Supplementary Information

Contents

1. Model Descriptions

AIM/CGE model is a one-year-step recursive-type dynamic general equilibrium model that covers all regions of the world. The AIM/CGE model includes 17 regions and 42 industrial classifications. Details of the model structure are described by Fujimori et al. (2012). The production sectors are assumed to maximize profits under multi-nested constant elasticity substitution (CES) functions and each input price. Energy transformation sectors input energy and value added as fixed coefficients of output. Power generation values from several energy sources are combined with a Logit function. Household expenditures on each commodity are described by a linear expenditure system function. The saving ratio is endogenously determined to balance saving and investment, and capital formation for each good is determined by a fixed coefficient. CO2, CH4, N2O, and F-gases are treated as GHGs. BC, CO, NH3, NMVOC, NOX, OC and sulfur are treated as air pollutant gases. Basically, the emissions factors are changed over time according to the implementation of air pollutant removal technologies and relevant legislation. The implementation of mitigation actions is represented by assuming either a global total emissions constraint. Once the emission constraint is implemented, the carbon price becomes a complementary variable to that constraint and determines marginal mitigation cost.

GCAM (Global Change Assessment Model) explores the complex relationship between economic activity, energy systems, land use systems, ecosystems, emissions and resulting impact on climate change. The main focus of this model is technology analysis and implications of various technology pathways for climate policies in a national and global context. The model includes 16 emissions tracked (e.g. CO2, CH4, N2O, and SO2), is divided into 14 regions and runs from 1990 to 2095 in time steps of 5 years. The model assumes that regional population and labor productivity growth assumptions are the main drivers for energy and land-use systems. The end-use energy service demands associated with time path of economic activity have been aggregated as three energy services- industrial energy services, building energy services, and transportation energy services. MAGICC is an embedded reduced form model of the carbon cycle, atmospheric chemistry and climate change that provides GHG concentrations, radiative forcing, and climate change. This is the only non-European model participating in the LIMITS project and further information on its specifications can be found in Calvin et al. (2011).

IMAGE (Integrated Assessment Modelling Framework) is in fact a complex modelling framework, i.e. several linked and integrated models describing long-term dynamics of global environmental variations, such as air pollution, climate change, and land-use change. The TIMER is the global energy model that describes the demand and production of primary and secondary energy and the related emissions of GHGs and regional air pollutants. The Land-Use Emissions Model (LUEM) computes the emissions of atmospheric pollutants (GHGs and air pollutants) from both natural and land-use related sources. The model provides results for 16 global regions. A detailed description of IMAGE can be found at Bouwman et al. (2006).

The MESSAGE (Model for Energy Supply Strategy Alternatives and their General Environmental Impact) model, version V, is a linear programming system engineering optimization model used for medium- to long-term energy system planning and policy analysis. The model minimizes total discounted energy system costs, and provides information on the utilization not only of several energy and technology related variables (from use to trade) but also on pollutant emissions. The model also includes generic representations of agriculture and forestry, including emissions and mitigation options for the GHGs and other radiatively active substances. The model includes 11 regions across the globe and provides results for the time period of 2100. Further information can be found at [1, 2]

REMIND (Regionalized Model of Investments and Development) is a global multi-region model that represents an inter-temporal energy-economy-environment. It incorporates the economy, the climate system and a detailed representation of the energy sector, maximizing global welfare based on nested regional macro-economic production functions. This model allows for unrestricted inter-temporal trade relations and capital movements between 11 world regions, providing information regarding technology options and policy proposals for climate mitigation. Mitigation costs estimates are based on technological opportunities and constraints in the development of new energy technologies. Further information can be found at Leimbach et al. (2009, 2010).

The WITCH (World Induced Technical Change Hybrid model) regional model allows for the analysis of the socio-economic dimensions of climate change. It provides figures of the economic consequences of climate policies and helps to devise optimal strategy planning for climate change mitigation. In this model the non-cooperative nature of international relationships is explicitly accounted for and climate policies across the 13 regions included and over time can be differentiated allowing considering several policy scenarios. The model most interesting features regard the endogenous treatment of technological innovation in the mitigation sector, and the modelling of multiple externalities, both climatic and technological, in a game-theoretic setup. The climate module provides information on climate change impact and optimal adaptation response. Further details on the model can be found at Bosetti et al. (2006, 2009).

2. Scenario Description

The reference scenario is a counterfactual scenario with no climate policies included and is based on median GDP and population projections.

The climate policy case includes both emissions reduction targets for the year 2020 as laid down in the Copenhagen pledges with inclusion of some plausibility considerations of the pledges and a long-term 450 ppm CO2e target (defined in terms of limits on the combined radiative forcing from all anthropogenic radiative agents assessed in the IPCC 4th assessment report, except nitrate aerosols, mineral dust aerosols, and land use albedo changes). Full where (region) and what (sector) flexibility of emissions reduction was assumed ensuring the selection of the cheapest globally available mitigation option at the margin.

