4	Combined stationary and mobile combustion	1A	1A1a, 1A1bc, 1A2, 1A3a, 1A3b, 1A3c, 1A3d, 1A3e, 1A4		
	Stationary and mobile combustion – other sectors agriculture	1A4	1A4		
	Stationary combustion – commercial and public services	1A4	1A4		
	Stationary combustion – energy industries	1A1	1A1a, 1A1bc		
	Stationary combustion – total Industry sector	1A2	1A2		
	Mobile combustion – total transport sector	1A3	1A3a, 1A3b, 1A3c, 1A3d, 1A3e		
	Stationary and mobile combustion – other sectors	1A4	1A4		
	Stationary combustion – residential	1A4	1A4		

	Other (not specified)	1A5	1A1a, 1A1bc, 1A2, 1A3a, 1A3b, 1A3c, 1A3d, 1A3e, 1A4		
Stationary and Mobile Combustion N_2O	Combined stationary and mobile combustion	1A	1A1a, 1A1bc, 1A2, 1A3a, 1A3b, 1A3c, 1A3d, 1A3e, 1A4		
	Stationary and mobile combustion – other sectors agriculture	1A4	1A4		
	Stationary combustion – commercial and public services	1A4	1A4		
	Stationary combustion – energy industries	1A1	1A1a, 1A1bc		
	Stationary combustion – total Industry sector	1A2	1A2		
	Mobile combustion – total transport sector	1A3	1A3a, 1A3b, 1A3c, 1A3d, 1A3e		
	Stationary and mobile combustion – other sectors	1A4	1A4		
	Stationary combustion – residential	1A4	1A4		
	Other (not specified)	1A5	1A1a, 1A1bc, 1A2, 1A3a, 1A3b, 1A3c, 1A3d, 1A3e, 1A4		
Semiconductor Production CF_4	Semiconductor production	2F6	2F7 ***		

Wastewater Treatment CH_4	Wastewater treatment	6B	6B		

* Please see Table A2 in appendix for the definitions of IPCC codes used in the EDGAR dataset

** Data in EDGAR dataset (category 2C) are all zeros for 2007 N2O emissions. Thus, the output growth rate approach is used for this subcategory

*** Category 2F6 is not available in EDGAR dataset. Instead 2F7 is used.

As noted in Rose et al. (2010a), the output based approach has significant drawbacks. In particular, it uses a single regional GDP deflator, which does not distinguish between sector specific changes in output prices. However, despite the drawbacks, output is a reasonable driver for these emissions sources and the distortion due to price changes is not likely to be consequential in analysis given the modest contribution of these sources to global emissions. For instance, as illustrated in Table 2, "Mineral Production" subcategory of INCH category is mapped to "nmm" GTAP sector[12] whose share in global GHG emissions in Version 6 Dataset is only 0.06%. In the case of "ODS Substitutes", "Fire extinguishing" and "Solvents" subcategories contribute 3.6% of global GHG emissions.

Table 2: Economic Output Growth Approach Implemented Subcategories and their Emission Shares in Global GHG Emissions

Category	Subcategory	GTAP Sector	Share (%)
Other Industrial Non-Agricultural Sources CH4	Mineral production	nmm	0.06
	Other not-classified	omf, ppp	0.03
Other Industrial Non-Agricultural Sources N2O	Ferroalloys production and iron and steel production	i_s	0.06
	Other not-classified	omf, ppp	0.03
ODS Substitutes HFC-134a	Fire extinguishing	crp	3.6
	Solvents	crp	3.6

Table 3 presents the mapping between the input emissions subcategories and the GTAP Version 6 and Version 8 dataset's sector structure (57 sectors). As described above, 2007 emissions data is developed at the subcategory level. The data are then mapped into the GTAP Version 8 region and sector aggregation.

[12] See Table A3 for the description of the GTAP sectors.

Table 3: Mapping from Input Subcategories into GTAP Sectors

Category	Subcategory	GTAP sector
Adipic and Nitric Production N_2O	Adipic acid production	crp
	Adipic acid and nitric acid production (combined)	crp
	Nitric acid production	crp
Aluminum Production CF_4	Aluminum production	nfm
Biomass Burning CH_4	Savanna burning	ctl
	Agricultural residue burning	pdr, wht, gro, v_f, osd, c_b, pfb, ocr
Biomass Burning N_2O	Savanna burning	ctl
	Agricultural residue burning	pdr, wht, gro, v_f, osd, c_b, pfb, ocr
Fugitives from Coal Mining Activities CH_4	Fugitives from coal mining activities	col
Livestock Enteric Fermentation CH_4	BUFFALO	ctl
	CAMEL_LLAMA	ctl
	DAIRY_CTL	rmk
	GOAT	ctl
	HORSE	ctl
	MULE_ASS	ctl
	NONDAIRY_CTL	ctl
	OTHER	oap
	POULTRY	oap
	SHEEP_LAMB	ctl
	SWINE	oap
	UKNOWN	ctl, oap, rmk
Electrical Transmission and Distribution SF_6	Electrical transmission and distribution	ely
HCFC-22 Production HFC-23	HCFC-22 production	crp
Human Sewage N_2O	Human Sewage	osg
Other Industrial Non-Agricultural Sources CH_4	Metal production listed under "other"	i_s, nfm
	Aluminum production	nfm
	Chemical industry	crp
	Ferroalloys production and iron and steel production	i_s
	Mineral production	nmm
	Other not-classified	omf, ppp
Other Industrial Non-Agricultural Sources N_2O	Chemical industry	crp
	Ferroalloys production and iron and steel production	i_s

	Other not-classified	omf, ppp
Landfilling of Solid Waste CH_4	Landfilling of solid waste	osg
Magnesium Manufacturing SF_6	Magnesium manufacturing	nfm
Livestock Manure Management CH_4	BUFFALO	ctl
	CAMEL_LLAMA	ctl
	DAIRY_CTL	rmk
	GOAT	ctl
	HORSE	ctl
	MULE_ASS	ctl
	NONDAIRY_CTL	ctl
	OTHER	oap
	POULTRY	oap
	SHEEP_LAMB	ctl
	SWINE	oap
	UKNOWN	ctl, oap, rmk
Livestock Manure Management N_2O	BUFFALO	ctl
	CAMEL_LLAMA	ctl
	DAIRY_CTL	rmk
	GOAT	ctl
	HORSE	ctl
	MULE_ASS	ctl
	NONDAIRY_CTL	ctl
	OTHER	oap
	POULTRY	oap
	SHEEP_LAMB	ctl
	SWINE	oap
	UKNOWN	ctl, oap, rmk
ODS Substitutes HFC-134a	Aerosols (MDI)	crp
	Aerosols (Non-MDI)	crp
	Fire extinguishing	crp
	Foams	crp
	Refrigeration/AC	ele
	Solvents	crp
Fugitives from Oil and Natural Gas Systems CH_4	Natural gas - distribution	gdt
	Natural gas - exploration	gas
	Natural gas - flaring	gas
	Natural gas - leakage	gdt

	Natural gas - leakage at industrial plants and power stations	gdt
	Natural gas - leakage at residential and commercial sectors	gdt
	Natural gas - production/processing	gdt, gas
	Natural gas - transmission	otp
	Natural gas - venting	gas
	Oil - distribution of products	p_c
	Oil - exploration	oil
	Oil - flaring	oil
	Oil - other	oil
	Oil - production	oil
	Oil - refining and storage	p_c
	Oil - transport	otp
	Oil - venting	oil
	Fugitives from Oil and Natural Gas Systems	gdt, oil,gas, p_c, otp
	Oil & Natural Gas - flaring	oil, gas
	Oil & Natural Gas - venting	oil, gas
Pasture, Range, and Paddock N_2O	BUFFALO	ctl
	CAMEL_LLAMA	------
	DAIRY_CTL	rmk
	GOAT	ctl
	HORSE	ctl
	MULE_ASS	ctl
	NONDAIRY_CTL	ctl
	OTHER	oap
	POULTRY	oap
	SHEEP_LAMB	ctl
	SWINE	oap
	UKNOWN	ctl, oap, rmk
Rice Cultivation CH_4	Rice Cultivation	pdr
Semiconductor Production CF_4	Semiconductor production	ele
Stationary and Mobile Combustion CH_4	Combined stationary and mobile combustion	all GTAP sectors except "dwe"
	Combined stationary and mobile combustion	pdr, wht, gro, v_f, osd, c_b, pfb, ocr, ctl, oap, rmk, wol, frs, fsh

