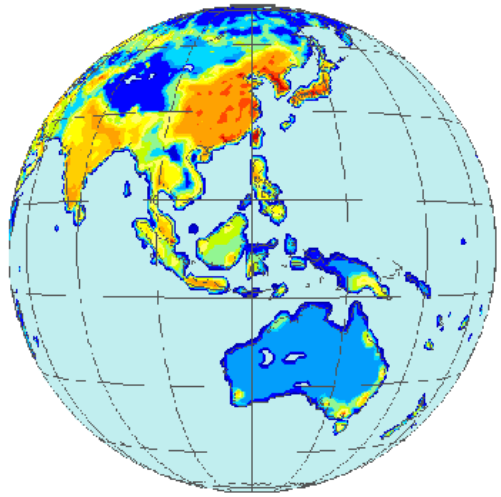
Model for Future Scenario Development



Toshihiko MASUI

National Institute for Environmental Studies

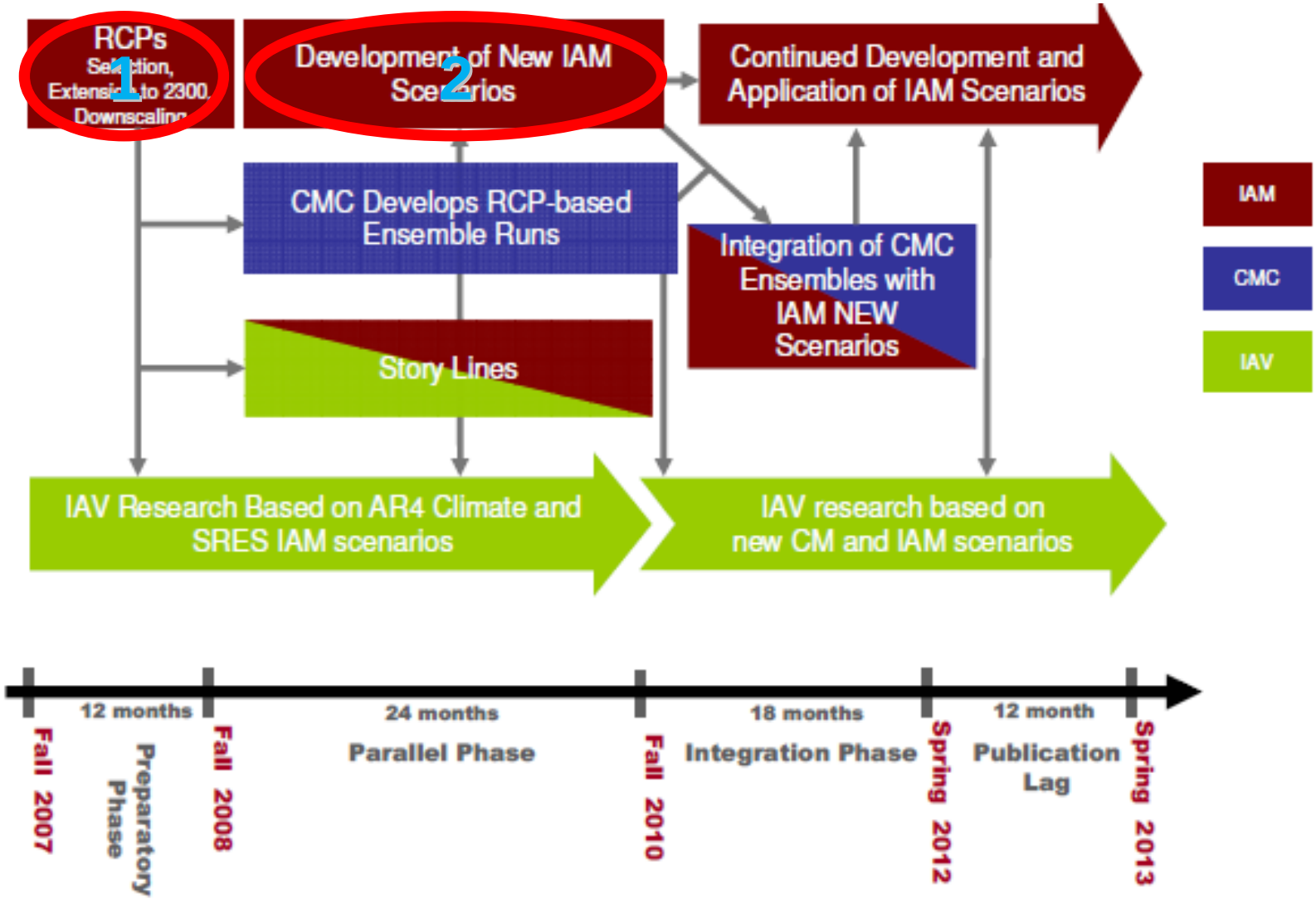
The 13th AIM Workshop

Ohyama Memorial Hall, NIES

16-18 February 2008

This presentation is supported by Dr. Kainuma, Dr. Hijioka, Dr. Kinoshita, Dr. Nozawa, Dr. Ishiwatari, Ms. Nishimoto, and Prof. Matsuoka.

Schedule of IPCC new scenario development



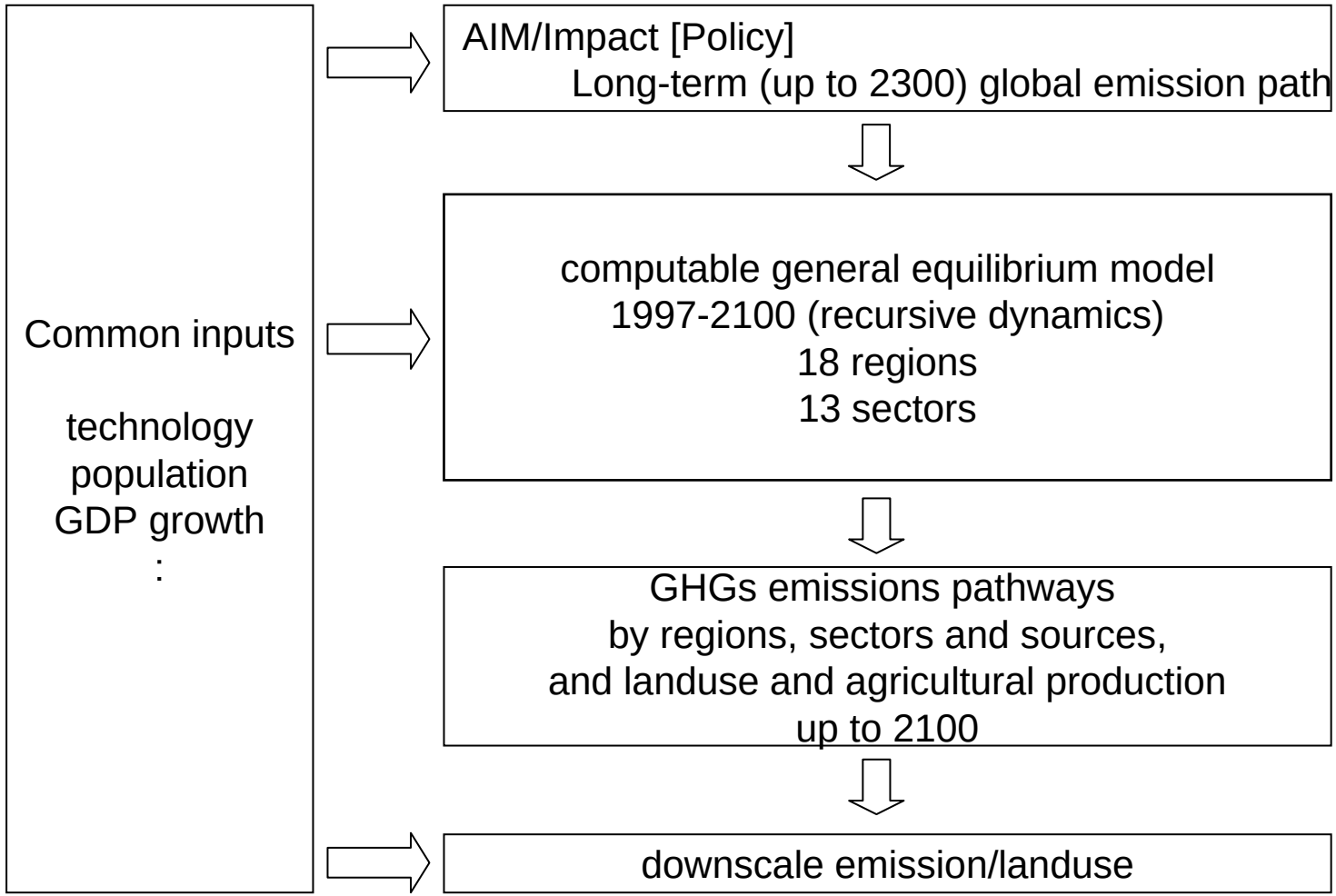
IAV: Impact, Adaptation and Vulnerability, IAM: Integrated Assessment Modeling

1. RCP (Representative Concentration Pathway)

- Results will be input to the climate models.
- Emissions up to 2300 following 2.9 (or 2.6), 4.5, 6 and 8.5 W/m2 will be estimated.