Table 2-1: Summary of Durban Platform climate change policies in 2020

Region	GHG emissions reduction in 2020(1)	GHG intensity reduction in 2020(2)	Modern Renewable share in electricity(3)	Installed renewable capacity in 2020 (4) (Wind, solar)	Installed nuclear power capacity (5)
EU27	-15% (2005)	-	20% (2020)	-	-
China	-	-40%	25% (2020)	200 GW; 50GW	41 GW (2020)
India	-	-20%	-	20 GW; 10GW	20 GW (2020)
Japan	-1% (2005)	-	-	5 GW; 28GW	-
USA	-5% (2005)	-	13% (2020)	-	-
Russia	+27% (2005)	-	4.5% (2020)	-	34GW (2030)
AUNZ	-13% (2005)	-	10% (2020)	-	-
Brazil	-18% (BAU)	-	-	-	-
Mexico	-15% (BAU)	-	17% (2020)	-	-
LAM	-15% (BAU)	-	-	-	-
CAS	-	-	-	-	-
KOR	-15% (BAU)	-	-	8 GW; -	-
IDN	-13% (BAU)	-	7.5% (2025)	-	-
SSA	-	-	-	-	-
CAN	-5% (2005)	-	13% (2020)	-	-
EEU	-	-	-	-	-
EFTA	-	-	-	-	-
MEA	-	-	-	-	-
NAF	-	-	20% (2020)	-	-
PAK	-	-	-	-	-
SAF	-17% (BAU)	-	-	-	-
SAS	-	-	-	-	-
SEA	-	-	15% (2020)	-	-
TUR	-	-	-	20 GW;-	-
TWN	-	-	-	-	-

Abbreviations:
AUNZ = Australia and New Zealand, LAM = Latin America
CAS = Central Asia
KOR = South Korea
IDN = Indonesia
SSA = Sub-Saharan Africa
CAN = Canada
EEU = Eastern Europe excl. EU27 and Russia

3. Assumptions on Pollution Control

In order to quantify the levels of AP control stringency, a global dataset of emission factors derived from the GAINS model [3] is provided. This dataset reflects recent developments in the air pollution legislation across the world and draws on data collection, model evaluation, and discussion with air quality policy, measurement and modeling communities; in particular work on the revision of the European Union National Emission Ceiling Directive, the UNECE LRTAP Task Force on Hemispheric Transport of Air Pollution (TF HTAP), UNEP Black Carbon and Tropospheric Ozone assessment, as well as various ongoing EU funded initiatives.

The projections of emission factor trajectories up to 2030 have been derived based on the World Energy Outlook (WEO) 2011 baseline scenario [4] implemented in the GAINS model. While the documentation of these recent emission scenarios is under preparation, the data has been made available to the modeling community via GEIA/ECCAD (*www.geiacenter.org*) and ECLIPSE (http://eclipse.nilu.no/) web portals. Furthermore, the similar dataset (based on the WEO 2009 ([5]) developed with GAINS has been documented in the past, e.g., [6-11] and subsequently applied to a number of studies [12-14].

Two sets of emission factors are available (with a third derived from these).

CLE: ‘current legislation’ – These emission factors assume efficient implementation of existing environmental legislation. It thus describes a scenario of pollution control where countries implement all planned legislation until 2030 with adequate institutional support. The CLE emission factors are “fleet average” values that are the aggregate emission factor of all ages of equipment operating in the given year.

MTFR: ‘maximum technically feasible reduction’ – These emission factors assume implementation of ‘best available technology’ as it exists today independent of their costs but considering economic lifetime of technologies and selected other constraints that could limit applicability of certain measures in specific regions. While, the full penetration of MTFR measures in the near-term is not a feasible scenario, these values serve rather as ultimately achievable air pollutant emission factors for conventional technologies considered being available at the present time.

SLE: Stringent policies, where emissions factors close up to 75% of the difference between CLE and MTFR (derived from two datasets above). Because the MTFR emission factors do not represent the impacts of vintaging or super-emitters, the derived SLE emission factors can be considered, in many cases, to be quite ambitious.

Emission factor estimates are provided for:

- All energy-related combustion (supply and demand), conversion, and transformation sectors.
- Years 2000, 2005, 2010, 2020, 2030
- 26 world regions;

- Sulfur dioxide (SO_2), nitrogen oxides (NO_x), organic carbon (OC), black carbon (BC), carbon monoxide (CO), and non-methane volatile organic carbons (NMVOC).

Note that the base-year 2000 emissions factors in this dataset may differ from other datasets that may be used for IAM calibration (e.g.[15]). For some substances, such as BC and OC, these differences may be substantial and this is a reflection of the large uncertainty in current emissions for these species. It is important to note that these differences in current emission factors, in general, do not translate to similar differences in MFR (or, for the most part, SLE) emissions factors, as these represent emission factors for technologies with strong emission controls. There are uncertainties here as well, but these are largely independent of uncertainties in current-day emissions.

Table 3-1 : Details of assumed pollution Controls

	Transport	Industry and power plants	International shipping	Other
Current legislation (CLE)				
Sulfur dioxide (SO_2)	OECD: EU fuel quality directive (2009/30/EC) and national legislation on the sulfur content in liquid fuels; Non-OECD: National legislation on the sulfur content in liquid fuels and coal	OECD: For EU, emission standards from the LCPD (2001), IED (2010), NEC (1991), UNECE (1999). National legislation elsewhere. Non-OECD: Increased use of low-sulfur coal, increasing penetration of flue gas desulfurization (FGD) after 2005 in new and existing plants according to national legislation.	MARPOL Annex VI revisions from MEPC57	Limiting open burning of agricultural waste (if legislation exists)
Nitrogen oxides (NO_x)	OECD: Emission controls for vehicles and off-road sources up to the EURO-IV/ EURO-V standard (vary by region) Non-OECD: National emission standards equivalent to approximately EURO III-IV standards (vary by region)	OECD: For EU, emission standards from the LCPD (2001), IEC (2010), NEC (1991), UNECE (1999). National legislation elsewhere. National emission standards on stationary sources– if stricter than in the LCPD Non-OECD: Primary measures for controlling of NO_x	MARPOL Annex VI revisions from MEPC57	Limiting open burning of agricultural waste (if legislation exists)
Carbon monoxide (CO)	As above for NO_x			Limiting open burning of agricultural waste (if legislation exists)
Volatile organic compounds	Measures as described above for NO_x; legislation on fuel quality and evaporative	A number of directives for the EU: e.g., Solvent Directive of the EU (1999), stage I directive (1995),		Limiting open burning of agricultural waste (if