	Stationary and mobile combustion – other sectors agriculture	wtr, trd, cmn, ofi, isr, obs, ros, osg
	Stationary combustion – commercial and public services	coa, oil, gas, p_c, ely, gdt
	Stationary combustion – energy industries	omn, cmt, omt, vol, mil, pcr, sgr, ofd, b_t, tex, wap, lea, lum, ppp, crp, nmm, i_s, nfm, fmp, mvh, otn, ele, ome, omf, cns
	Stationary combustion – total Industry sector	otp, wtp, atp
	Mobile combustion – total transport sector	pdr, wht, gro, v_f, osd, c_b, pfb, ocr, ctl, oap, rmk, wol, frs, fsh, wtr, trd, cmn, ofi, isr, obs, ros, osg, HH
	Stationary and mobile combustion – other sectors	HH
	Stationary combustion – residential	osg
Stationary and Mobile Combustion N_2O	Combined stationary and mobile combustion	----
	Combined stationary and mobile combustion	pdr, wht, gro, v_f, osd, c_b, pfb, ocr, ctl, oap, rmk, wol, frs, fsh
	Stationary and mobile combustion – other sectors agriculture	wtr, trd, cmn, ofi, isr, obs, ros, osg
	Stationary combustion – commercial and public services	coa, oil, gas, p_c, ely, gdt
	Stationary combustion – energy industries	omn, cmt, omt, vol, mil, pcr, sgr, ofd, b_t, tex, wap, lea, lum, ppp, crp, nmm, i_s, nfm, fmp, mvh, otn, ele, ome, omf, cns
	Stationary combustion – total Industry sector	otp, wtp, atp
	Mobile combustion – total transport sector	pdr, wht, gro, v_f, osd, c_b, pfb, ocr, ctl, oap, rmk, wol, frs, fsh, wtr, trd, cmn, ofi, isr, obs, ros, osg, HH
	Stationary and mobile combustion – other sectors	HH
	Stationary combustion – residential	osg
Cropland Soils N_2O	Soil	pdr, wht, gro, v_f, osd, c_b, pfb, ocr, ctl, oap, rmk
Wastewater Treatment CH_4	Wastewater treatment	osg

In addition to reconciling emissions categories across data sources, we also had to reconcile inconsistencies in country coverage. The raw input data of Rose et al. (2010b) covered 226 countries, which was the number of primary regions that the GTAP dataset-build covered for Versions 6, 7 and 8. (The number of model regions in each release of the GTAP dataset varies depending on national data availability, but primary regions are intended to remain invariant across releases.) In contrast, FAO data includes several additional regions[13] and exclude a few regions included in the GTAP dataset[14]. The EDGAR dataset sometimes covers more than the 226 primary regions, however the country coverage by GHG and category can varies widely, with some gas-category emissions having as few as 80 countries. Since emissions growth rates are estimated by GHG, category, and country, there are several GHG-category-country triples that do not have growth rates based on EDGAR or FAO. For these cases, the economic output growth approach is applied.[15] Notice that this approach implies implementation of GTAP output-based growth rates for some countries and emissions based growth rates for other countries in the same emissions category.

An additional issue that arose in developing the Version 8 dataset was emissions growth rates that seemed high. The outliers based on the EDGAR dataset are presented in Table 4, where there are two major blocks: 1) countries with suspiciously high growth rates, and 2) countries with extremely high but explainable growth rates. In the first block, the same four countries in two input categories, i.e., "Adipic and Nitric Production N_2O" and "Other Industrial Non-Agricultural Sources N_2O"[16] have the same growth rates, equal to 99900%. Since, no justification is found for such a uniform increase in N_2O emissions in these countries, we apply the GTAP output-based growth rate approach. The emission shares of these countries, namely Latvia, Macedonia, Mauritius, and Peru, in the global N_2O emissions through "Adipic and Nitric Production" activity in 2001 were 0.01%, 0.004%, 0.007%, and 0.003%, respectively. Therefore, it is not expected that this adjustment will cause misleading results in our procedure.

In the second block of Table 4, Mozambique's and Chad's fugitive methane emissions from oil and natural systems are estimated to grow by almost 171,876% and 343,827%, respectively, between 2001 and 2007. In this case, however, there are reasonable explanations, so the growth rates are unchanged. Inspection of the Energy Information Agency's natural gas and oil production data for Mozambique and Chad reveals that there has been a significant increase in production, and therefore a substantial increase in fugitive methane emissions from oil and natural gas systems is reasonable (see Figures 1 and 2).

In addition to these two blocks, there is a third block of countries which are presented in the Appendix in Table A4. These counties have appear to have quite high growth rates and we encourage users of the dataset to scrutinize them and share any insights with the authors of this report. For the time being, these growth rates are left unaltered.

[13] Channel Islands, Pacific Islands Trust Territory, Pitcairn Islands, Svalbard and Jan Mayen Islands, Belgium-Luxembourg, Isle of Man, Western Sahara

[14] Taiwan and Macao

[15] The full mapping of 226 primary regions to countries covered in FAO and EDGAR are in Appendix Table A1.

[16] Both categories use the same emissions data in the EDGAR dataset: category 2B (see Table 1).

Table 4: Countries with extremely high growth factors in EDGAR dataset

	Category	Number of Outliers	Country	Growth Rate (%)	Updated Growth Rates
Suspiciously high	Adipic and Nitric Production N_2O & Other Industrial Non-Agricultural Sources N_2O	4	Latvia	99,900	0
			Macedonia, the former Yugoslav Republic of	99,900	0
			Mauritius	99,900	0
			Peru	99,900	0
Extremely high but explainable	Fugitives from Oil and Natural Gas Systems CH4	2	Mozambique	171,876	171,876
			Chad	343,827	343,827