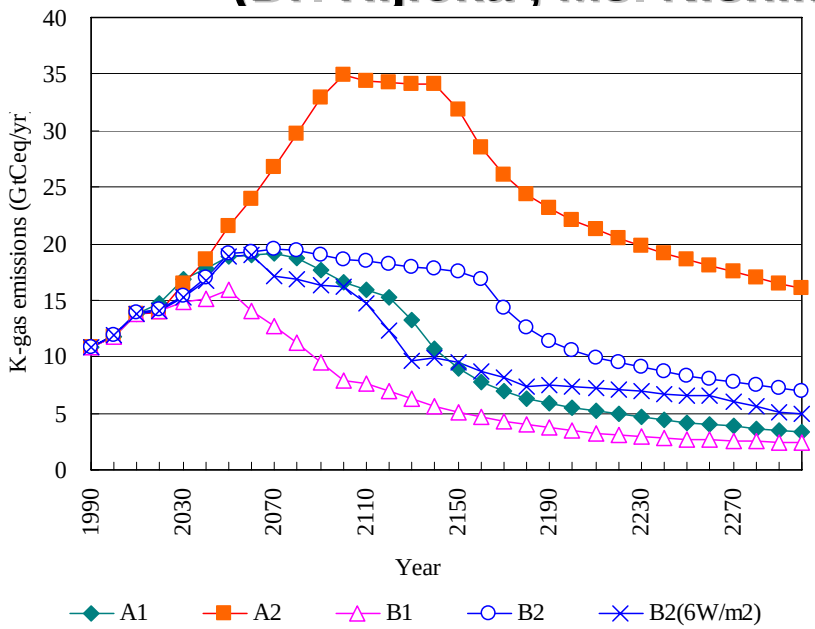
Variable	Units	Spatial scale	
Greenhouse gases		Concentrations	Emissions
CO_2 (fossil fuel, industrial, land-use change)	ppm and Pg/yr	Global average	Sum
CH_4	ppb and Tg/yr	Global average	$\leq 1^\circ$ x 1°
N_2O	ppb and Tg/yr	Global average	$\leq 1^\circ$ x 1°
HFC's	ppb and Tg/yr	Global average	Sum
PFC's	ppb and Tg/yr	Global average	Sum
CFC's	ppb and Tg/yr	Global average	Sum
SF_6	ppb and Tg/yr	Global average	Sum
*Aerosols**			
Sulfur (SO_2)	Tg/yr	Generated by ESM	$\leq 1^\circ$ x 1°
Black Carbon (BC)	Tg/yr	Generated by ESM	$\leq 1^\circ$ x 1°
Organic Carbon (OC)	Tg/yr	Generated by ESM	$\leq 1^\circ$ x 1°
*Chemically active gases**			
CO	Tg/yr	Generated by ESM	$\leq 1^\circ$ x 1°
NO_x	Tg/yr	Generated by ESM	$\leq 1^\circ$ x 1°
VOC's	Tg/yr	Generated by ESM	$\leq 1^\circ$ x 1°
NH_4	Tg/yr	Generated by ESM	$\leq 1^\circ$ x 1°
Land-use & land cover			
CO_2 flux (land-use change)	Tg/yr	n/a	$\leq 1^\circ$ x 1°
Land-use & land cover	Fraction of types	$\leq 1^\circ$ x 1°	

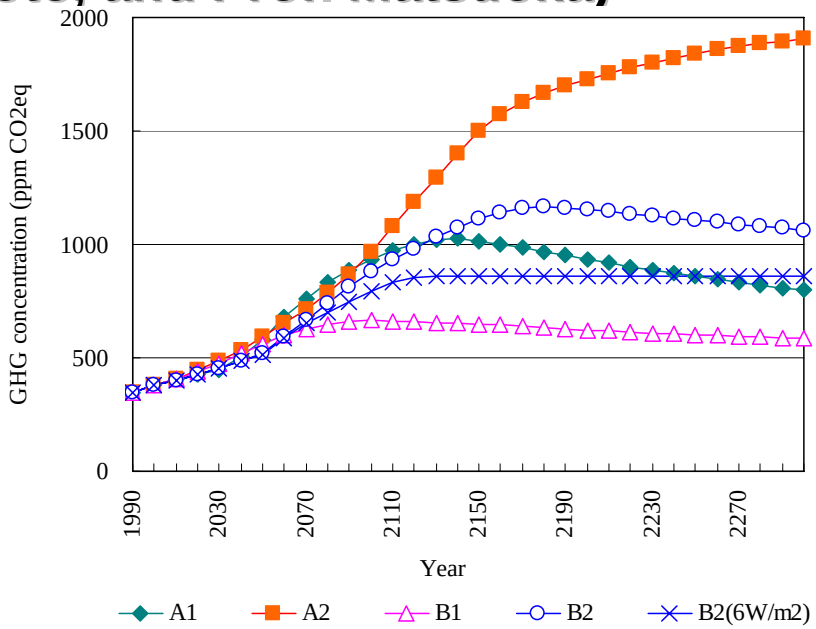
Methodology for RCP

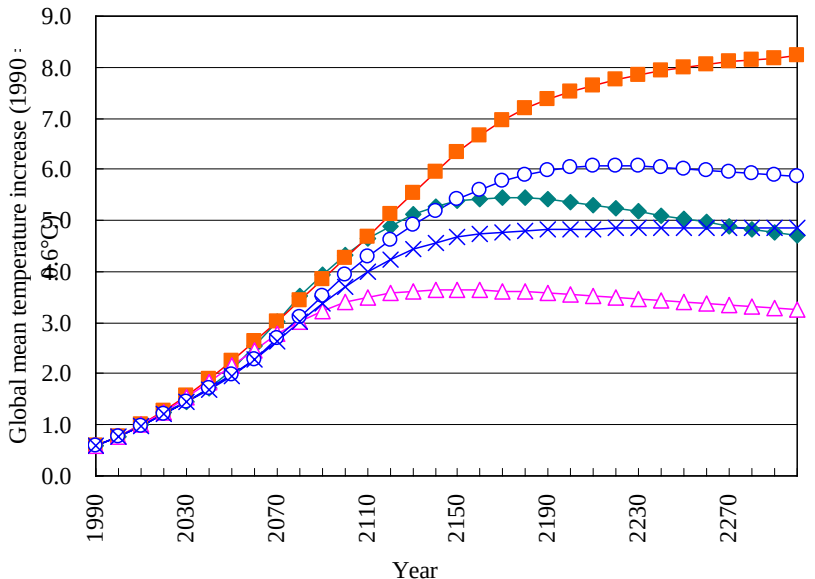


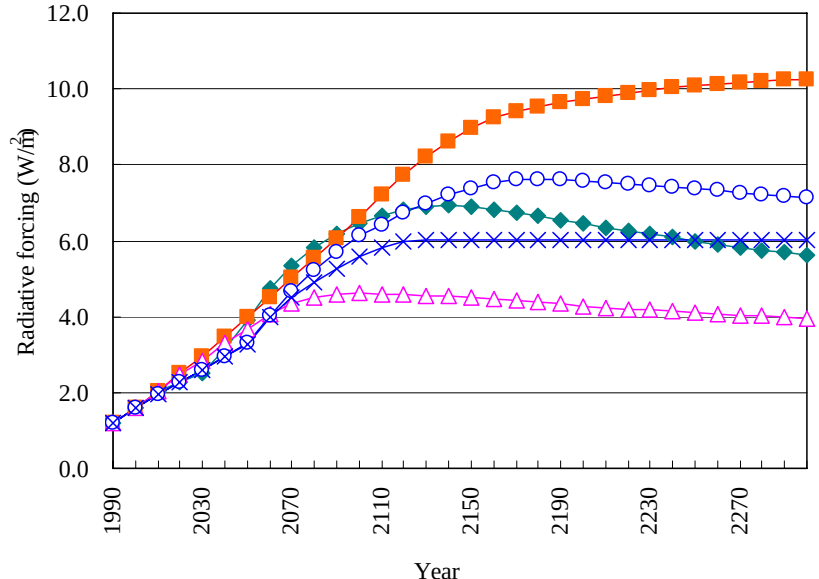
Results from AIM/Impact [Policy]

(Dr. Hijioka , Ms. Nishimoto, and Prof. Matsuoka)









AIM/Ecosystem for RCP

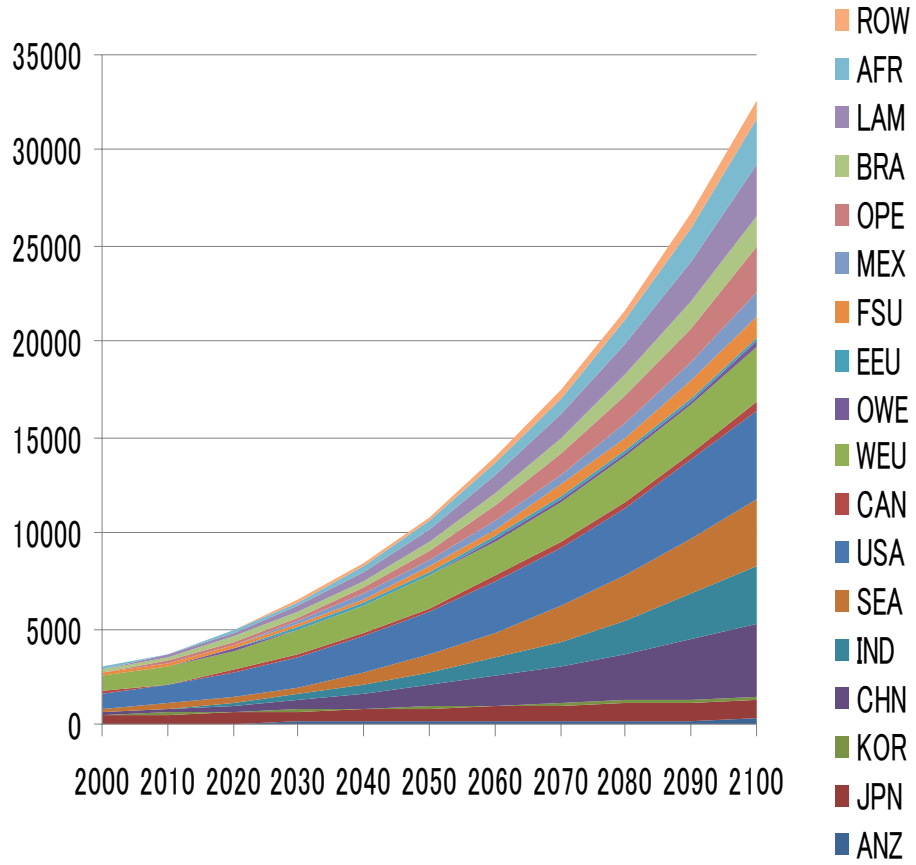
- Global computable general equilibrium model
- 1997-2100 (recursive dynamics)
- Base data: GTAP 5 and IEA energy balance table
- 18 regions
- 13 sectors
- Treated GHGs: CO2, CH4, N2O, HFC*, PFC*, CFC*, SF6*, SOx, BC, OC, CO, NOx, NMVOC, NH3