(VOC)	losses	NEC (1991), UNECE(1999)		legislation exists)
Ammonia (NH_3)		End-of-pipe controls in industry (fertilizer manufacturing)		NEC, 1991 and UNECE (1999)
PM2.5 (including BC and OC)	As for NOx	For the OECD like for SO2, NOx,; for the Non-OECD, improving enforcement of PM control with end of pipe measures required by national legislation; often linked to FGD requirements		Limiting open burning of agricultural waste (if legislation exists)
Additional Measures in Stringent legislation (SLE): Corresponding to 70% of Maximum Technologically Feasible Reduction Levels				
SO_2	As in CLE	High-efficiency flue gases desulfurization (FGD) on existing and new large boilers Use of low-sulfur fuels and simple FGD techniques for smaller combustion sectors High-efficiency controls on process emission sources	Same as CLE	Reduction in agricultural waste burning
NO_x	OECD and Non-OECD: EURO-5 and EURO-6 for light duty vehicles	Selective catalytic reduction at large plants in industry and in the power sector Combustion modifications for smaller sources in industry and in the residential and commercial sectors High-efficiency controls on process emission sources	Same as CLE	Reduction in agricultural waste burning
CO	As in CLE			Reduction in agricultural waste burning
VOC	As in CLE	Regular monitoring, flaring, as well as control of the evaporative loses from storage Solvent use: full use of potential for substitution with low-solvent products in both "do it yourself" and industrial applications, modification of application methods and introduction of		Reduction in agricultural waste burning

		solvent management plans		
NH_3		End-of-pipe controls in industry (fertilizer manufacturing)		Substitution of urea fertilizers, rapid incorporation of solid manure, low nitrogen feed and bio-filtration
PM2.5 (including BC and OC)	As in CLE	High-efficiency electrostatic precipitators, fabric filters, new boiler types, filters, good practices	Revised MARPOL Annex VI (2005) regulations	Reduction in agricultural waste burning

1. LCPD, 2001: Council Directive 88/609/EEC of 24 November 1988 on the limitation of emissions of certain pollutants into the air from large combustion plants
2. IED, 2010: Industrial Emissions Directive (2010/75/EU) http://ec.europa.eu/environment/air/pollutants/stationary/ied/legislation.htm
3. NEC, 1991: National Emission Ceiling Directive (2001/81/EC),
4. UNECE, 1999: The 1999 Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone; ;http://www.unece.org/env/lrtap/multi_h1.html
5. Solvent Directive of the EU, 1999: 1999/13/EC Council Directive 1999/13/EC on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain activities and installations
6. Stage 1 Directive, 1995: 1994/63/EC aims to prevent emissions to the atmosphere of volatile organic compounds (VOCs) from off-road sourcesMARPOL: International Convention for the Prevention of Pollution

4. Sector Definitions

Table 4-1: Definition of Sectors

Variable	**Definition**
Energy Supply	Emissions from Extraction and Distribution of Fossil Fuels (including fugitive Emissions, IPCC category 1B); Electricity production and distribution, district heating and other energy conversion (e.g. refineries, synthetic fuel production)
Energy Demand	Emissions from all energy end-use sectors, including industry emissions. Includes International Shipping.
Land Use	Total anthropogenic emissions from land use (Burning of Agricultural waste .(IPCC category 4F), Emissions from Deforestation , Emissions from Fertilizer use, Enteric Fermentation, manure management, Use of pesticides (IPCC categories 4A, 4B, 4C, 4D), Emissions from agricultural rice production, Emissions from agricultural livestock, including manure management, Emissions from fertilizer use
Solvents	Emissions from Solvent and other Product Use (IPCC Category 3)
Waste	Emissions from Landfills, wastewater treatment, human wastewater disposal and waste incineration (non-energy) (IPCC category 6)

5. Regional Definitions

Table 5-1: Definition of Regions

Macro region	Acronym	Countries
Asia	ASIA	China, China Hong Kong SAR, Republic of Korea, Indonesia, Dem. People's Republic of Korea, Mongolia, Brunei Darussalam, Malaysia, Singapore, India, Sri Lanka, Papua New Guinea, Vanuatu, Samoa, Tonga, Philippines, Afghanistan, Bangladesh, Bhutan, Nepal, Pakistan, Cambodia, Lao People's Democratic Republic, Myanmar, Taiwan, Thailand, Viet Nam
Middle East + Africa	MAF	Burundi, Comoros, Djibouti, Eritrea, Ethiopia, Kenya, Madagascar, Mauritius, Reunion, Rwanda, Somalia, Uganda, United Republic of Tanzania, Central African Republic, Chad, Democratic Republic of the Congo, Sudan, Egypt, Iran, Bahrain, Iraq, Kuwait, Oman, Qatar, Saudi Arabia, United Arab Emirates, Yemen, Israel, Jordan, Lebanon, Syrian Arab Republic, Algeria, Libyan Arab Jamahiriya, Morocco, Tunisia, Lesotho, South Africa, Swaziland, Malawi, Mozambique, Zambia, Zimbabwe, Angola, Botswana, Namibia, Cameroon, Congo, Equatorial Guinea, Gabon, Sao Tome and Principe, Benin, Burkina Faso, Cape Verde, Cote d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, Togo
OECD	OECD90	Australia, Austria, Belgium, Luxembourg, Netherlands, Canada, Switzerland, Portugal, Spain, Finland, France, Ireland, United Kingdom, Greece, Italy, Japan, Iceland, Norway, New Zealand, Fiji, Solomon Islands, Germany, Denmark, Sweden, Turkey, United States of America
Latin America + Caribbean	LAM	Argentina, Uruguay, Brazil, Chile, Mexico, Aruba, Bahamas, Barbados, Cuba, Dominican Republic, Grenada, Guadeloupe, Haiti, Jamaica, Martinique, Netherlands Antilles, Puerto Rico, Saint Lucia, Saint Vincent and the Grenadines, Trinidad and Tobago, Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Panama, Bolivia, Colombia, Ecuador, French Guiana, Guyana, Paraguay, Peru, Suriname
Reforming Economies	REF	Slovenia, Bulgaria, Cyprus, Hungary, Malta, Kazakhstan, Poland, Estonia, Latvia, Lithuania, Albania, Bosnia and Herzegovina, Croatia, The Former Yugoslav Republic of Macedonia, Czech Republic, Slovakia, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan, Romania, Armenia, Azerbaijan, Georgia, Russian Federation, Belarus, Republic of Moldova, Ukraine