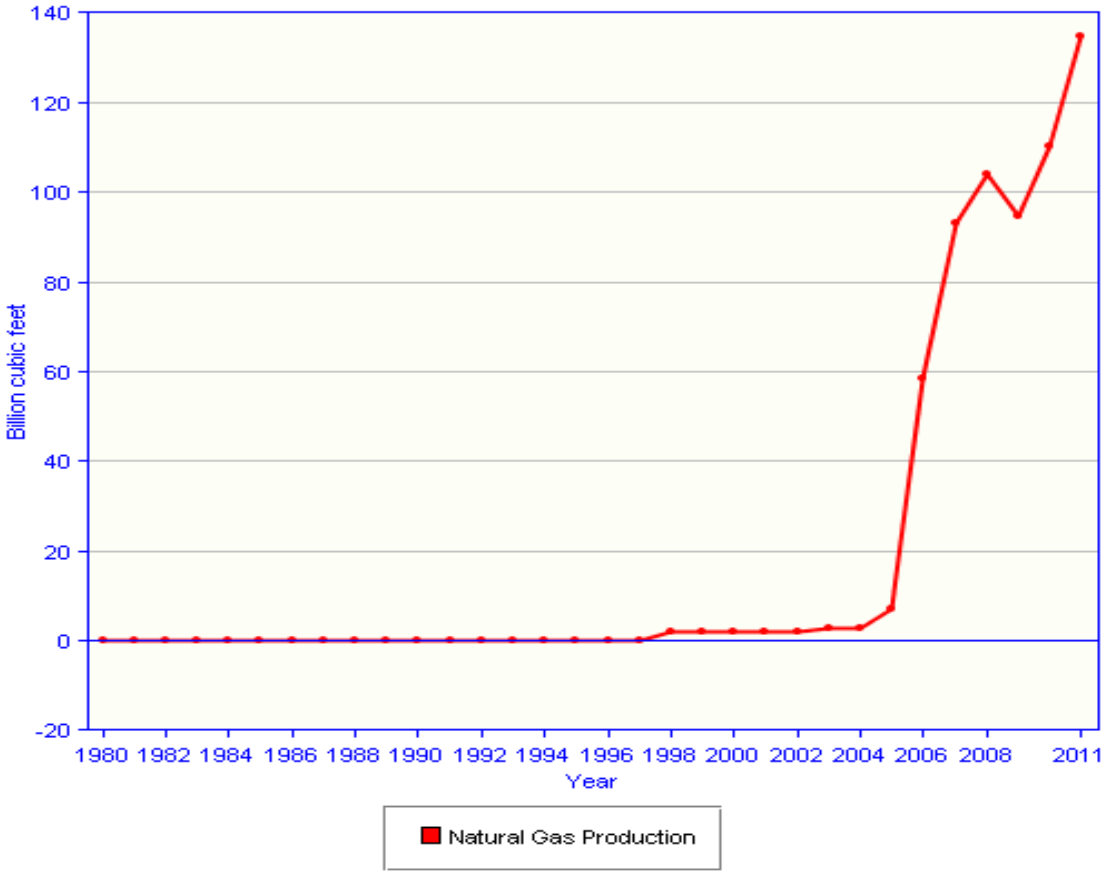

Figure 1: Mozambique's natural gas production between 1980 and 2011 (Reference: EIA (http://www.eia.gov/countries/country-data.cfm?fips=MZ))

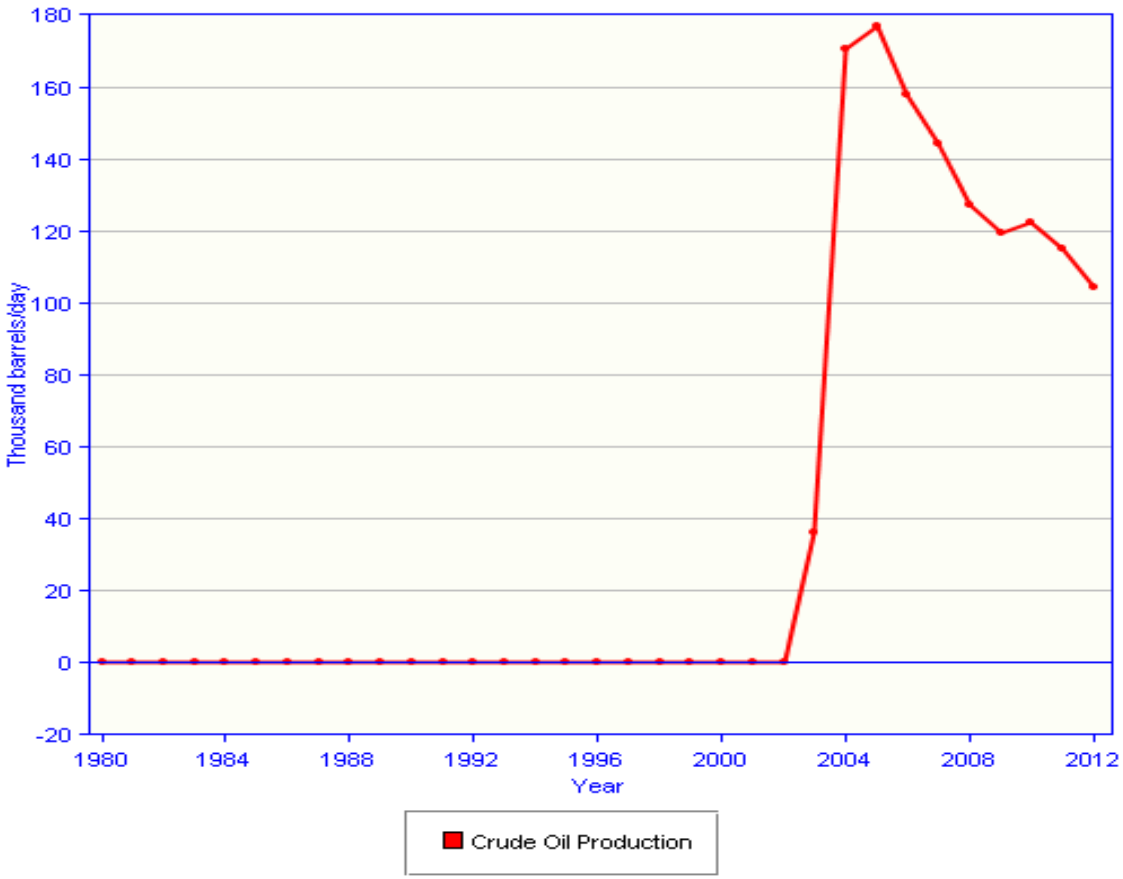

Figure 2: Chad's oil production between 1980 and 2011 (Reference: EIA (http://www.eia.gov/countries/country-data.cfm?fips=CD)**)**

Growth outliers based on the FAO dataset are presented in Table 5. In the FAO crops data, "Cropland Soils" related N_2O emissions for Serbia and Montenegro growth 29,707% between 2001 and 2007 (Table 5). Since we do not expect Serbia and Montenegro to increase its cropland soil related N_2O emissions by 29,707% from 2001 to 2007, the growth rate of Serbia and Montenegro in N_2O emissions from cropland soils category is assumed to be unchanged between 2001 and 2007. Since contribution of Serbia and Montenegro to the global N_2O emissions through SOIL category is 0.001%, this is likely small enough to be ignored.

Table 5: Outliers in the FAOSTAT crops dataset

Category	Number of Outlier Regions	Outliers	Country	Growth Rate (%)	Updated Growth Rates
Cropland Soils N2O	1	srb	Serbia and Montenegro	29,707	0

There are some livestock sector emissions growth rates which also appear high, and we encourage interested users to inspect these entries in Appendix Table A5. However, no adjustments were made to these growth rates.

3. Results

In this Version 8 dataset, total global emissions of non-CO_2 greenhouse gases are 2783.3 million metric tons of carbon equivalent emissions (MMTCEq) in 2007, with methane (CH_4) accounting for 62.4%, nitrous oxide (N_2O) accounting for 31.8% and F-gases accounting for 5.7% of total emissions (Figure 3).[17] The composition by gas is similar to the distribution of gases in the 2001 and 2004 emissions datasets. Comparing the Version 6 and Version 8 datasets, total emissions grew by 13.7%, methane by 12%, N_2O by 13%, and F-gases by 44.4%. Total emissions of each gas in the Version 6 (2001), Version 7 (2004) and Version 8 (2007) datasets can be seen in Figure 3 which shows modest aggregate growth for each gas over the period. Note that one must be cautious in interpreting changes in results across versions of the dataset since different methods were applied.