  *: given as scenario
- Emission sources: fossil fuel combustion and activity
- Simulations: 6W/m2 case

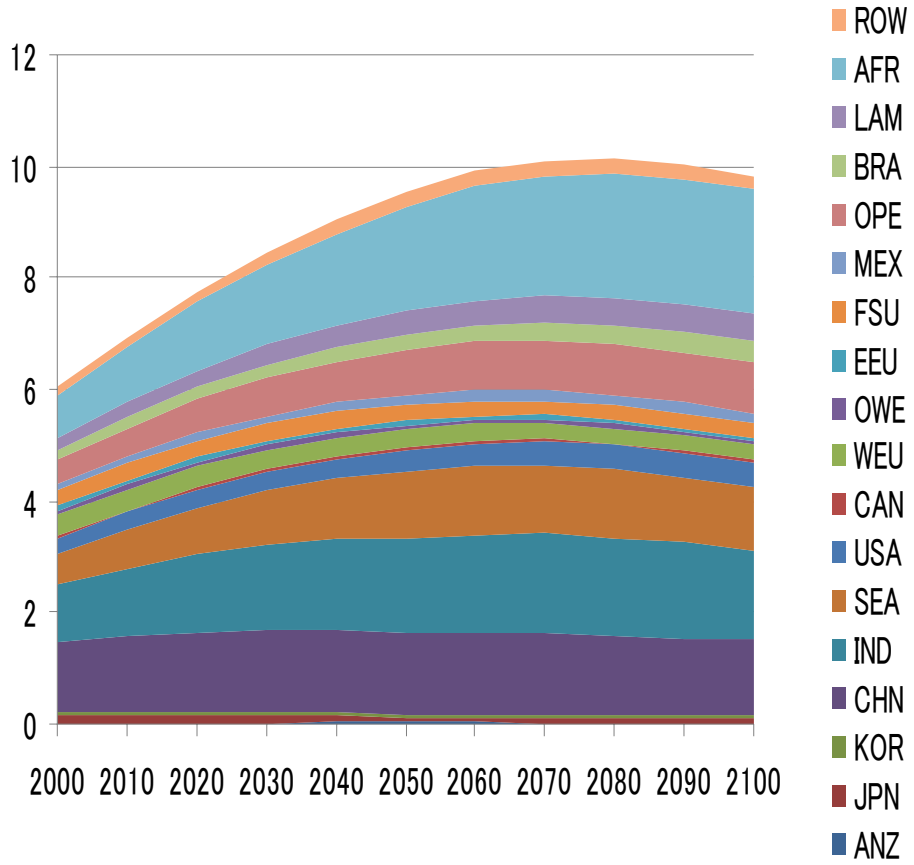
Definition of region and sector

18 regions		13 sectors	
ANZ	Australia/NZ	GAS	Natural gas works
JPN	Japan	ELE	Electricity and heat
KOR	Korea, Rep.	OIL	Refined oil products
CHN	China	COL	Coal transformation
IND	India	CRU	Crude Oil
SEA	South & SE Asia	EII	Energy Intensive Industry
USA	USA	AGR	Agriculture
CAN	Canada	LVK	Livestock
WEU	EU-15	FRS	Forestry
OWE	Other Western Europe	FSH	Fishing
EEU	Eastern Europe	OIN	Other Industry
FSU	FSU	TT	Transport
MEX	Mexico	SER	Service
OPE	OPEC		
BRA	Brazil		
LAM	Latin America		
AFR	Africa		
ROW	Rest of the World		

GDP and population

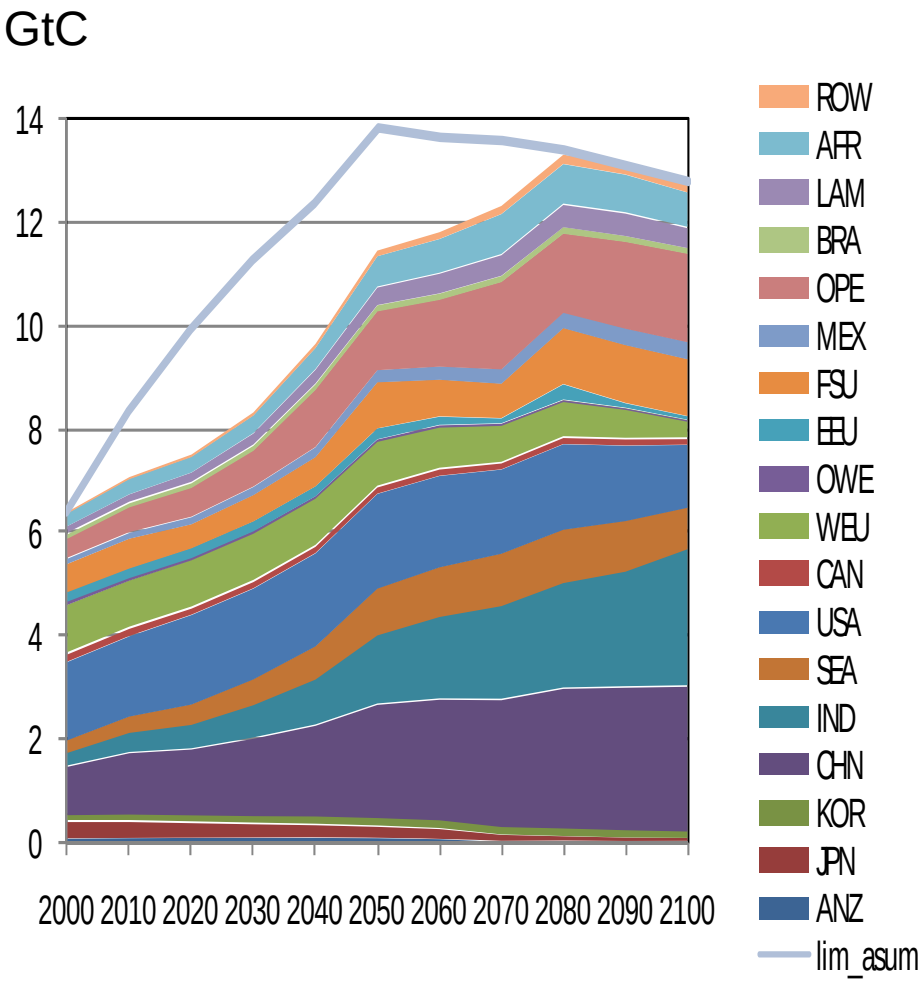


GDP (10 bil. $ at 1997 price)

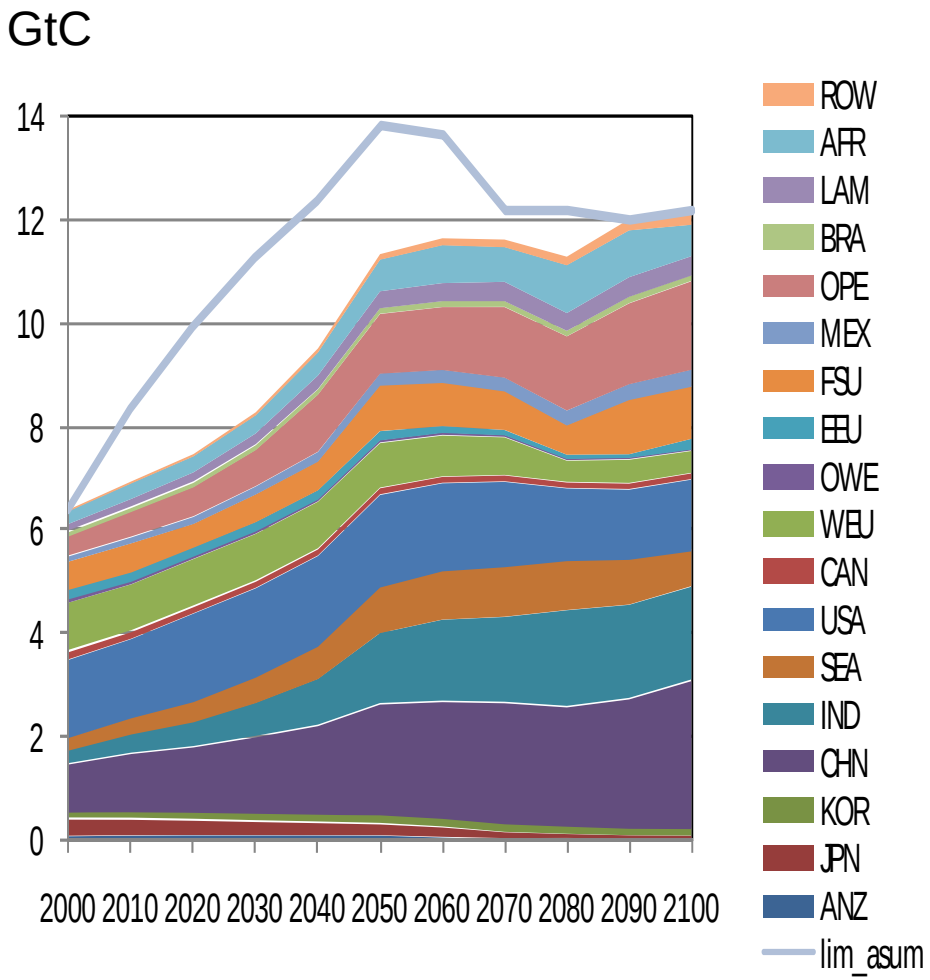


Population (bil. people)