6. Air Quality Modeling

For atmospheric analysis, the TM5-FASST model [16], a reduced-form global air quality source-receptor model (AQ-SRM) was used, allowing for computation of PM2.5 concentrations for several scenarios developed by all six IAMs. In this simplified model the relation between the emissions of compound *i* from source *x* and resulting pollutant *j* concentration (where *j* = *i* in case of a primary component) at receptor *y* is expressed by a simple linear relation which mimics the underlying meteorological and chemical processes:

$$C_{ij}(x,y) = C_j^0(y) + A_{ij}(x,y)E_i(x)$$

where $C_{ij}(x,y)$ is the concentration of species j at receptor y formed from precursor i emitted at source x, $E_i(x)$ is the emission rate (kg/yr) of precursor i at source x, $A_{ij}(x,y)$is the so-called source-receptor coefficient between source location x and receptor location y for emitted precursor i leading to end product j, and $C_j^0(y)$ is a constant for pollutant j and location y. The source-receptor coefficients are stored as matrices with dimension [x,y]. There is a single matrix for each precursor i and for each resulting component j from that precursor.

The SRCs have been derived from a set of runs with the full chemical transport model TM5-CTM [17] by applying emission perturbations for each of a defined set of source regions and precursor components. TM5-CTM explicitly solves the mass balance equations of the species using detailed meteorological fields and sophisticated physical and chemical process schemes. TM5-CTM covers the global domain with a resolution of 1°x1°. The reduced form TM5-FASST model produces 1°x1° resolution grid maps of PM2.5 surface concentrations taking as input annual emission rates of pollutants for each of 56 TM5-FASST regions. For population exposure calculations, the resulting PM.5 grid maps are interpolated to 7.5'x7.5' to match high resolution population grid maps [12, 18].

The SRCs are stored as matrices for each precursor and for each corresponding resulting component. These have been derived from a set of runs with the full chemical transport model TM5-CTM (Tracer Model, version 5, Krol et al. (2005)) where the base emission value was changed by 20% for a defined set of 56 source regions (see Figure 1) and major air pollutant precursors, like SO_2, NOx, BC, OC, NMVOC, and NH_3. In practice this means that for each region the change in concentration of all affected pollutant species was calculated by reducing by 20% the emissions of a precursor over a source region. The base run had as a reference emission dataset the AR5 RCP year 2000[1]. The resulting concentrations were obtained for a global domain at 1°x1° resolution. Having established and stored all relevant source-receptor matrices, those are subsequently used to calculate the resulting concentration change from any emission by scaling them with actual emission changes. An overview of all considered precursor-pollutant combinations are given in Table 2. This set of linear equations for all components and all source and receptor regions emulates the full-fledged TM5-CTM, and constitutes the 'kernel' of TM5-FASST.

[1] Representative Concentration Pathways (tntcat.iiasa.ac.at:8787/RcpDb) from the Fifth Assessment Report of IPCC (https://www.ipcc.unibe.ch/AR5/)

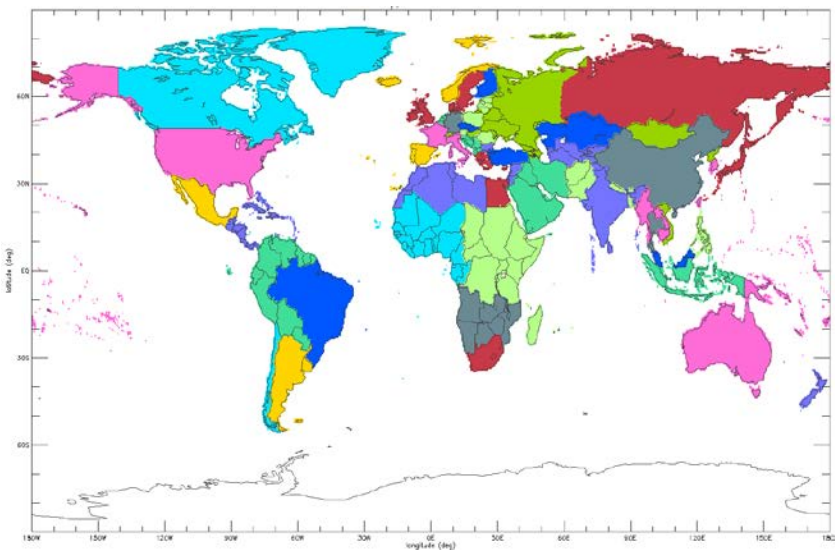

Figure 2definition of the 56 source regions within TM5-FASST. EU27 is represented by 16 regions.