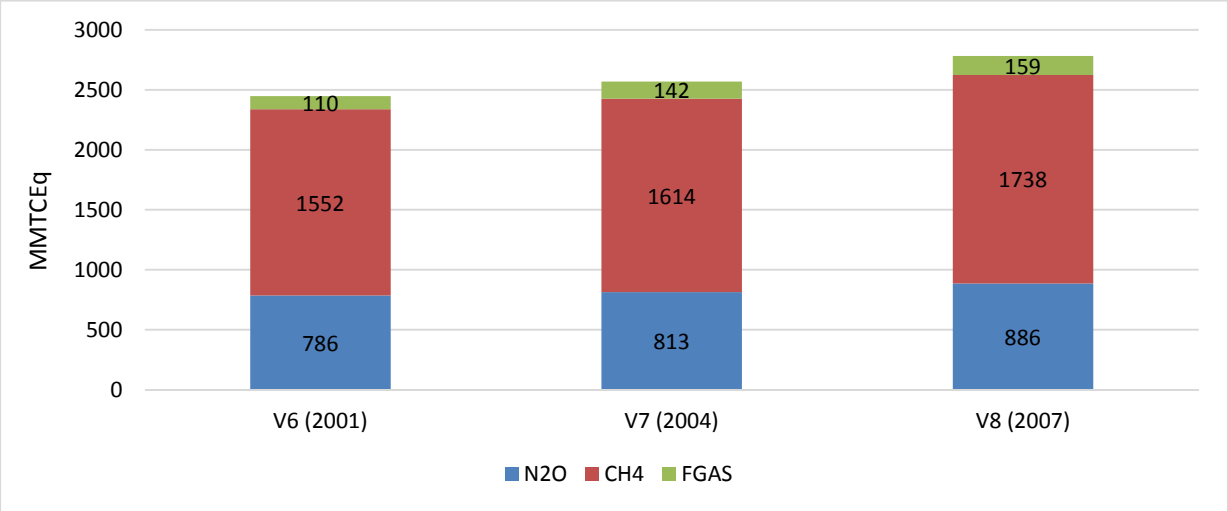

Figure 3: Total Emissions by Gas across Versions

Figures 4, 5, and 6 depict sector emissions for each gas group by GTAP sector. In the case of nitrous oxide (N_2O), the dominant sources of emissions are the agricultural sectors, with beef cattle and fruits and vegetables leading the way. We also see that the relative importance of these two leading emissions sources changes significantly between 2001, when cattle dominated, and 2007, when fruit and vegetable production catches up to cattle in global emissions. In the case of methane emissions (CH_4), beef cattle once again lead the way, followed by other government services (e.g., landfills) and paddy rice production. Figure 6 shows that emissions of F-gases are confined to three manufacturing sectors in GTAP (crp, nfm, ele), along with electricity production and distribution (ely).

In the GTAP dataset, non-CO_2 emissions are associated with four classes of economic drivers: output, primary factors (land, labor and capital), intermediate inputs (e.g., fertilizers), and household consumption. Table 6 shows that the main driver of global GHG emissions is primary factors in all three dataset versions. However, its share decreases in Version 8, while the shares of

[17] To convert to carbon dioxide equivalent emissions simply multiple by (44/12). Carbon equivalent emissions were computed using the 100-year global warming potentials of the IPCC's Second Assessment Report, which are the global warming potentials used under the United Nations Framework Convention on Climate Change.

output and intermediate input increase from 37.8% to 39.2% and from 19.3% to 20.3%, respectively. Figure 7 shows that from V6 to V8, the share of household related emissions declines from 0.4% of global GHG emissions in Versions 6 and 7, to 0.3% in the Version 8 dataset. This is mainly driven by the SMCH and SMN2 categories. Additional comparisons of emissions across GTAP regions for the different dataset versions can be found in the Appendix. The top four N_2O emitting regions are China, USA, Brazil, and XSS (Rest of Sub-Saharan Africa), while the top four CH_4 emitting regions are China, XSS, USA, and India, closely followed by Brazil, Russia, XME (Rest of Middle East), and XSU (Rest of Former Soviet Union). For F-gases, USA, China, Japan, and Russia are the largest emitters.

Table 6: Global GHG Emission Shares by Economic Driver (%)

	Output	Primary Factor	Intermediate Input	Household
V6 (2001)	37.8	42.6	19.3	0.4
V7 (2004)	38.5	42.2	18.9	0.4
V8 (2007)	39.2	40.1	20.3	0.3