CO2 emissions (excluding natural source)



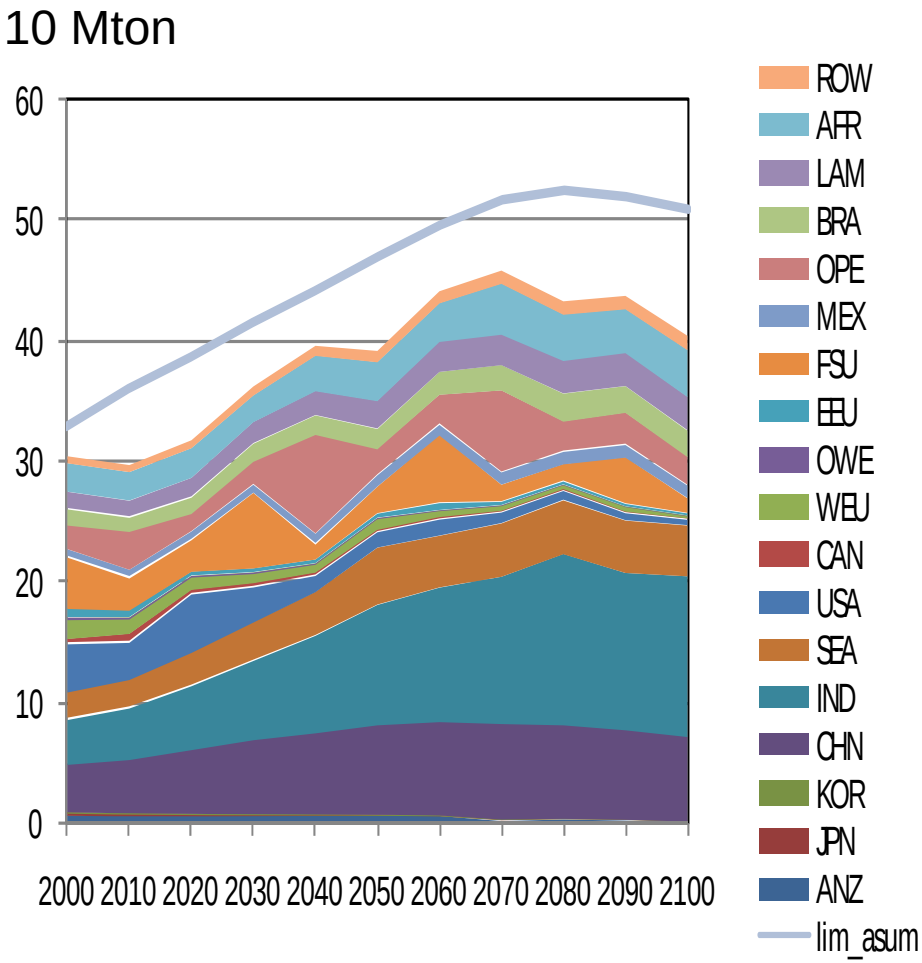
reference



6W/m2

From fossil fuel

CH4 emissions (excluding natural source)



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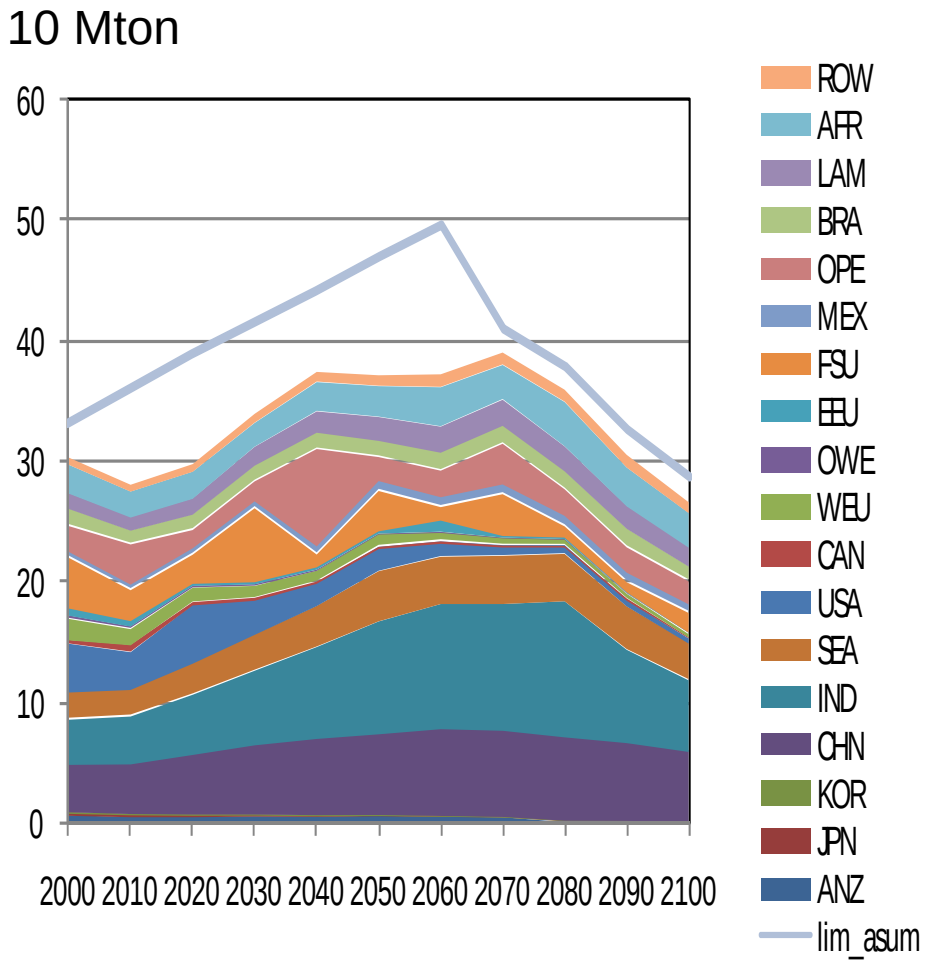
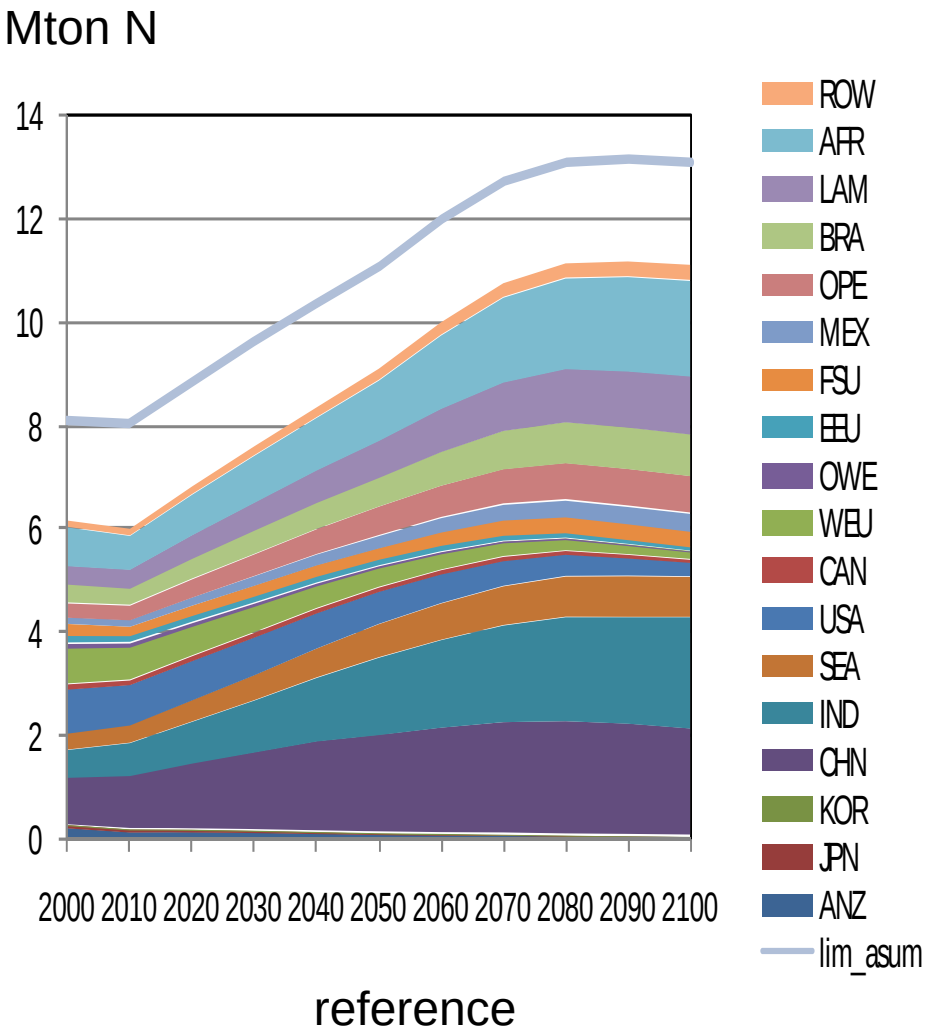
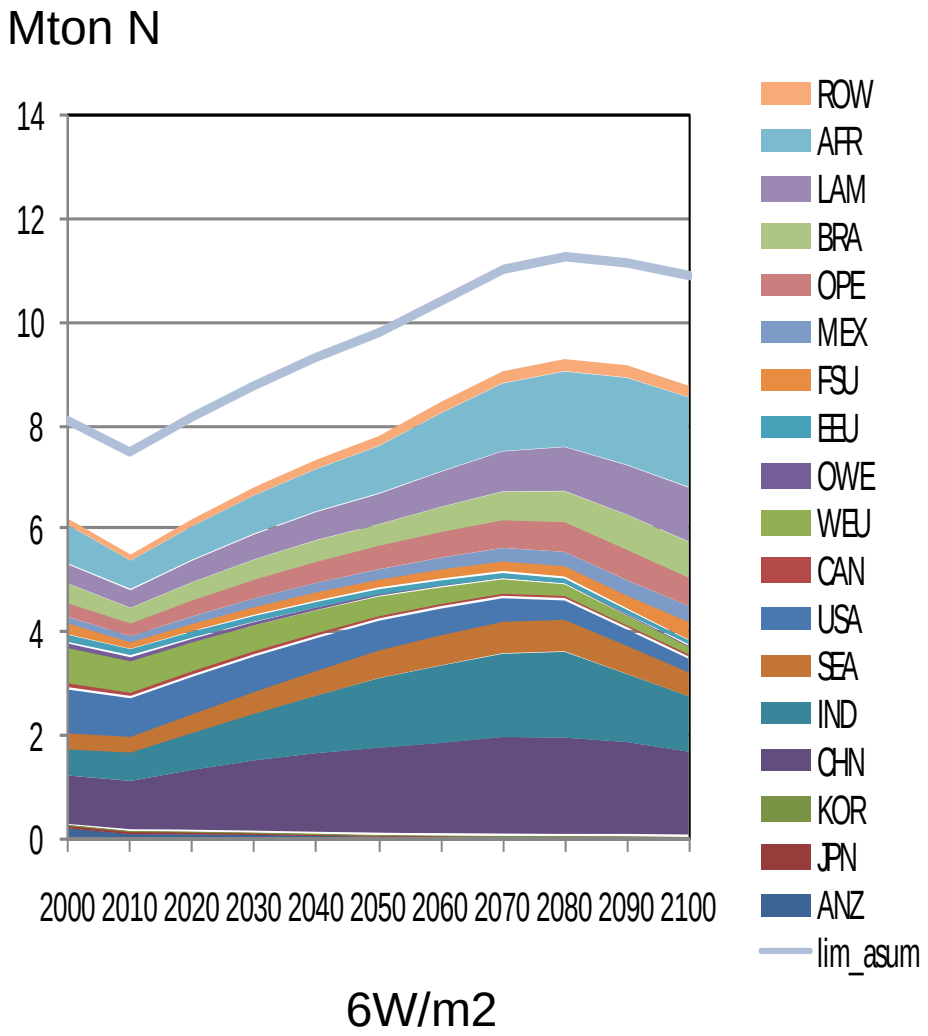