Table 6-1 Relevant emitted precursor-pollutant pairs. The number of x's gives a qualitative indication of the most influential precursors (xxx: highest influence). Influences indicated by one x are due to feedback mechanisms affecting the level of oxidants, and hence the lifetime of OH radicals, in the atmosphere, which in turn affects the oxidation rate of the precursors.

Pollutant→	SO_2	NO_x	NH_3	O_3	CH_4	SO_4	NO_3	NH_4	BC	POM	SOx	NOy	BC
Precursor↓	gas	gas	gas	gas	gas	pm	pm	pm	pm	pm	dep	dep	dep
SO_2 (g)	xxx	x	xx	x	x	xxx	xx	x x			xxx		
NO_x (g)	x	xxx	xx	xxx	xx	xx	xxx	x x			x	xxx	
NH_3 (g)	x	x	xxx	x	x	xx	xx	x xx			x		
BC (pm)									xxx				xxx
POM (pm)										x xx			
NMVOC (g)	x	x	x	xxx	xx	x	x	x			x		
CO (g)*				xxx	xx								
CH_4 (g)*	x	x	x	xx	xxx	x	x	x			x		

* From HTAP, 2011

The resulting air pollutant concentrations, and their specific spatial distribution, are then further processed into impacts, such as the effect of particulate matter on human health (mortalities, reduction of statistical life expectancy), the impact of O_3 on vegetation and crop damage, the deposition of eutrophying or acidifying components to sensitive ecosystems. Mostly these calculations are based on simple empirical dose-response functions from literature, making use of additional data to be overlaid with the pollutant concentration (or derived metric) in order to properly calculate the exposure (population maps, crops and vegetation maps, sensitive ecosystem maps, etc.).

The available 3D aerosol fields in the 20% emission perturbation runs with TM5-CTM are used to derive the change in global forcing for each of the perturbed emitted precursors. Applying the methodology described by Fuglestvedt et al., 2010, the resulting forcing responses [W/m²]/[kg/yr] are then further used to calculate the global warming potential (GWP) and global temperature potential (GTP) for a set of time horizons H. In this way, a set of climate metrics is obtained which is consistent with the air quality metrics, health and ecosystem impacts calculated from the concentration and deposition fields

TM5-FASST is currently implemented as an interactive Excel application (56x56 SR matrices) and as an IDL (Interactive Data Language) programme (56-to-1°x1° grid SR matrices).

The available 3D aerosol fields in the 20% emission perturbation runs with TM5-CTM are used to derive the change in global forcing for each of the perturbed emitted precursors. Applying the methodology described by Fuglestvedt et al., 2010, the resulting forcing responses [W/m²]/[kg/yr] are then further used to calculate the global warming potential (GWP) and global temperature potential (GTP) for a set of time horizons H. In this way, a set of climate metrics is obtained which is consistent with the air quality metrics, health and ecosystem impacts calculated from the concentration and deposition fields.

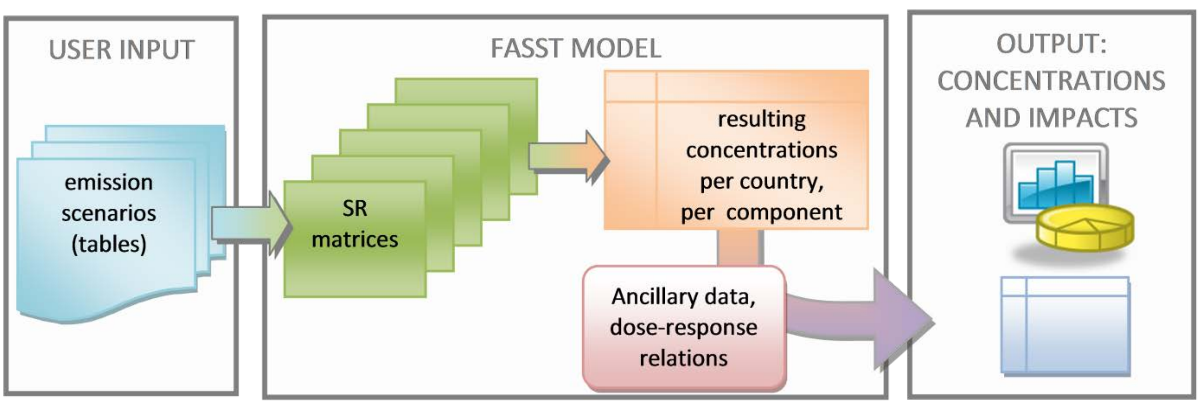

Figure 6-1 Overview of the major components in the TM5-FASST tool. The traditional process-modeling is replaced by simple matrix calculations.

The pollutant emissions determined by each of the IAMs for their native regions were re-distributed according to the TM5-FASST regions and used as input to determine concentration maps and impacts on health and vegetation (not discussed in this study). This was achieved by using available sector-specific 1°x1° gridded emission inventories from previous assessments (GEA, 2011) to derive the relative contribution of each country to the emission of each IAM native region, which leads to an estimated disaggregation of IAM regional emissions to country level, after which the country emissions are aggregated to 56 TM5 source regions, needed for the application of SRC. By aggregating the final concentration and population exposure results again at the level of the 5 IAM regions, errors in the emission redistribution between individual countries are deemed to be largely cancelled out. This procedure was done for each scenario and for the years 2030 and 2050. The PM2.5 values were then aggregated into 10 global regions and for each model and different years it was possible to determine the changes across scenarios to evaluate the effectiveness and co-benefits of policy implementation.