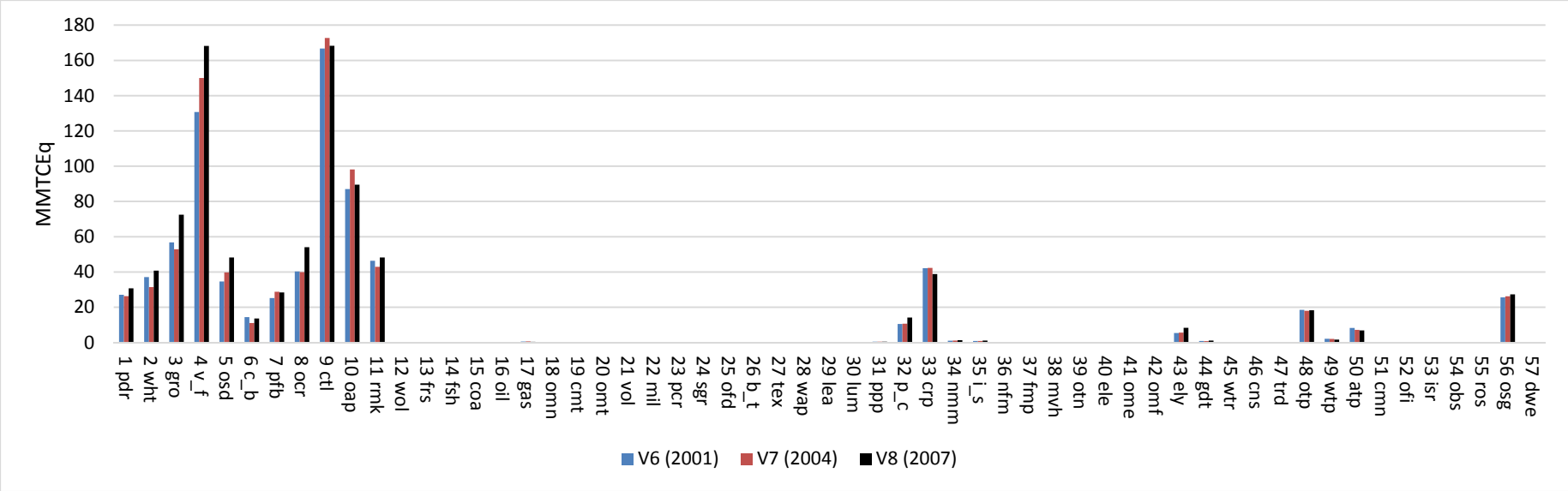

Figure 4: Global N2O Emissions by GTAP Sector in MMTCEq across Versions

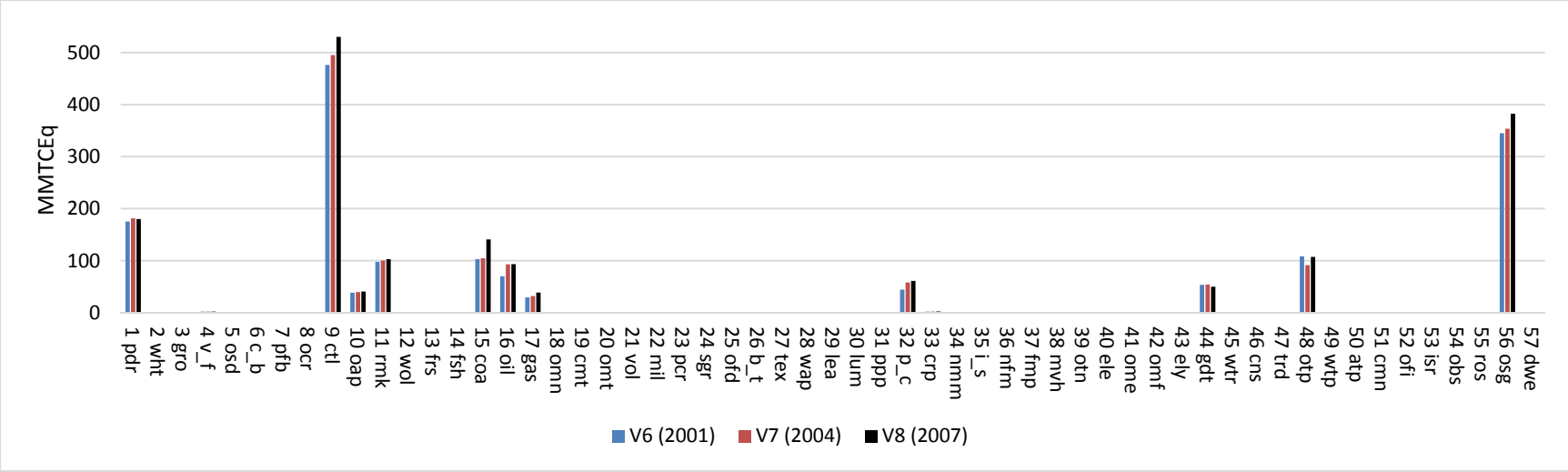

Figure 5: Global CH4 Emissions by GTAP Sector in MMTCEq across Versions

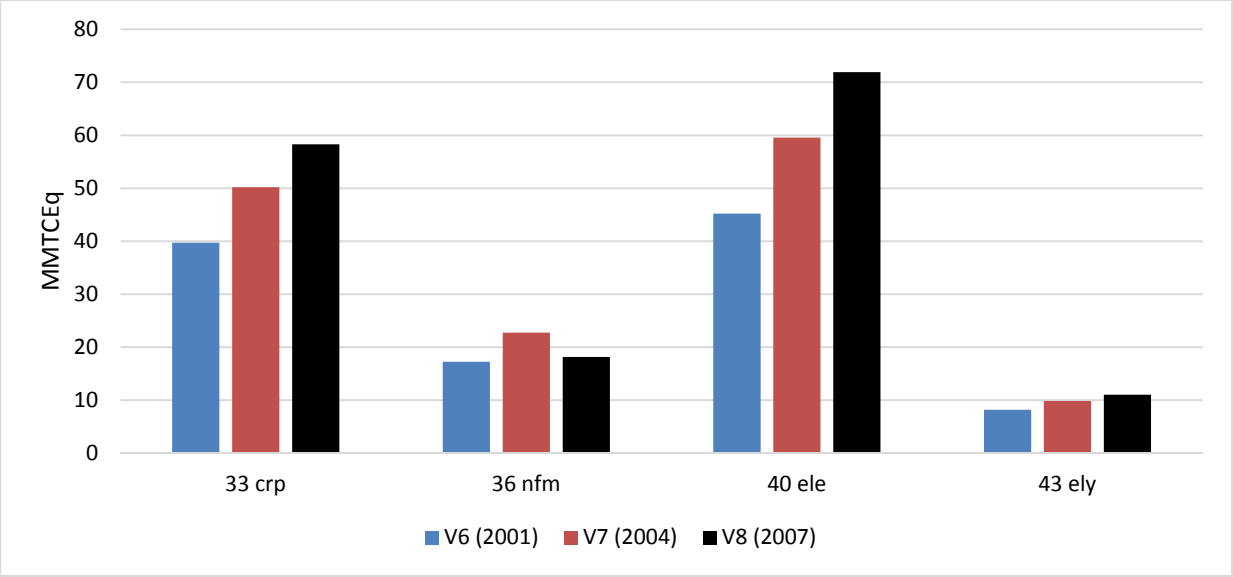

Figure 6: Global F-Gas Emissions by GTAP Sector in MMTCEq across Versions

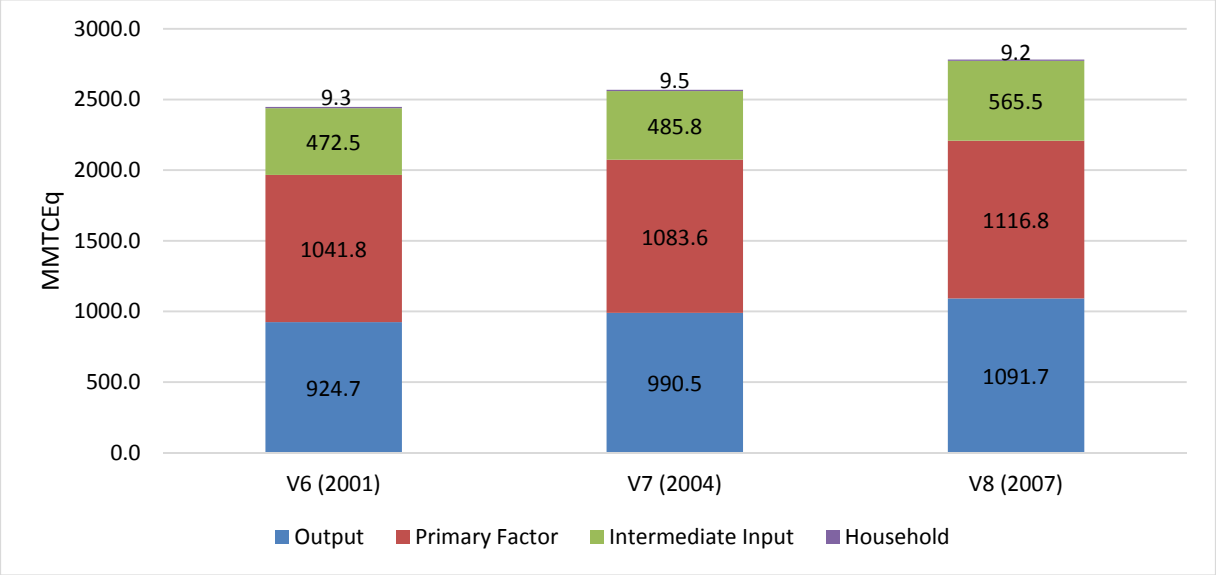

Figure 7: Global GHG emissions by main drivers across Versions

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Appendix

Table A1: Primary Region Mappings

226-Country Code	FAO	EDGAR
AFG	Afghanistan	Afghanistan
ALB	Albania	Albania
DZA	Algeria	Algeria
ASM	American Samoa	American Samoa
AND	Andorra	Angola
AGO	Angola	Anguilla
AIA	Anguilla	Antarctica
ATG	Antigua and Barbuda	Antigua and Barbuda
ARG	Argentina	Argentina
ARM	Armenia	Armenia
ABW	Aruba	Aruba
AUS	Australia	Australia
AUT	Austria	Austria
AZE	Azerbaijan	Azerbaijan
BHS	Bahamas	Bahamas
BHR	Bahrain	Bahrain
BGD	Bangladesh	Bangladesh
BRB	Barbados	Barbados
BLR	Belarus	Belarus
BEL	Belgium	Belgium
BLZ	Belize	Belize
BEN	Benin	Benin
BMU	Bermuda	Bermuda
BTN	Bhutan	Bhutan
BOL	Bolivia (Plurinational State of)	Bolivia
BIH	Bosnia and Herzegovina	Bosnia and Herzegovina
BWA	Botswana	Botswana
BRA	Brazil	Brazil
BRN	Brunei Darussalam	Brunei Darussalam
BGR	Bulgaria	Bulgaria
BFA	Burkina Faso	Burkina Faso
BDI	Burundi	Burundi
KHM	Cambodia	Cambodia
CMR	Cameroon	Cameroon
CAN	Canada	Canada
CPV	Cape Verde	Cape Verde
CYM	Cayman Islands	Cayman Islands
CAF	Central African Republic	Central African Republic
TCD	Chad	Chad
CHL	Chile	Chile
CHN	China	China
COL	Colombia	Colombia
COM	Comoros	Comoros

226-Country Code	FAO	EDGAR
COD	Democratic Republic of the Congo	Congo the Democratic Republic of the
COG	Congo	Congo
COK	Cook Islands	Cook Islands
CRI	Costa Rica	Costa Rica
CIV	Côte d'Ivoire	Cote d'Ivoire
HRV	Croatia	Croatia
CUB	Cuba	Cuba
CYP	Cyprus	Cyprus
CZE	Czech Republic	Czech Republic
DNK	Denmark	Denmark
DJI	Djibouti	Djibouti
DMA	Dominica	Dominica
DOM	Dominican Republic	Dominican Republic
ECU	Ecuador	Ecuador
EGY	Egypt	Egypt
SLV	El Salvador	El Salvador
GNQ	Equatorial Guinea	Equatorial Guinea
ERI	Eritrea	Eritrea
EST	Estonia	Estonia
ETH	Ethiopia	Ethiopia
FLK	Falkland Islands (Malvinas)	Falkland Islands (Malvinas)
FRO	Faroe Islands	Faroe Islands
FJI	Fiji	Fiji
FIN	Finland	Finland
FRA	France	France
GUF	French Guiana	French Guiana
PYF	French Polynesia	French Polynesia
GAB	Gabon	Gabon
GMB	Gambia	Gambia
GEO	Georgia	Georgia
DEU	Germany	Germany
GHA	Ghana	Ghana
GIB	Gibraltar	Gibraltar
GRC	Greece	Greece
GRL	Greenland	Greenland
GRD	Grenada	Grenada
GLP	Guadeloupe	Guadeloupe
GUM	Guam	Guam
GTM	Guatemala	Guatemala
GIN	Guinea	Guinea
GNB	Guinea-Bissau	Guinea-Bissau
GUY	Guyana	Guyana
HTI	Haiti	Haiti
HND	Honduras	Honduras
HKG	Hong Kong	Hong Kong
HUN	Hungary	Hungary
ISL	Iceland	Iceland