6W/m2

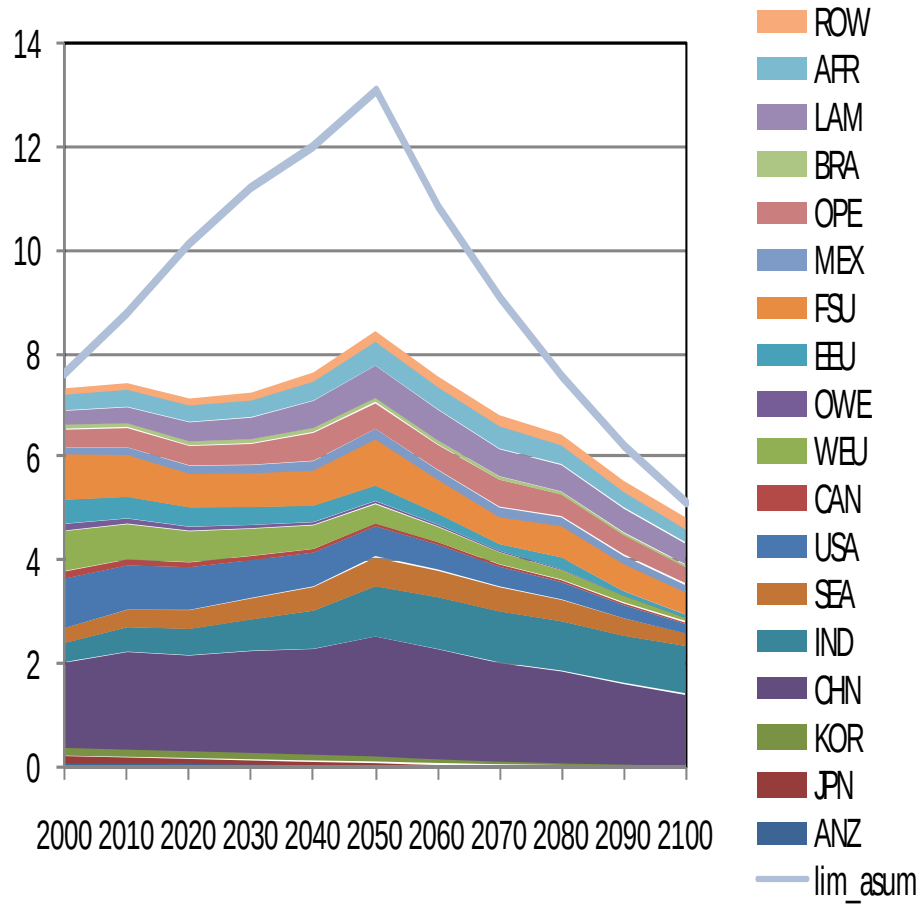
N2O emissions (excluding natural source)





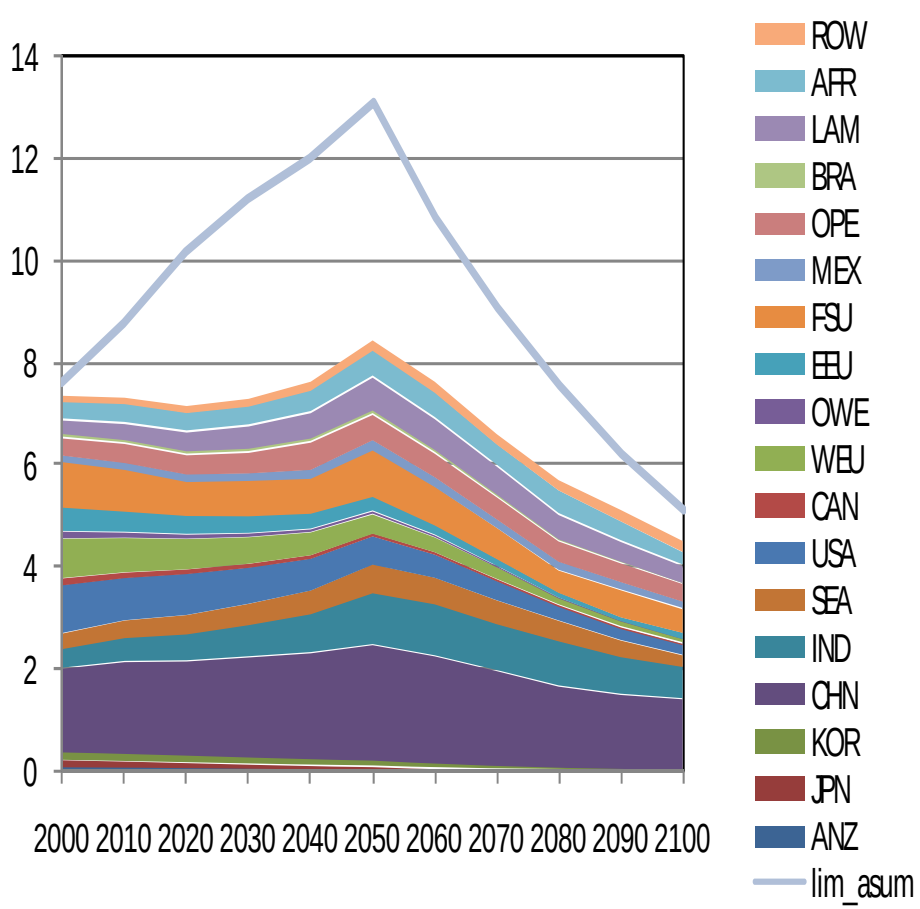
SOx emissions (excluding natural source)