7. Additional Results

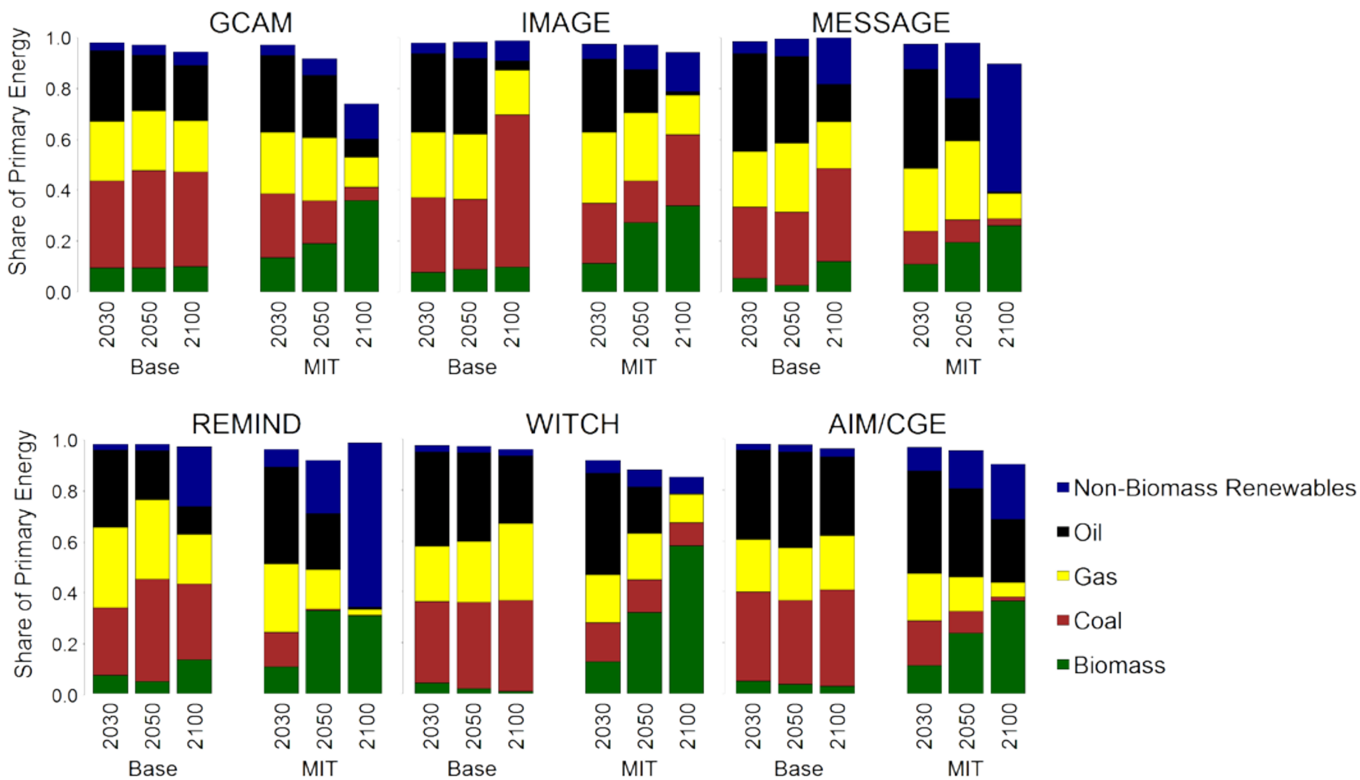

Figure 7-1:: Primary Energy by Sector across IAMs

Figure 7-2: Emissions of CO, VOC and OC

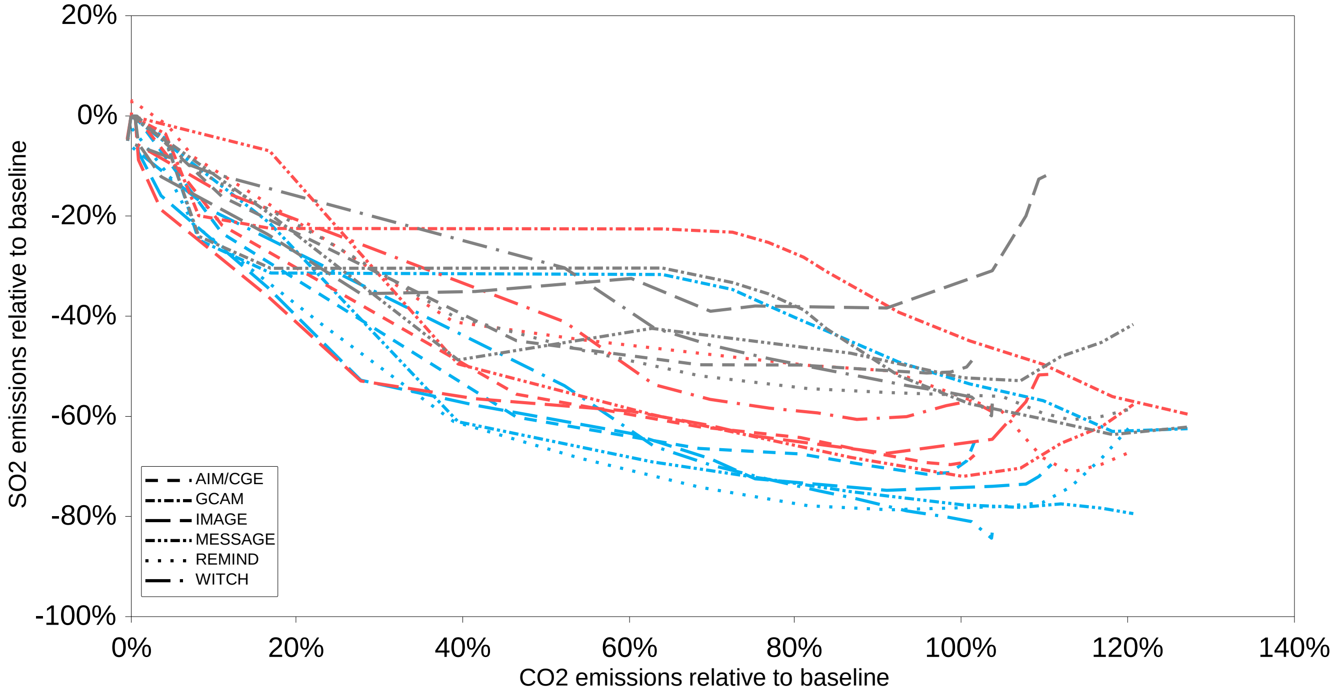