226-Country Code	FAO	EDGAR
IND	India	India
IDN	Indonesia	Indonesia
IRN	Iran (Islamic Republic of)	Iran, Islamic Republic of
IRQ	Iraq	Iraq
IRL	Ireland	Ireland
ISR	Israel	Israel
ITA	Italy	Italy
JAM	Jamaica	Jamaica
JPN	Japan	Japan
JOR	Jordan	Jordan
KAZ	Kazakhstan	Kazakhstan
KEN	Kenya	Kenya
KIR	Kiribati	Kiribati
PRK	Democratic People's Republic of Korea	Korea, Democratic People's Republic of
KOR	Republic of Korea	Korea, Republic of
KWT	Kuwait	Kuwait
KGZ	Kyrgyzstan	Kyrgyzstan
LAO	Lao People's Democratic Republic	Lao People's Democratic Republic
LVA	Latvia	Latvia
LBN	Lebanon	Lebanon
LSO	Lesotho	Lesotho
LBR	Liberia	Liberia
LBY	Libya	Libyan Arab Jamahiriya
LIE	Liechtenstein	n.a.
LTU	Lithuania	Lithuania
LUX	Luxembourg	Luxembourg
MAC	n.a.	Macao
MKD	The former Yugoslav Republic of Macedonia	Macedonia, the former Yugoslav Republic of
MDG	Madagascar	Madagascar
MWI	Malawi	Malawi
MYS	Malaysia	Malaysia
MDV	Maldives	Maldives
MLI	Mali	Mali
MLT	Malta	Malta
MHL	Marshall Islands	Marshall Islands
MTQ	Martinique	Martinique
MRT	Mauritania	Mauritania
MUS	Mauritius	Mauritius
MYT	Mayotte	Mayotte
MEX	Mexico	Mexico
FSM	Micronesia (Federated States of)	Micronesia, Federated States of
MDA	Republic of Moldova	Moldova, Republic of
MCO	Monaco	n.a.
MNG	Mongolia	Mongolia
MSR	Montserrat	Montserrat

226-Country Code	FAO	EDGAR
MAR	Morocco	Morocco
MOZ	Mozambique	Mozambique
MMR	Myanmar	Myanmar
NAM	Namibia	Namibia
NRU	Nauru	Nauru
NPL	Nepal	Nepal
ANT	Netherlands	Netherlands
NLD	Netherlands Antilles	Netherlands Antilles
NCL	New Caledonia	New Caledonia
NZL	New Zealand	New Zealand
NIC	Nicaragua	Nicaragua
NER	Niger	Niger
NGA	Nigeria	Nigeria
NIU	Niue	Niue
NFK	Norfolk Island	Norfolk Island
MNP	Northern Mariana Islands	Northern Mariana Islands
NOR	Norway	Norway
OMN	Oman	Oman
PAK	Pakistan	Pakistan
PLW	Palau	Palau
PSE	Occupied Palestinian Territory	n.a.
PAN	Panama	Panama
PNG	Papua New Guinea	Papua New Guinea
PRY	Paraguay	Paraguay
PER	Peru	Peru
PHL	Philippines	Philippines
POL	Poland	Poland
PRT	Portugal	Portugal
PRI	Puerto Rico	Puerto Rico
QAT	Qatar	Qatar
REU	Réunion	Reunion
ROM	Romania	Romania
RUS	Russian Federation	Russian Federation
RWA	Rwanda	Rwanda
SHN	Saint Helena, Ascension and Tristan da Cunha	Saint Helena
KNA	Saint Kitts and Nevis	Saint Kitts and Nevis
LCA	Saint Lucia	Saint Lucia
SPM	Saint Pierre and Miquelon	Saint Pierre and Miquelon
VCT	Saint Vincent and the Grenadines	Saint Vincent and the Grenadines
WSM	Samoa	Samoa
SMR	San Marino	n.a.
STP	Sao Tome and Principe	Sao Tome and Principe
SAU	Saudi Arabia	Saudi Arabia
SEN	Senegal	Senegal
SRB	Serbia and Montenegro	Serbia and Montenegro
SYC	Seychelles	Seychelles

226-Country Code	FAO	EDGAR
SLE	Sierra Leone	Sierra Leone
SGP	Singapore	Singapore
SVK	Slovakia	Slovakia
SVN	Slovenia	Slovenia
SLB	Solomon Islands	Solomon Islands
SOM	Somalia	Somalia
ZAF	South Africa	South Africa
ESP	Spain	Spain
LKA	Sri Lanka	Sri Lanka
SDN	Sudan (former)	Sudan
SUR	Suriname	Suriname
SWZ	Swaziland	Swaziland
SWE	Sweden	Sweden
CHE	Switzerland	Switzerland
SYR	Syrian Arab Republic	Syrian Arab Republic
TWN	n.a.	Taiwan_Province of China
TJK	Tajikistan	Tajikistan
TZA	United Republic of Tanzania	Tanzania_United Republic of
THA	Thailand	Thailand
TLS	Timor-Leste	Timor-Leste
TGO	Togo	Togo
TKL	Tokelau	Tokelau
TON	Tonga	Tonga
TTO	Trinidad and Tobago	Trinidad and Tobago
TUN	Tunisia	Tunisia
TUR	Turkey	Turkey
TKM	Turkmenistan	Turkmenistan
TCA	Turks and Caicos Islands	Turks and Caicos Islands
TUV	Tuvalu	Tuvalu
UGA	Uganda	Uganda
UKR	Ukraine	Ukraine
ARE	United Arab Emirates	United Arab Emirates
GBR	United Kingdom	United Kingdom
USA	United States of America	United States
URY	Uruguay	Uruguay
UZB	Uzbekistan	Uzbekistan
VUT	Vanuatu	Vanuatu
VEN	Venezuela (Bolivarian Republic of)	Venezuela
VNM	Viet Nam	Viet Nam
VGB	British Virgin Islands	Virgin Islands_British
VIR	United States Virgin Islands	Virgin Islands_USA
WLF	Wallis and Futuna Islands	Wallis and Futuna
YEM	Yemen	Yemen
ZMB	Zambia	Zambia

Table A2: Definition of IPCC codes

IPCC code	Source name	Comment
1. Energy: Fuel Combustion (1A) and Fugitive emissions from fuel (1B)		
1A1a	Public electricity and heat production	Including auto producers of electricity and heat
1A1bc	Other energy industries	
1A2	Manufacturing industries and construction	
1A3a	Domestic aviation	
1A3b	Road transportation	
1A3c	Rail transportation	
1A3d	Domestic navigation	
1A3e	Other transportation	
1A4	Residential and other sectors	
1B1	Fugitive emissions from solid fuels	
1B2	Fugitive emissions from oil and gas	Including venting and flaring
1C1	Memo: International aviation	
1C2	Memo: International navigation	
2. Industrial Processes (non-combustion) and 3. Product Use		
2A	Production of minerals	
2B	Production of chemicals	
2C	Production of metals	
2D	Production of pulp/paper/food/drink	
2E	Production of halocarbons and SF_6	
2F1	Refrigeration and air conditioning	
2F2	Foam blowing	
2F3	Fire extinguishers	
2F4	Aerosols	
2F5	F-gas as solvent	
2F7	Semiconductor/electronics manufacture	Including FPDs and PV cells
2F8	Electrical equipment	
2F9	Other F-gas use	
2G	Non-energy use of lubricants/waxes (CO_2)	
3	Solvent and other product use	
4. Agriculture (including Savanna burning)		
4A	Enteric fermentation	
4B	Manure management	
4C	Rice cultivation	