10 Mton S



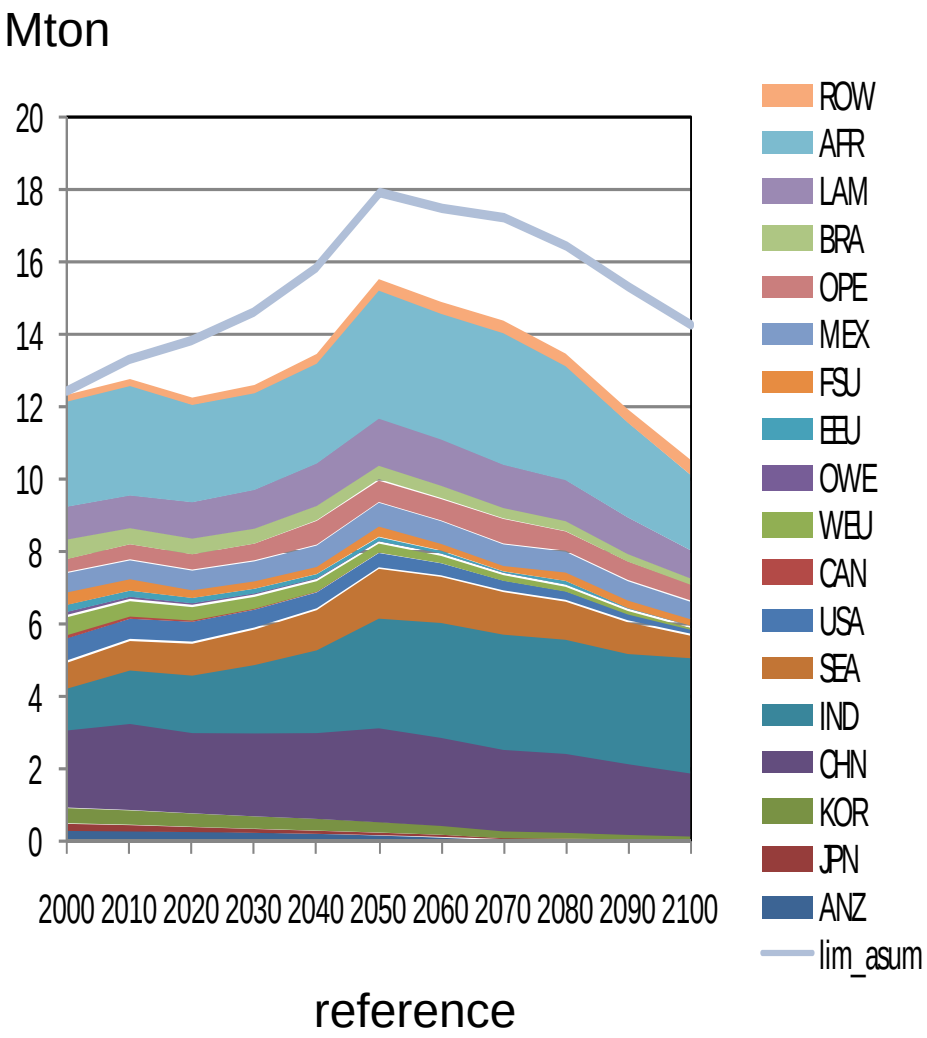
reference

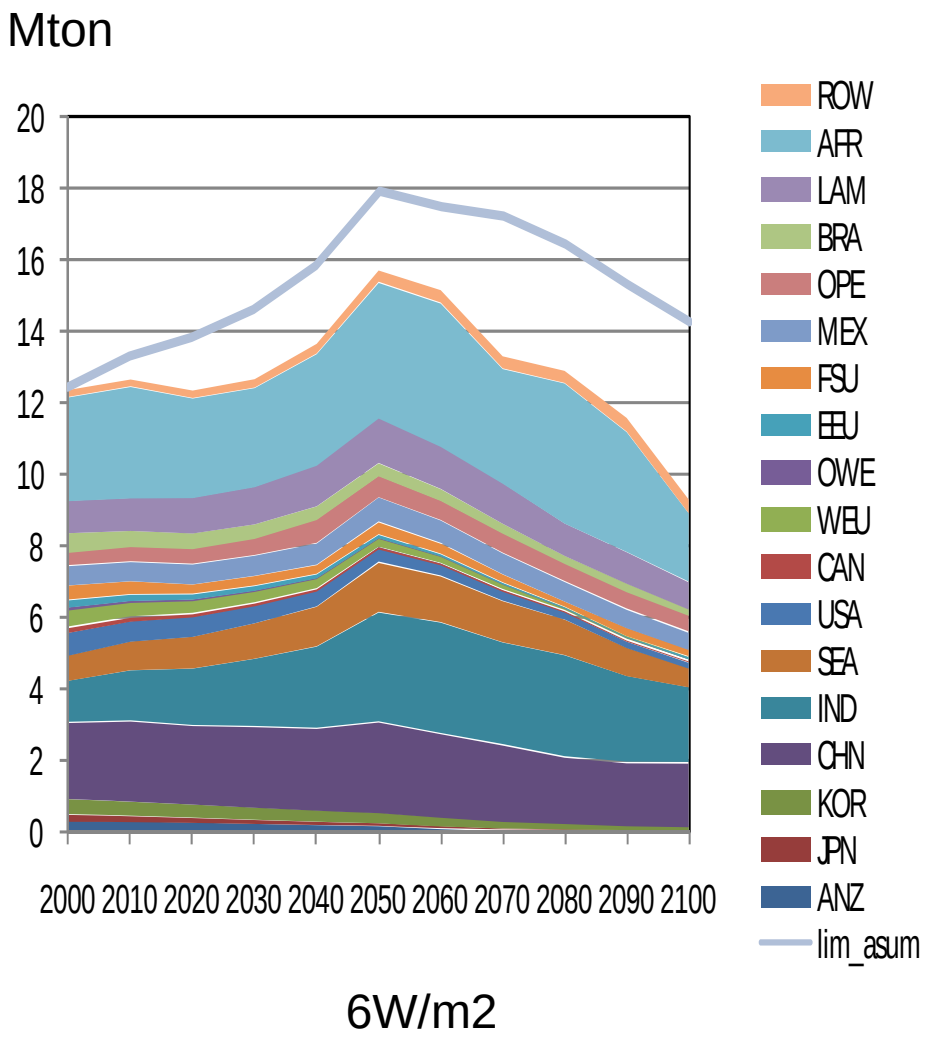
10 Mton S



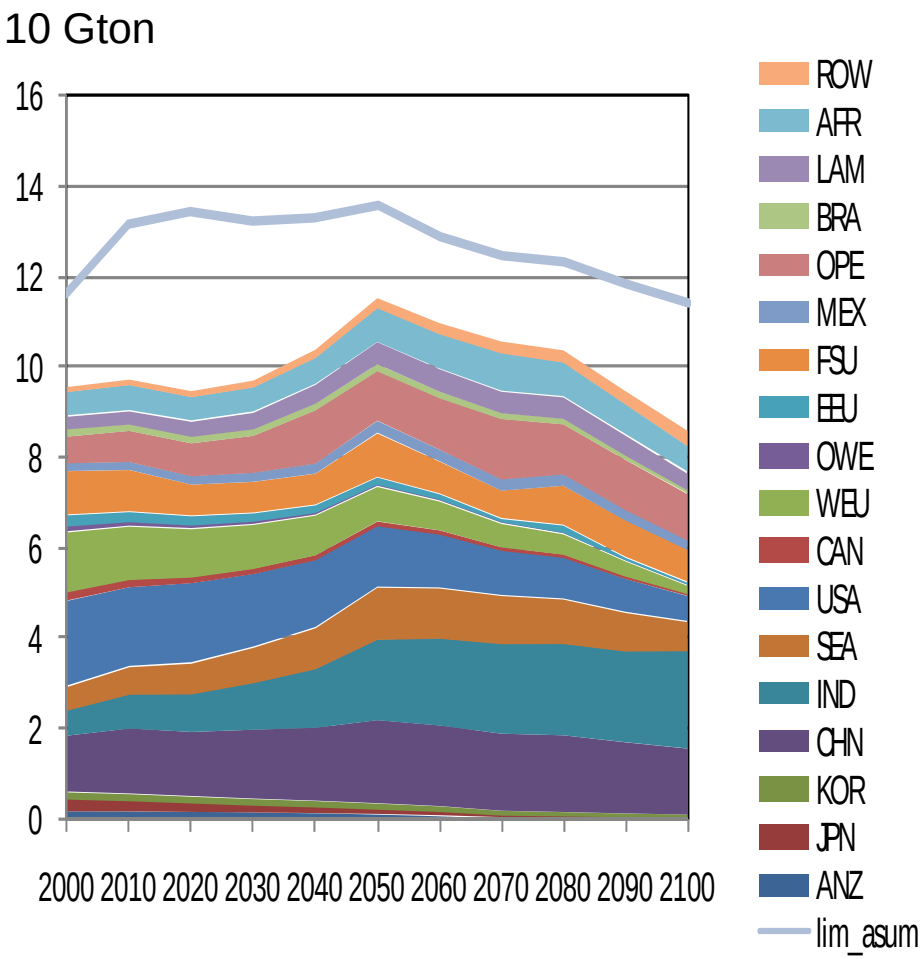
6W/m2

BC emissions





NOx emissions



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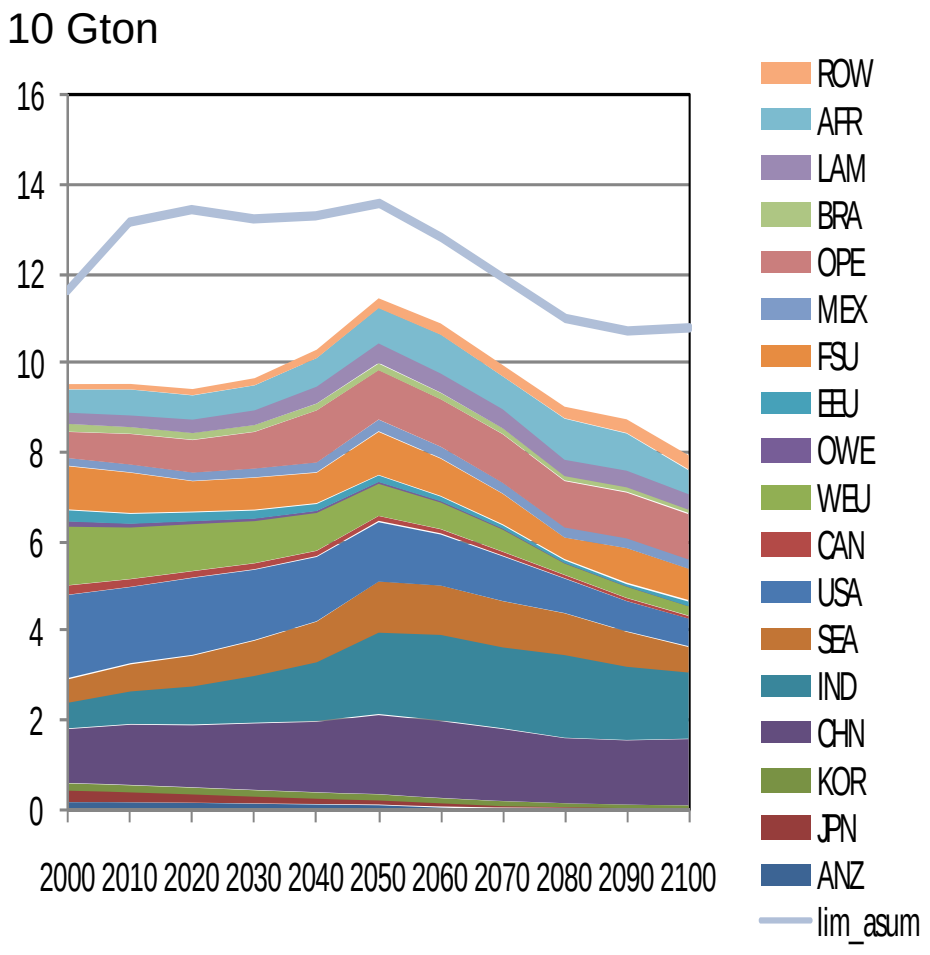