Figure 7-3: Cumulative Reductions in MIT scenarios CO_2 and air pollutants (2010-2050)

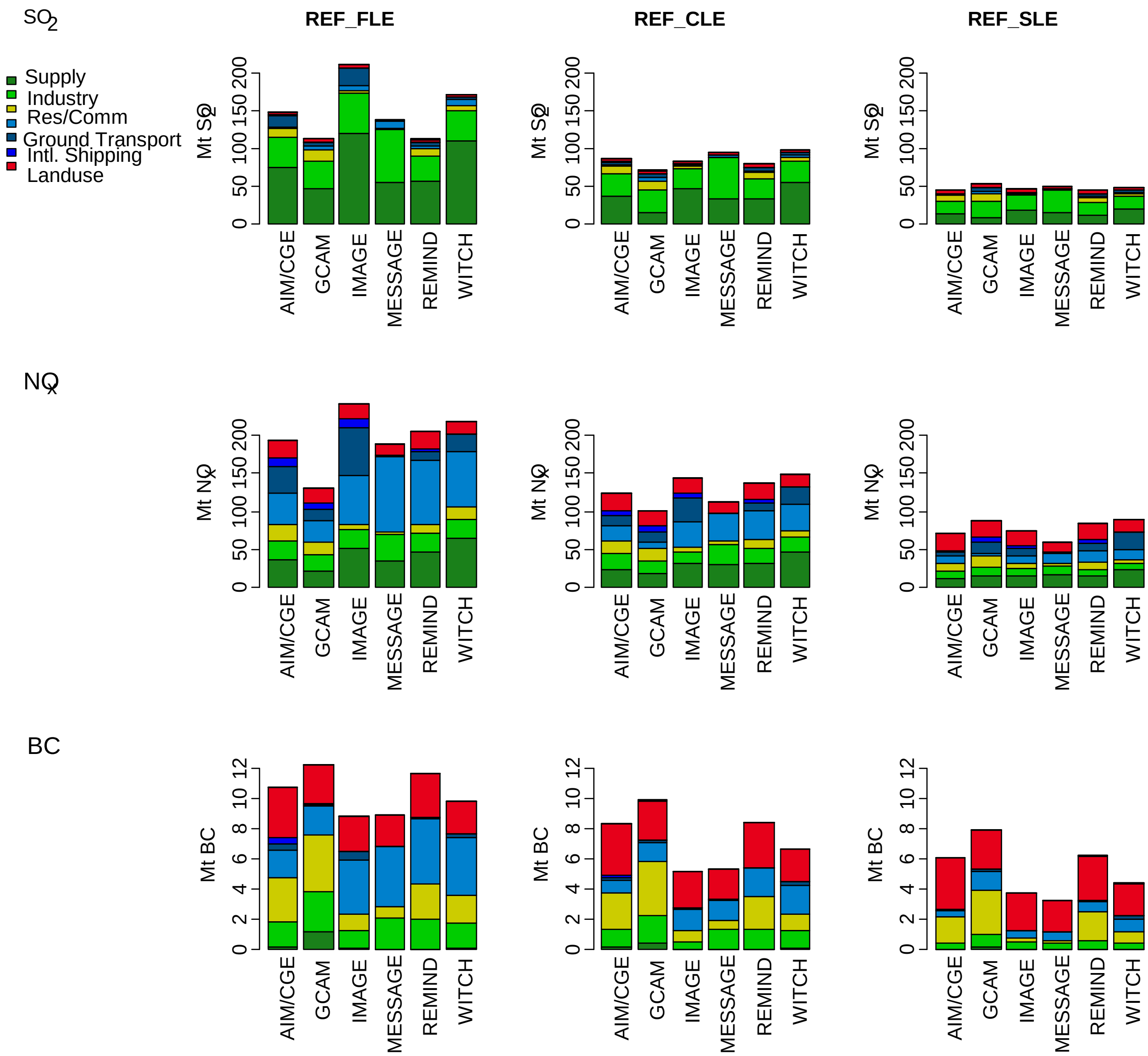

Figure 7-4: Emissions by sector, REF scenario (above), MIT scenario (below)