4D1	Direct soil emissions	
4D2	Manure in pasture/range/paddock	
4D3	Indirect N_2O from leaching/runoff in agriculture	
4D4	Other direct soil emissions	Including CO_2 from urea application and soil liming
4E	Savanna burning	
4F	Agricultural waste burning	
5. Land Use Change and Forestry		
5A	Forest fires	Including peat fires
5C	Grassland fires	
5D	Decay of wetlands/peatlands	Included in 5F2 Post-burn decay
5F	Other vegetation fires	
5F2	Forest Fires-Post burn decay	Incl. decomposition of peatlands due to drainage
6. Waste		
6A	Solid waste disposal on land	
6B	Wastewater handling	
6C	Waste incineration	
6D	Other waste handling	
7. Other anthropogenic sources		
7A	Fossil fuel fires	Includes underground coal fires and Kuwait oil fires
7B	Indirect N_2O from non-agricultural NO_x	
7C	Indirect N_2O from non-agricultural NH_3	
7D	Other anthropogenic sources	

Source: http://edgar.jrc.ec.europa.eu/faq6.php

Table A3: GTAP Sectors

	Code	Description
1	PDR	Paddy rice
2	WHT	Wheat
3	GRO	Cereal grains nec
4	V_F	Vegetables, fruit, nuts
5	OSD	Oil seeds
6	C_B	Sugar cane, sugar beet
7	PFB	Plant-based fibers
8	OCR	Crops nec
9	CTL	Bovine cattle, sheep and goats, horses
10	OAP	Animal products nec
11	RMK	Raw milk
12	WOL	Wool, silk-worm cocoons
13	FRS	Forestry
14	FSH	Fishing
15	COA	Coal
16	OIL	Oil
17	GAS	Gas
18	OMN	Minerals nec
19	CMT	Bovine meat products
20	OMT	Meat products nec
21	VOL	Vegetable oils and fats
22	MIL	Dairy products
23	PCR	Processed rice
24	SGR	Sugar
25	OFD	Food products nec
26	B_T	Beverages and tobacco products
27	TEX	Textiles
28	WAP	Wearing apparel
29	LEA	Leather products
30	LUM	Wood products
31	PPP	Paper products, publishing
32	P_C	Petroleum, coal products
33	CRP	Chemical, rubber, plastic products
34	NMM	Mineral products nec
35	I_S	Ferrous metals

36	NFM	Metals nec
37	FMP	Metal products
38	MVH	Motor vehicles and parts
39	OTN	Transport equipment nec
40	ELE	Electronic equipment
41	OME	Machinery and equipment nec
42	OMF	Manufactures nec
43	ELY	Electricity
44	GDT	Gas manufacture, distribution
45	WTR	Water
46	CNS	Construction
47	TRD	Trade
48	OTP	Transport nec
49	WTP	Water transport
50	ATP	Air transport
51	CMN	Communication
52	OFI	Financial services nec
53	ISR	Insurance
54	OBS	Business services nec
55	ROS	Recreational and other services
56	OSG	Public Administration, Defense, Education, Health
57	DWE	Dwellings

Table A4: Countries with notable growth rates in EDGAR dataset

Category	Number of Outliers	Country	Growth Rate (%)
Aluminum Production CF4	1	Azerbaijan	680
Biomass Burning CH4_SAVAN	2	Indonesia Cambodia	782 746
Biomass Burning CH4_AGRES	1	Maldives	185
Biomass Burning N2O_SAVAN	2	Indonesia Cambodia	783 744
Fugitives from Coal Mining Activities CH4	2	Albania Cape Verde	3117 2128
Electrical Transmission and Distribution SF6	1	Taiwan_Province of China	482
HCFC-22 Production HFC-23	1	Argentina	734
Other Industrial Non-Agricultural Sources CH4_ALLMTL	2	Albania Serbia and Montenegro	393 281
Other Industrial Non-Agricultural Sources CH4_ALMNFER	2	Albania Serbia and Montenegro	393 281
Other Industrial Non-Agricultural Sources CH4_CHMIND	2	Iran Nigeria	753 700
Other Industrial Non-Agricultural Sources CH4_IRNSTL	2	Albania Serbia and Montenegro	393 281
ODS Substitutes HFC-134a	1	El Salvador	1319
Semiconductor Production CF4	1	Spain	2801
Stationary and Mobile Combustion CH4_STM_AG	1	Tajikistan	286
Stationary and Mobile Combustion CH4_STM_CPS	1	Tajikistan	286
Stationary and Mobile Combustion CH4_STM_EN	1	Cambodia	4570
Stationary and Mobile Combustion CH4_STM_IND	1	Kyrgyzstan	580
Stationary and Mobile Combustion CH4_STM_MO	1	Cambodia	4570
Stationary and Mobile Combustion CH4_STM_OTH	1	Tajikistan	286
Stationary and Mobile Combustion CH4_STM_RES	1	Tajikistan	286
Stationary and Mobile Combustion N2O_STM_AG	2	Cyprus Turks and Caicos Islands	1847 1446
Stationary and Mobile Combustion N2O_STM_CPS	2	Cyprus Turks and Caicos Islands	1847 1446
Stationary and Mobile Combustion N2O_STM_EN	1	Cambodia	993
Stationary and Mobile Combustion N2O_STM_IND	1	Qatar	412
Stationary and Mobile Combustion N2O_STM_MO	1	Moldova, Republic of	283

Stationary and Mobile Combustion N2O_STM_OTH	2	Cyprus Turks and Caicos Islands	1847 1446
Stationary and Mobile Combustion N2O_STM_RES	2	Cyprus Turks and Caicos Islands	1847 1446
Wastewater Treatment CH4	1	Moldova, Republic of	120

Table A5: Countries violating the 6 standard deviation rule in FAO livestock data

Category	Animal	Number of Outlier Regions	Country	Growth Rate (%)
Livestock Enteric Fermentation CH4	BUFFALO	1	Armenia	687
	CAMEL_LLAMA	2	Eritre	347
			Iraq	538
	GOAT	1	Turkmenistan	364
	HORSE	2	French Guiana	271
			Quatar	239
	MULEASS	1	Mozambique	113
	NONDAIRY_CTL	1	Libyan Arab Jamahiriya	315
	SWINE	1	French Guiana	271
Livestock Manure Management CH4	BUFFALO	1	Armenia	687
	CAMEL_LLAMA	1	Eritrea	302
	GOAT	1	Turkmenistan	364
	HORSE	2	French Guiana	271
			Quatar	239
	MULEASS	1	Mongolia	199
	NONDAIRY_CTL	1	Libyan Arab Jamahiriya	315
	OTHER	2	French Guiana	176
			Singapore	152
	POULTRY	2	French Guiana	176
			Singapore	152
	SWINE	1	French Guiana	271
	UKNOWN	2	French Guiana	176
			Singapore	152
Livestock Manure Management N2O	BUFFALO	1	Armenia	687
	CAMEL_LLAMA	1	Mongolia	446
	GOAT	1	Turkmenistan	364
	MULEASS	1	Mongolia	446
	OTHER	1	French Guiana	205
	POULTRY	1	French Guiana	205
	SHEEP_LAMB	2	Lithuania	218
			Sierra Leone	213
	SWINE	1	French Guiana	271
	UKNOWN	1	French Guiana	205