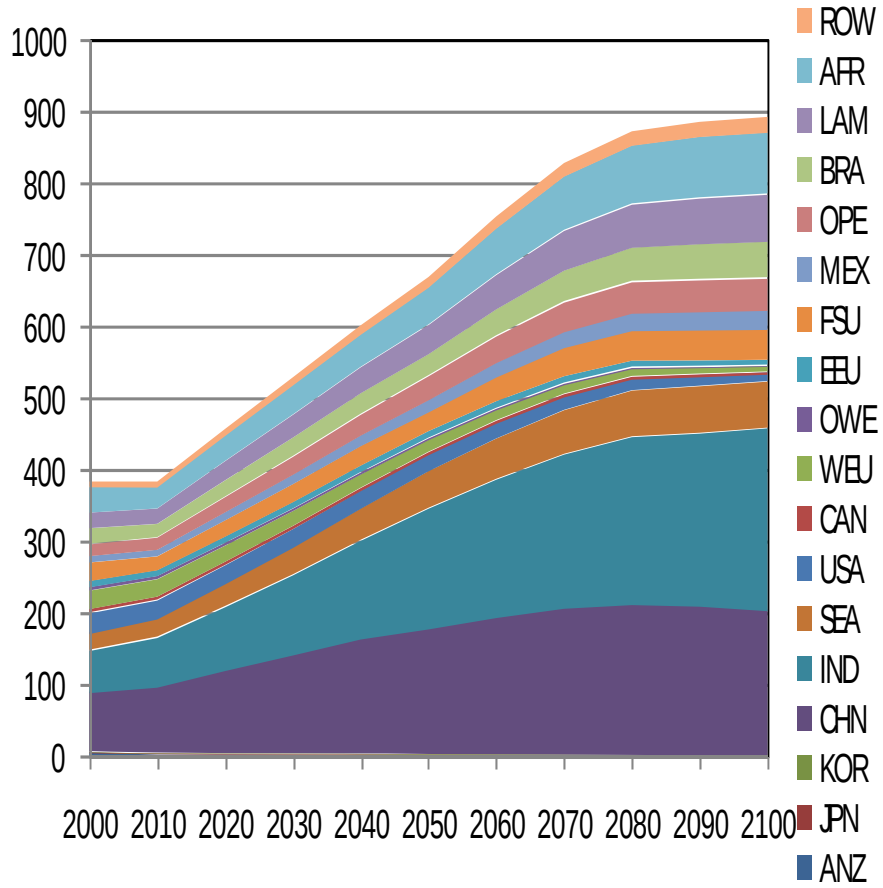


6W/m2

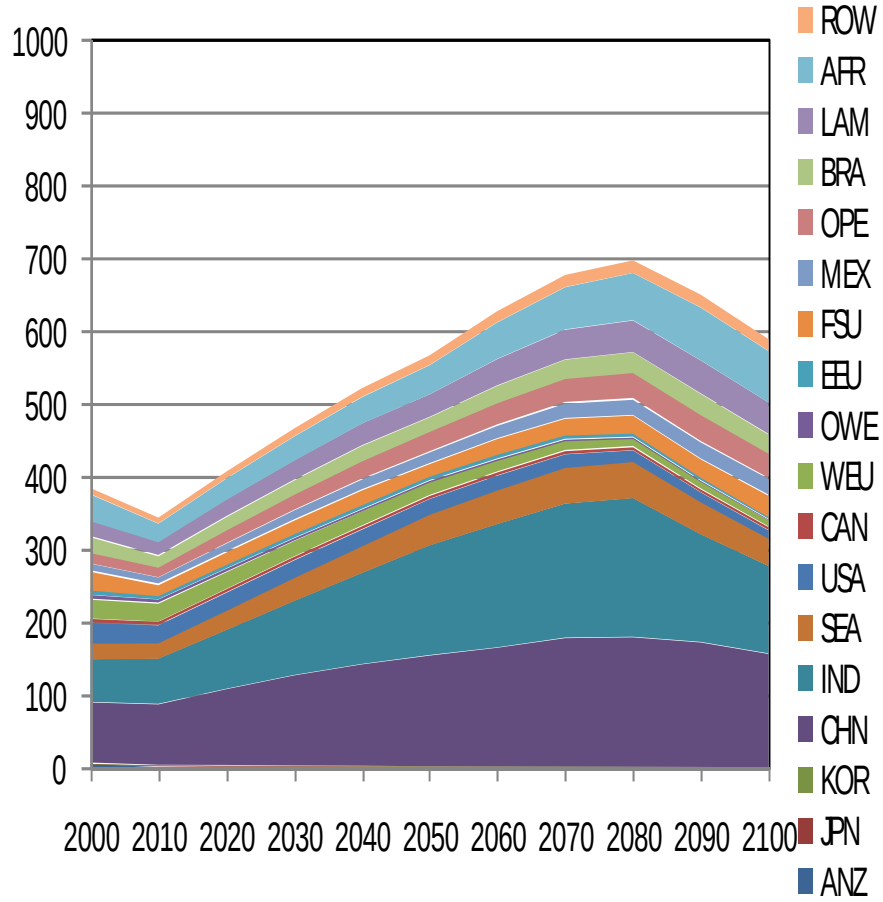
NH3 emissions

100 Gton NH3-N



reference

10 Gton NH3-N

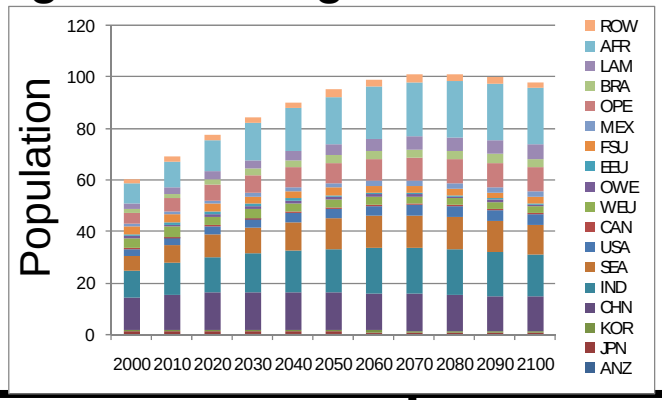


6W/m2

Schematic diagram of downscaling

(Dr. Nozawa and Dr. Ishiwatari)