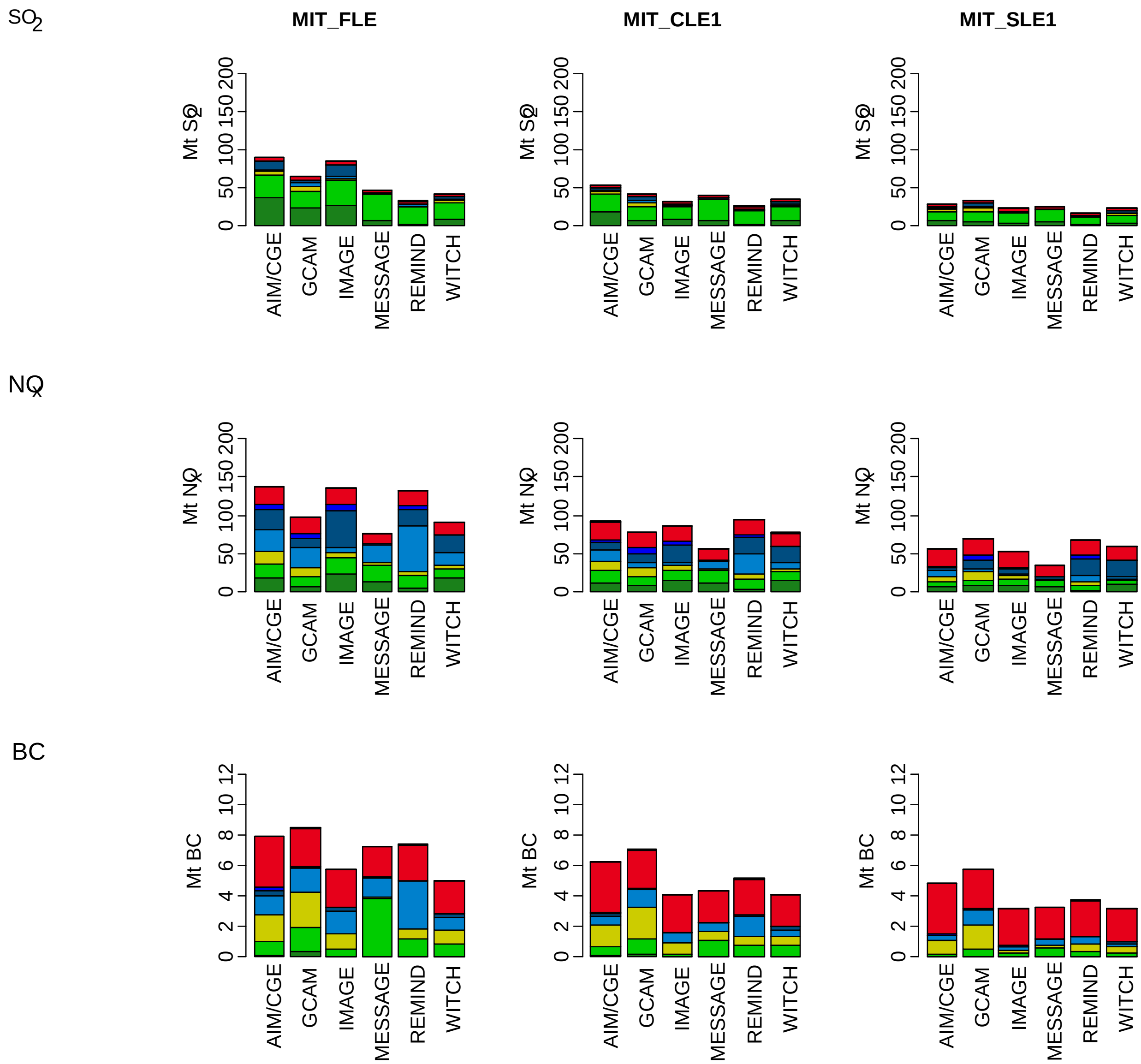
SO2
NOx
BC
MIT_FLE
MIT_CLE1
MIT_SLE1
Mt SO2
Mt NOx
Mt BC
0
50
100
150
200
0
2
4
6
8
10
12
AIM/CGE
GCAM
IMAGE
MESSAGE
REMIND
WITCH

Table 7-1: Regional population-weighted change in man-made PM2.5 (μg/m³) in 2050 relative to 2010 for 4 scenarios, obtained with the TM5-FASST model. Mean and standard deviation resulting from input emissions provided by 6 IAMs.

	REF CLE2050-2010		REF SLE2050-2010		MIT CLE2050-2010		MIT SLE2050-2010	
	mean	σ	mean	σ	mean	σ	mean	σ
NAM	-2.4	0.8	-3.1	0.7	-3.1	0.9	-3.5	0.8
EUR	-4.2	1.0	-5.0	0.8	-5.3	0.9	-5.8	0.7
CHINA+	-6.0	4.0	-13.5	3.6	-13.8	3.7	-17.5	3.4
INDIA	11.9	4.7	-6.2	4.0	-5.0	6.6	-12.9	5.2
REST_ASIA	-2.0	1.2	-4.1	1.1	-4.3	1.3	-5.3	1.0
AFRICA	0.3	1.3	-1.3	1.5	-1.5	1.5	-2.3	1.4
LATIN_AM	-1.1	1.6	-1.8	1.8	-2.3	1.2	-2.7	1.1
MIDDLE_EAST	-0.3	1.9	-3.3	1.8	-3.1	2.5	-4.7	2.2
PAC_OECD	-3.1	1.3	-3.9	1.1	-3.8	1.7	-4.2	1.6
REF_ECON	-2.2	1.2	-3.9	0.7	-4.0	0.9	-4.8	0.8

8. References

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3. Amann, M., et al., *Cost-effective control of air quality and greenhouse gases in Europe: modeling and policy applications.* Environmental Modelling and Software, 2011. **26**(12): p. 1489–1501.
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