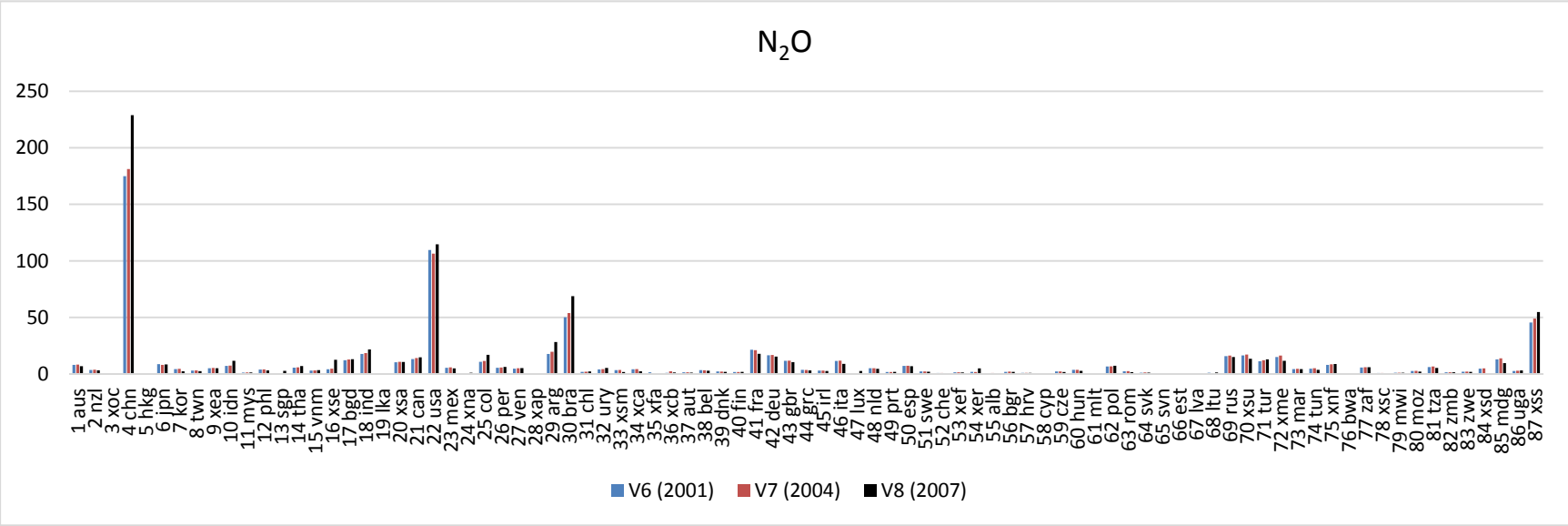

Figure A1a: N_2O emissions by Version 6 Regions across Versions (MMTCEq)

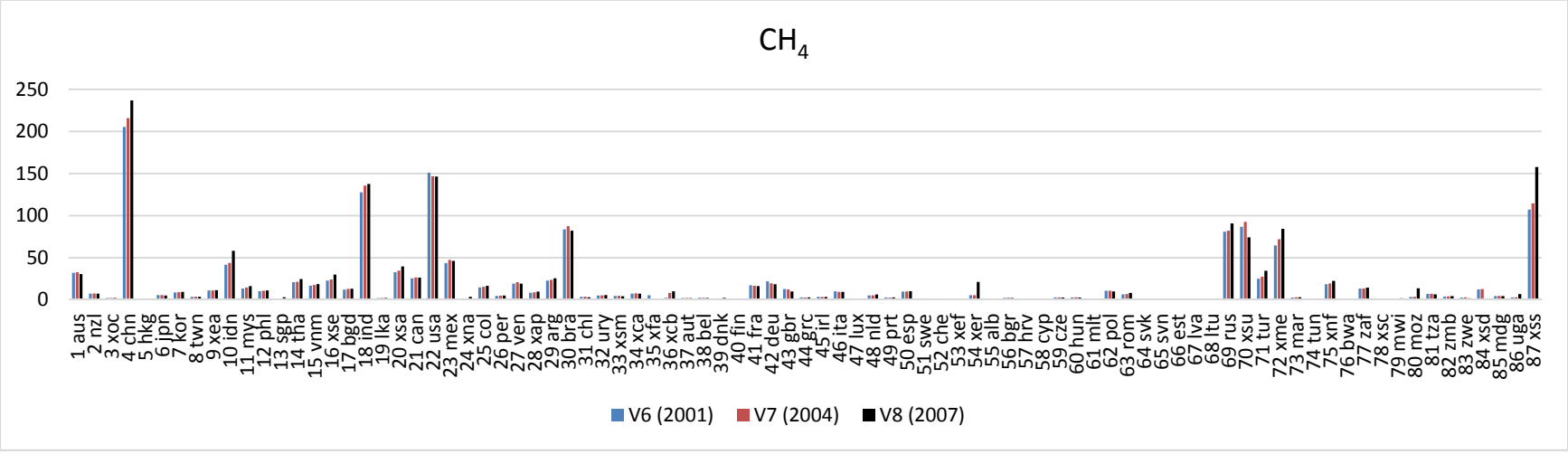

Figure A1b: CH_4 emissions by Version 6 Regions across Versions (MMTCEq)

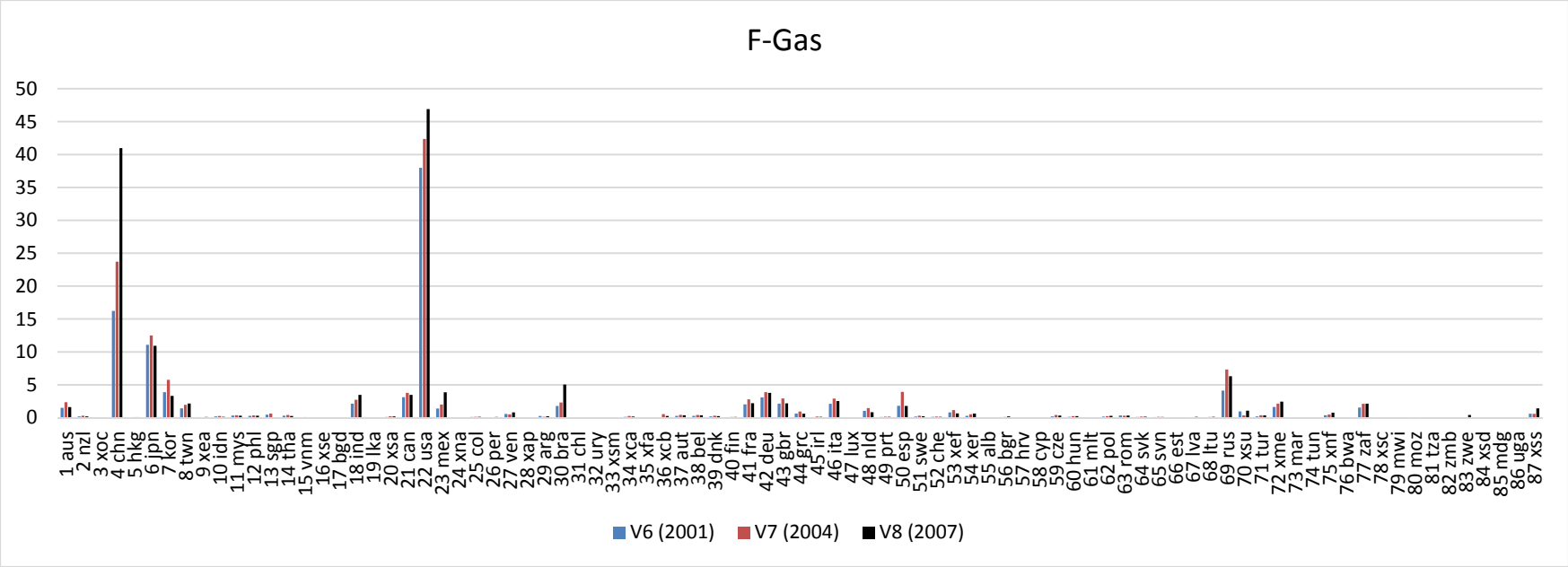

Figure A1c: F-Gases emissions by Version 6 Regions across Versions (MMTCEq)