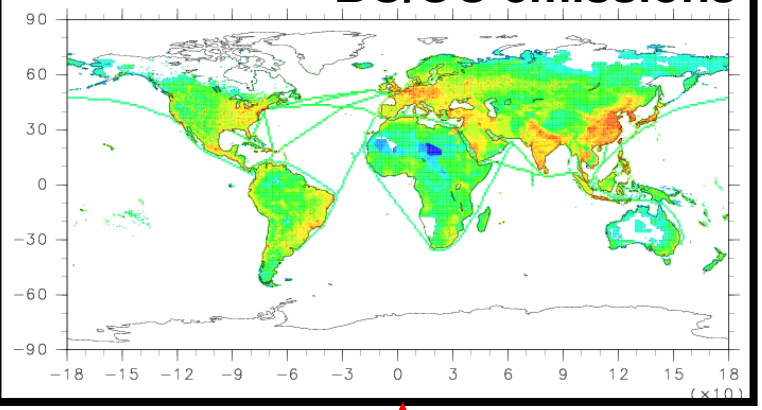
Regional driving forces/AIM outputs



BC/OC Emissions

GDP Population

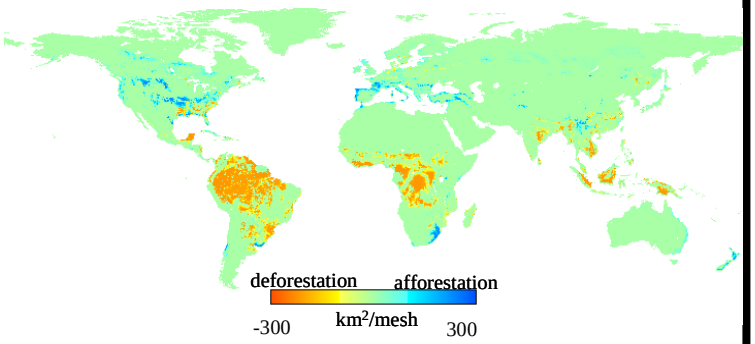
BC/OC emissions



Agricultural Production
Management Cost
Land Use

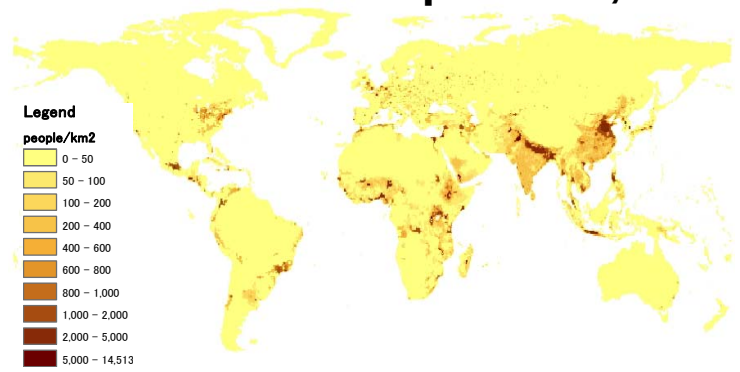
GDP Population

Land use



Land use change

Population, GDP

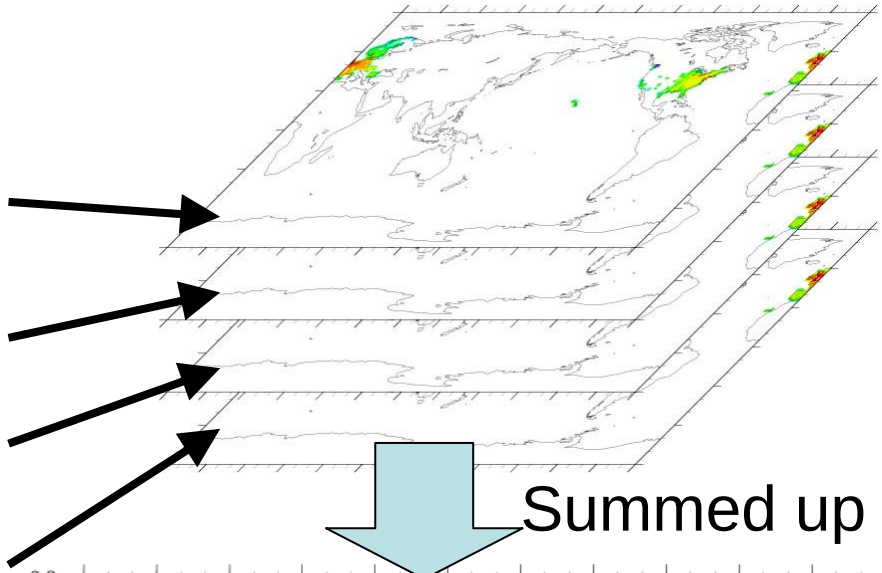


AIM Regional 0.5 arcdeg

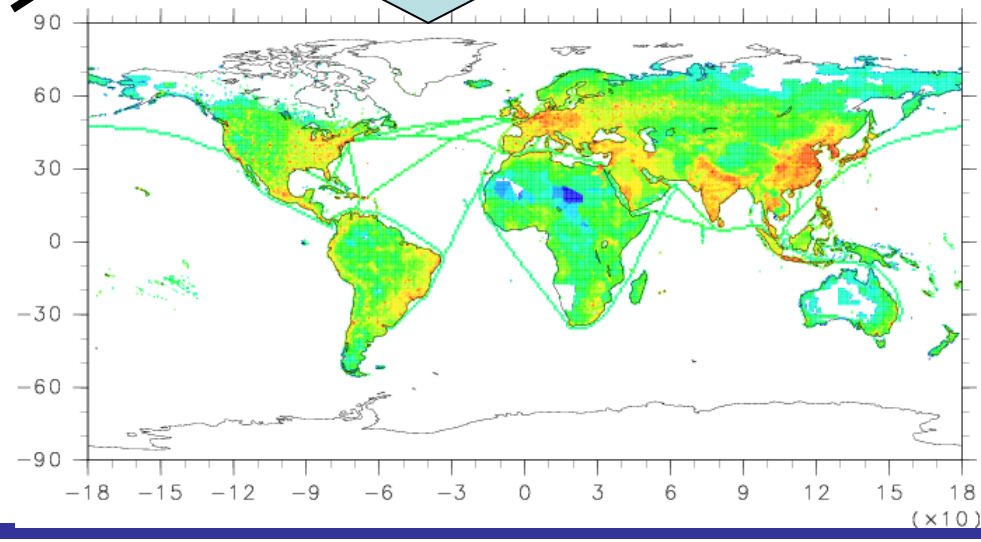
Methods to downscale global scenarios for BC/OC emissions

(Dr. Nozawa and Dr. Ishiwatari)

Sector	Region	Proxy
Electricity and heat	Western Europe	Total population
Electricity and heat	USA	Total population
…	…	…
Agriculture	Western Europe	Rural population
…	…	…



Summed up

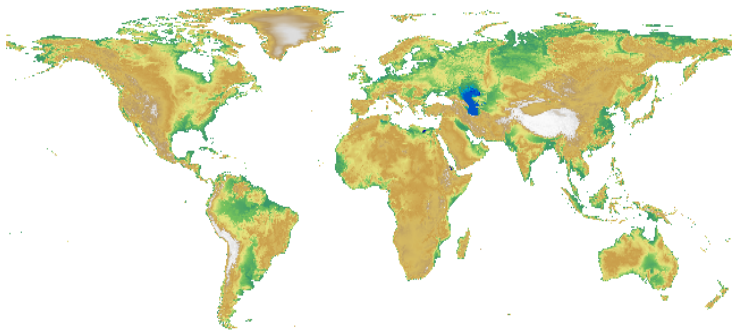


BC/OC emissions are downscaled for each sector and each region using appropriate gridding proxy, and then are summed up.

Downscale of land-use change

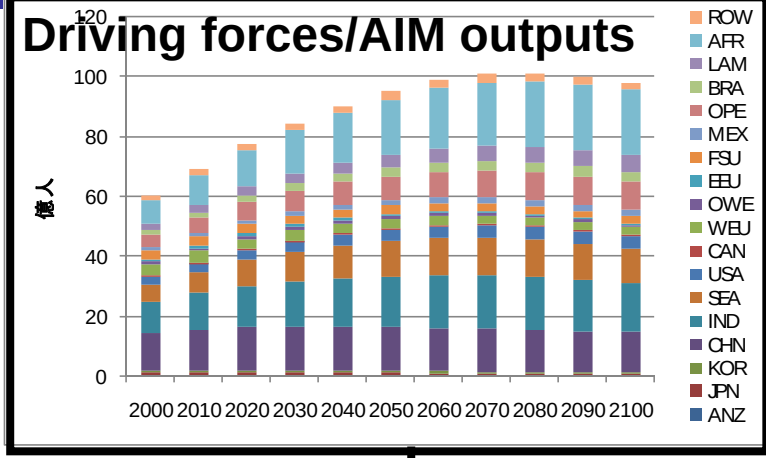
(Dr. Kinoshita)

Geographical data etc.



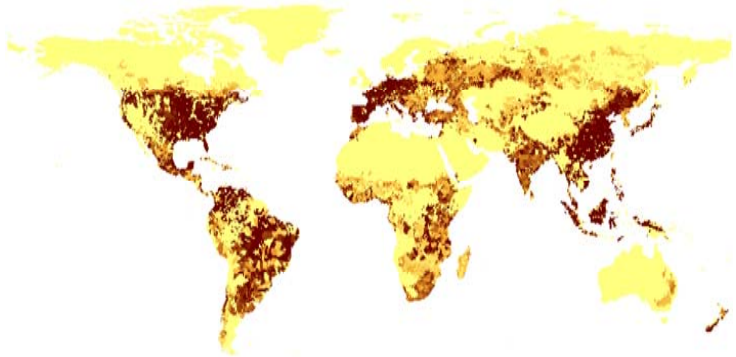
Slope, Elevation
Soil
Meteorological data

Driving forces/AIM outputs



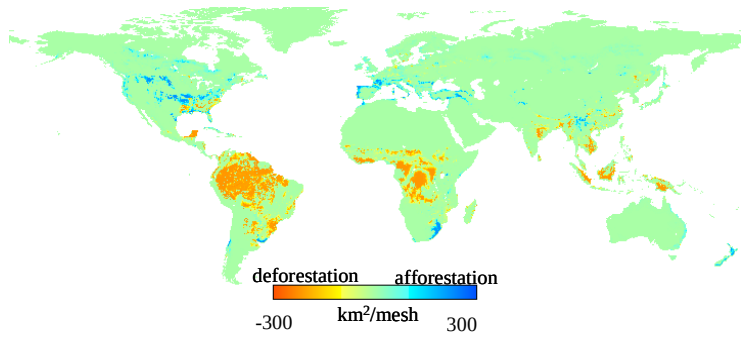
Prices
Land cover change

Productivity (agriculture)



Benefits

Land use



AIM Regional → 0.5 arcdeg

2. IPCC new scenarios proposed by AIM team

- Last November, we had a training workshop on global model.
- Basic structure
  - Computable general equilibrium model
  - Dataset based on GTAP6inGAMS
  - 25 regions and goods
  - Recursive dynamics from 2001 to 2100
- Features
  - Aggregate household & government into one final demand sector
  - Add more energy supply sectors
  - Modify fossil fuel extraction and trade
  - Modify production function
  - Treated GHGs: same as AIM/Ecosystem for RCP
    - CO2, CH4, N2O, HFC*, PFC*, CFC*, SF6*, SOx, BC, OC, CO, NOx, NMVOC, NH3
- Refer to Linkage (WB), EPPA (MIT)
- Still I modify the model, benchmark dataset, future scenario...

Definition of sectors

AGR	agriculture
LVK	livestock
FRS	forestry
FSH	fishing
OMN	mining (except fossil fuels)
EIS	energy intensive products
M_M	metal and machinery
OMF	other manufactures
WTR	water
CNS	construction

TRT	transport
CMN	communication
OSG	public service
SER	other service
COA	coal
OIL	crude oil
P_C	petroleum products
GAS	gas
GDT	gas manufacture distribution
ELY	electricity

Definition of regions

JPN	Japan
CHN	China
KOR	Korea
IDN	India
IND	Indonesia
THA	Thailand
XSE	Other South-east Asia
XSA	Other South Asia
AUS	Australia
NZL	New Zealand
XRA	Rest of Asia-Pacific
CAN	Canada

USA	USA
XE15	EU-15 in Western Europe
XE10	EU-10 in Eastern Europe
RUS	Russia
XRE	Rest of Europe
ARG	Argentine
BRA	Brazil
MEX	Mexico
XLM	Other Latin America
XME	Middle East
ZAF	South Africa
XAF	Other Africa

Discussion during this session

- How to proceed the new scenario development
  - What is different from other groups
  - How to quantify the driving forces
    - population
    - GDP
    - technologies
    - resources
  - Who will quantify the scenarios
    - We need your support!
- How to present the new scenario
  - Each team will propose independently
  - Each team concept will be aggregated into “AIM scenario”